FRONTISPIECE to the ROYAL ENCYCLOPÆDIA.

A GENERAL DISPLAY of the ARTS and SCIENCES.

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THE NEW
ENCYCLOPÆDIA;
OR, MODERN UNIVERSAL
DICTIONARY
OF
ARTS AND SCIENCES,
ON A NEW AND IMPROVED PLAN.

IN WHICH ALL THE RESPECTIVE SCIENCES ARE ARRANGED INTO

COMPLETE SYSTEMS,

THE ARTS DIGESTED INTO

DISTINCT TREATISES,

And Philosophical Subjects introduced in separate Dissertations.

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A GENERAL CIRCLE OF SCIENCE;

AND FORMS THE MOST COMPREHENSIVE

LIBRARY OF UNIVERSAL KNOWLEDGE

THAT WAS EVER PUBLISHED IN THE ENGLISH LANGUAGE.

IN THREE VOLUMES.

BY WILLIAM HENRY HALL, ESQUIRE.

The Third Edition,

Revised, Corrected, and Enlarged, with considerable Additions, Improvements and modern Discoveries,

BY THOMAS AUGUSTUS LLOYD,

Assisted by Gentlemen of Scientific Knowledge.

NON SIBI, SED PATRIÆ. CATO.

VOL. I.

Illustrated with upwards of One Hundred and Fifty large superb Copper-Plates, accurately descriptive of the different Subjects to which they refer.

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TO THE

KING.

SIRE,

PERMIT me to lay before your *Majeſty* thoſe Labours and Efforts, which have been exerted to diſplay the advanced State to which the Arts and Sciences have attained under your *Majeſty's* Influence and Encouragement.

As the Arts and Sciences are at this Period ſo generally cultivated, and ſo liberally encouraged, thoſe who labour to advance them, only in the humble Department of collecting and arranging the Diſcoveries of others, eſſentially conduce to facilitate their Attainment; and, by ſhewing what is already obtained, excite Emulation, and quicken Invention.

There is a Time reſerved in the Fate of every Nation to arrive at its Perfection; and the riſing Genius of Britain bears a promiſing Aſpect of attaining, under your *Majeſty's* Protection, the Summit of Excellence in the Purſuits of *Philoſophy* and *Literature*.

Among the Variety of Literary Productions, there certainly cannot be any better calculated for diſſeminating univerſal Knowledge, or that more deſerves the Countenance and Protection of the Great, than a Work which comprehends the whole Circle of Arts and Sciences. For this Reaſon, as well as your *Majeſty's* known Patronage, and thorough Knowledge of the Polite Arts, the Editor is emboldened to lay this Work at your *Majeſty's* Feet; eſpecially, as Productions which tend to enlarge the Boundaries of Science have a peculiar Claim to the Countenance and Protection of *Monarchs*; for, by the Diffuſion of Science, Man is civilized, the Inlets to Happineſs are opened, and Society is formed on a firm, advantageous, and ſolid Baſis.

The elegant Enjoyments of Life are heightened in Proportion to our Knowledge of thoſe Sciences, which owe their Birth to an Acquaintance with the Powers of Nature and Art, without which, Rank and Fortune would be of little Value. It is the Source of Happineſs, as it extends the Views and enlarges the Comprehenſion, by which Means the Dignity of our Nature is ſupported, and the beſt Foundation laid for the Advancement of intellectual Acquirements.

In the Survey of animated Nature, we ſee that the Protection of the great Creator is extended to the minuteſt Parts of his Creation; Beings, infinitely ſmall, manifeſting to the aſtoniſhed Eye, the ſame Proportion, Regularity, and Deſign, as thoſe of the firſt Magnitude; all of which enjoy their reſpective Comforts, and triumph in the Bounty of the Sovereign of the Univerſe.

The Mind, from a Review of the Beauty and Order in which all Things are formed, and the ſeveral Uſes to which they are appropriated, is led to contemplate the wonderful Effects of Divine Omnipotence, and adore the beneficent Creator in all his Works, which proceed from Wiſdom, and originate in Love.

The Editor has ſelected impartially the Communications of the Learned and Ingenious of every Nation; and feels a peculiar Pleaſure in ſtating thoſe modern Diſcoveries and Improvements, which do equal Honour to his native Country, and the diſtinguiſhed Liberality and Munificence of his Sovereign. Theſe Diſcoveries and Improvements, which owe their Progreſs ſo materially to the Protection of your *Majeſty*, muſt be productive of the moſt happy Tendency; and the Knowledge they communicate muſt diffuſe that permanent Glory which cannot be obtained either by Conqueſt or Dominion.

That your *Majeſty* may long enjoy the exalted Satisfaction of promoting the Arts and Sciences, ſo worthy of your Royal Protection, is the ſincere Wiſh of

Your *Majeſty's* moſt dutiful
And obedient Subject
And Servant,
W. H. HALL.

PREFACE.

THE study of the Arts and Sciences, which is now become the prevailing taste, is, perhaps, one of the great advantages peculiar to the present times. The learned of every nation in Europe now form one literary republic, and all unite their endeavours to promote the same useful end of improving the various branches of science; being all animated with the same noble emulation of advancing them still nearer to perfection.

Our natural powers are capable of culture and refinement to a very high degree; and the proper exertion and application of our faculties are not only conducive, but absolutely essential, to our happiness, whether considered as individuals or social beings. Every attempt, therefore, to enlarge our views, to improve our talents, to direct our efforts, and to form our nature for intellectual enjoyments, must ever be considered as a matter of the highest importance.

Amongst the wealth of literature, there are not any productions which so effectually tend to the advancement of *general* knowledge as a Dictionary of Arts and Sciences, wherein every article, of which the whole system of nature consists, is depicted in all its different colours. It records and transmits to future ages, many inventions and improvements, which might otherwise have sunk into oblivion; it forms a compendious history of science; it furnishes the outlines of its gradual progress and advancement; and, by preserving a summary of what has been already explored, it lays a farther foundation for more extensive discoveries and improvements. In this latter view of its use and importance, it may not be improperly compared to a map of science, in which the line that terminates the *terra cognita* is distinctly marked out for the direction of those whose ingenuity and industry are exerted in extending the circle of knowledge, and in exploring those regions that are yet unknown.

In estimating the importance and utility of a Scientific Dictionary, it is a matter of no small consideration, that it supplies, in a great measure, the want of a large library, by furnishing the inquisitive and curious with a fund of knowledge dispersed in many volumes, and in many different languages, which cannot be procured without difficulty, and considerable expence; it being the custom of almost every nation to lay their various labours before the public in their own language. This renders it necessary for all those who desire to be thoroughly acquainted with the improvements of the learned and ingenious in different parts of Europe, to load their memories with several different languages; but this is a task too laborious, and requires too much time, to be attempted by the far greater part of those who are desirous of being thoroughly acquainted with the arts and sciences of Europe in their present state of perfection: therefore, as this Work contains translations from the best authors, not only of the newest discoveries and improvements, but of those less novel, though equally interesting, it obviates the arduous task of acquiring a knowledge of several languages, to render us acquainted with the state of the sciences in other nations.

A work of this kind, from its extent and arrangement, is suited to the occasions and convenience of the generality of readers, who have neither leisure or opportunity to recur to those different sources of information, whence the materials which compose this Work are collected and compiled. It is admirably adapted to the nature and necessary limits of a popular work; designed not only for public libraries, or for the use of those who spare no expence in obtaining the best means of information, but for disseminating literature and science throughout the subordinate classes of mankind. With this view we have adopted the happy medium between a work consisting merely of definitions, etymologies, and references, and a voluminous collection of diffuse and elaborate treatises, which, from their price, would be restricted to few purchasers, and, and from their prolixity, would be too tedious to be consulted. A reduction of the vast bulk of science into a lesser compass, by selecting all that is essential, and rejecting all that is superfluous, is therefore of no small advantage to all those concerned in the acquisition of universal knowledge. By means of this Work, a fund of knowledge becomes attainable on easy terms, adapted to those whose avocations do not admit of devoting much time to the study of extensive and elaborate subjects; as also to the man of pleasure, who usually appropriates so small a portion of his time to the pursuit of knowledge. It is no less advantageous to men of letters, whatever branch of science they devote themselves to; since polymathy, or a general acquaintance with the sciences, is indispensibly requisite to arrive at excellence in any one of them, by reason of that near connection subsisting between the several departments, and the mutual lights they afford each other.

The deviation made from the plan of Chambers, and others, by introducing detached Systems on the Sciences, Treatises on the Arts, and Dissertations on Philosophical Subjects, it is hoped will meet with the approbation of the reader; and, in order to exhibit these important branches of knowledge in their full extent and lustre, we have re-united all the detached parts, that their proportions, their relations one to another, and to the general system, of which they are constituent articles, might be more clearly and obviously perceived. This method has been pursued throughout the course of the Work; and it is certain that such a plan, regularly and successfully prosecuted, must be productive of numberless advantages. But when subjects, instead of being digested into systems, or disposed in their natural order, are dilacerated, dissected, and disseminated, without regard to connection or systematic combination, merely as the succession of the initials of the words, which constitute their technical terms, determine, without mentioning their antecedents and consequents, such a work should be rather called a Collection of Miscellanies than a *Dictionary of Arts and Sciences*. Works executed upon this plan cannot have a due influence on the mind; and an understanding formed upon such models, would rather be a chaos of detached and heterogeneous ideas, than a regular intellect. It is only by thinking in method, by reducing our ideas to a proper and rational order, by observing what they possess in common, and what are their relations or differences, that our reasoning faculties are capable of making any progress whatever. Without these assistances, we might be ranked amidst sensitive or conscious beings, but could never attain to the human or rational character.

To obviate any objection to Systems and Treatises, which might be suggested from an idea of the necessity of perusing a whole system for information, concerning only a particular part, the Editors have been attentive, in the alphabetical department of the Dictionary, to give a compendious yet clear account of the several detached parts, which they refer for further information to the particular system to which they appertain. Thus the System is rendered an improvement of the Alphabet, and the Alphabet an advantage to the System, which is the only method by which the whole circle or body of knowledge, with all its parts and dependencies, can be fully and advantageously displayed.

Detached articles are divided into three kinds. The first consists of such as, independent of particular Systems, admit of a full and complete illustration as they stand in the Alphabet; the second, of such as require partly to be discussed under the Systems to which they belong, and partly under their own proper denominations; the third, of such as are sufficiently elucidated in the Systems to which they appertain. Those of the first kind need no references. Those of the second, being only partially explained under their particular denominations, require references to the Systems where the illustrations are completed. For those of the last, as no explication is found necessary under the technical Terms, we refer to the Systems of which they are constituent parts for an ample discussion of the subject.

Thus the systematic reader will be fully and regularly informed, by referring to the science he is desirous of exploring; and the proficient who wishes to refresh and strengthen his memory in any particular part, may find the same by turning to the Alphabet, which, having general references, serves as an Index to the Systems and Treatises; whilst others, who are willing to content themselves with partial and detached views of subjects, will find them explained under the articles by which they are denominated. An uniformity of classic order is strictly preserved in every System throughout the Work, so as to render the whole of the Plates in this NEW ENCYCLOPÆDIA both ornamental and useful, by which means they bear an equal *uniformity of System* with the various descriptions to which they refer. Thus a chain is carried on from one end of an art to the other; that is, from the first or simplest complication of ideas, appropriated to the art which we call the elements or principles thereof, to the most complex or general one,

the name or term that repreſents the whole; and by a courſe of references, from particulars to generals, from premiſes to concluſions, from cauſe to effect, and *vice verſa*; i. e. from more to leſs complex, and from leſs to more; a communication is thereby opened between the ſeveral parts of the Work, ſo as to concentrate the component parts of univerſal knowledge.

The great utility of detached Syſtems and Treatiſes will obviouſly appear from the following particular inſtances; in which may be ſeen, how abortive and impotent are the attempts of thoſe compilers of dictionaries who have endeavoured, by their references, to direct their readers to form a ſyſtematic knowledge from the detached and ſcattered parts of the Alphabet: as for inſtance, in a part of the Preface to Chambers's Dictionary, which adverts to the plan of the work, amongſt an enumeration of articles, is mentioned, in particular, the article *Agriculture*, to obtain a compleat knowledge of which all the competent parts are ſeparately to be referred to; as *Tillage* and *Improvement* of *Soils*, *Clay*, *Sand*, *Earth*, &c. by the operations of *Ploughing*, *Fallowing*, *Burning*, *Semination*, *Manuring*, &c. to produce *Corn*, *Hemp*, *Flax*, &c. for *Malt*, *Farina*, &c. *Granary*, *Threſhing*, &c. The culture of *Trees*, *Timber*, &c. by *Planting*, *Shrewding*, *Barking*, &c. for *Coppice*, *Park*, *Paddock*, *Hedge*, *Paſture*, &c. But how extremely difficult it would be to follow this ſubject through ſuch a multitude of references, as well as new ones which ſpring from every one of them, any perſon may eaſily conceive. From theſe obſervations, we hope that our plan, in the introduction of Syſtems and Treatiſes, will be allowed ſufficiently obvious, whatever exceptions may be taken to the execution of it. By retaining practical and ſcientific men to form the ſeveral Syſtems and Treatiſes, together with the voluntary contributions with which the Editors have been ſo liberally favoured by ſubſcribers and literary gentlemen, we have been enabled to digeſt and arange the alphabetical parts of the Dictionary with more deliberation, attention and accuracy; and it is preſumed theſe circumſtances will ſtamp an additional value on this Work, and give it a decided preference to all others of a ſimilar kind. The plan was not haſtily adopted, but maturely concerted, and deliberately digeſted, by the Editors, and thoſe concerned in the various departments; ſo that, through their conjunctive efforts, they have been enabled, by great labour, intenſe application, and accurate inveſtigation, to render this Dictionary ſubſervient to every important purpoſe of knowledge; bring into a moderate compaſs the whole *Circle of Science*, and execute an arduous undertaking in a manner ſuperior to any on the ſame ſcale *in the Engliſh Language*.

We have endeavoured to give the ſubſtance of every thing that has been hitherto diſcovered in the ſeveral branches of knowledge; firſt, as they appear to our ſenſes, as produced by nature, or with the aſſiſtance of art; as in *Chymiſtry*, *Medicine*, &c. ſecondly, to our imagination; as in *Grammar*, *Rhetoric*, *Poetry*, &c. thirdly, to our reaſon; as in *Phyſics*, *Metaphyſics*, *Logic*, and *Mathematics*; with the ſeveral ſubordinate parts ariſing from each; and numerous remote particulars, not immediately reducible to any of theſe heads; as *Heraldry*, *Philology*, *Antiquities*, *Cuſtoms*, &c. To accompliſh a taſk ſo arduous and important, neither labour nor expence has been ſpared; every reſearch has been made; particular Syſtems on the Sciences have been collected and compared. Such as could be abridged without diſadvantage, have been epitomized with all poſſible care; while others, which were more conciſe in their ſubjects, have been more cloſely purſued, and more faithfully retained. When topics have been obſcurely or imperfectly treated, the utmoſt endeavours have been uſed to ſupply theſe defects; and original eſſays have been inſerted on ſuch parts of ſcience as the Compilers have not found properly illuſtrated by other authors.

We have not been content with taking what was already collected in other dictionaries, but have had recourſe to the originals themſelves, and have augmented our Work with a large acceſſion from other quarters. There are but few parts of the commonwealth of learning but have been applied to on this occaſion. Not to mention the ſmall matters which have been furniſhed from our own ſtock, the reader will find extracts from a great number of books of all kinds, either overlooked by former lexicographers, or not then extant; as well as a multitude of improvements and diſcoveries, which have not yet gained admiſſion into any other dictionary; by which means the progreſs of the Arts and Sciences are brought down to the preſent period.

Conſiderable ſums have been expended in the purchaſe of *new Publications* illuſtrative of the Arts and Sciences, not only in the Engliſh but foreign languages; and it is conſidered as a material advantage to this Work, that it was introduced at a time ſo fortunately ſeaſonable for the conveyance of that knowledge it is intended to diffuſe; for theſe reaſons, that the republication of Chambers's Cyclopædia eight years ago, in which Dr. Rees has introduced many of the neweſt improvements, and lateſt diſcoveries, and thereby extended the work to two volumes more than it originally formed; it has therefore afforded us ample ſcope for ſelecting the new and additional information attached to that work. Another circumſtance which tends to enhance the value of this Dictionary, is the republication of the Encyclopædia Britannica, from which we are enabled to derive the ſame advantages as from the former. We have likewiſe the opportunity of ſelecting from the French Encyclopedie, which is much more voluminous than either the Cyclopædia, or Encyclopædia Britannica. And further, as our Work is publiſhed at a period ſo much later than either of theſe works, we have an opportunity of incorporating all the valuable information contained in theſe publications; to which are added all the improvements and important diſcoveries that have taken place not only in theſe kingdoms, but in every poliſhed nation in Europe, whereby the Arts and Sciences are brought to a greater degree of perfection in this Publication than in any other work of the kind.

Particular care has been taken to deduce the Theories of Arts with all poſſible accuracy, in a ſeries of concluſions drawn from intuitive truths, or from principles previouſly diſcovered. But wherever ſuch a ſeries has not been duly obſerved by others, and where it appeared impoſſible, from the ſtate of learning, to ſupply that deficiency, we muſt be forgiven for only exhibiting, as certain, ſuch as have been well authenticated, without impoſing on the public *conjectural* for *real* improvements. Yet in points wherein heſitation and conjecture occur, we have not remained ſilent; and a number of probable ſolutions, not commonly met with, have been offered to the public attention. Nor have we concealed thoſe conjectures that appeared to be founded on rational principles; for if all conjectures were to be excluded, a very conſiderable part of polite literature, and, it may be added, of human knowledge, muſt, of courſe, meet the ſame fate. We are in many of the ſciences obliged to recur to conjecture. In Phyſic we have ſigns, ſymptoms, probabilities, which are nothing but conjectures. In Rhetoric, Civil Law, and other ſciences, conjectures maintain their ground: and as they are the means of diſcovering truth ſometimes concealed, and, as Quintilian ſays, "ſerve to lead the reader to truth," they may be conſidered, in many inſtances, as conducive to the preſent purpoſe. In diſputed points, arguments and objections have been diſplayed in their full force; a method which is ſo far from leading to ſcepticiſm, that it not only appears the moſt efficacious, but the only real means of eſtabliſhing truth. Thus every reader will ſee his favourite ſyſtem attacked and defended in ſuch a manner that his own judgment may determine the victory. And thus the Editors have preſerved their eſſential character of impartiality, in ſtating what is advanced by the partizans of different opinions, and ſubmitting the whole to the deciſion of the reader.

In treating of ſuch ſubjects as were peculiar to certain authors, the obligations are acknowledged by the Editors in the courſe of the Work; but in ſuch ſubjects as were common to many writers, they did not imagine thoſe acknowledgments required either by their own gratitude, or the curioſity of their readers. And that all poſſible means of improvement may be put in the power of the reader, the names of thoſe authors who have been moſt diſtinguiſhed in the various departments of art or ſcience, are ſubjoined to the extracts taken from their reſpective works; by which means he will be enabled to conſult more at large each particular author in his own province. But ſo much pains have been taken to ſelect and extract from each whatever is valuable, that it is preſumed the neceſſity of this reſearch will be in a great meaſure precluded, as our ſources have been numerous, and our extracts copious. The principal difficulty lay in the form and economy of it; to diſpoſe ſuch a multitude of materials ſo as not to make a confuſed heap of incoherent parts, but one conſiſtent whole; and this we hope has been moſt fully accompliſhed.

The editors of ſimilar compilations, it is preſumed, may not readily excuſe our culling ſuch flowers from their works as we thought worthy of tranſplanting; but it ſhould be remembered, that they alſo borrowed of their predeceſſors; for it will be found, on examination, that in all ſelections of this kind, this privilege has been claimed; and, indeed, as the matter borrowed belongs as much to one as to the other, there is no juſt cauſe of complaint. A compiler can by no means pretend to an excluſive property in a paſſage of an author, which he has himſelf poſſeſſed on a very diſputable title. Every bird from whom the daw had ſtolen feathers, might claim his own plumage; nor can he pretend an excluſive right, who, perhaps, has no right at all, but by the connivance of the real and original poſſeſſor.

Should it be obſerved, that the Work contains little *original* matter, we, in anſwer, muſt reply, that it contains as much as was poſſible for the Editors to produce, under the laborious taſk of reading, arranging, and adjuſting the multifarious ſubjects that neceſſarily came under conſideration; that it is what it ought to be, a *univerſal collection*; not the produce of one man's abilities, for that would go but a little way, but the aggregate treaſure of a whole commonwealth. Should any individual undertake to write a dictionary, even of ſome one particular art, from his own fund alone, we might venture to prognoſticate it would be of little value. It was not our deſign to entertain our gueſts with juſt what our ſcanty granaries afforded, but we have ranſacked, as it were, the whole world more fully to enrich the banquet. No author worthy of notice, either ancient or modern, foreign or domeſtic, has paſſed unconſulted; philoſophers, divines, mathematicians, critics, caſuiſts, grammarians, phyſicians, antiquaries, and mechanics, have been all brought under contribution.

After embarking in ſo great an undertaking, we were determined to perſevere with unremitting attention, and to make every effort, of which we were capable, for improving the Work, and ſecuring the approbation of our readers. With an induſtry and ardour, which the hope of giving ſatisfaction to the public animated, and which the extent and importance of the undertaking both deſerved and required, we have devoted to the accompliſhment of this laborious taſk, our whole time and attention, during the courſe of many years; and we think ourſelves happy, that no accident has prevented the progreſs of a Publication, to the completion, as well as the reputation and ſucceſs of which, our wiſhes and labours have been uniformly directed. We reflect with pleaſure, that our labours, in the cauſe of ſcience, have been ſo favourably received; and truſt that we may be allowed to interpret the extenſive ſale with which the Work has been honoured, as a teſtimony of the approbation, as it is a full proof of the candour, of the public. But though we acknowledge that candour, and confide in it, we muſt urge thoſe apologies which are furniſhed by the magnitude of this Publication, and the variety of ſubjects it comprehends; and we ſhould have been unworthy of the indulgence we have experienced, and to which we farther appeal, if we had not conſidered it as an encouragement to unremitting application.

It is very natural to ſuppoſe, that a work of ſuch magnitude as this, and containing ſuch a variety of articles, muſt be ſubject to errors, though all poſſible means have been uſed to avoid ſuch defects. But the moſt careful cannot elude human fallibility. Accidents of this kind will not appear ſurpriſing, when we conſider in what a variety of ways we are open to error. Perhaps an author, on whom we depend, deceives us; our own judgment betrays us; our attention leaves us for a moment; or, ſuppoſe we eſcape all theſe ſnares, we may be brought into a ſcrape by an amanuenſis; or, if we get clear here, we are in imminent danger of miſcarrying in the hands of the printer. And it muſt be acknowledged, that, after all that has been, or can be, collected towards forming a complete work of this kind, there will ſtill remain much ſcope for emendation. There will be errors to correct, and defects to ſupply. In ſhort, the moſt we can ſay is, that we hope there will be but few miſtakes found in this Work, in compariſon with others of a like kind. Many thouſands we have corrected, both in dictionaries and other works, from whence we have collected our materials. We therefore flatter ourſelves, that what we have overlooked, the reader will frequently be enabled to correct; and that there will not be many errors found in the book, which the book itſelf will not be able to rectify.

In a collection ſo large and multifarious as that which is here ſubmitted to the public, the critic muſt be ſevere, and the genius minute, who could ſtop to animadvert upon every trivial inaccuracy of ſtyle; for where the ſubjects are ſo indefinitely varied, and where propriety requires that each ſhould be expreſſed in a manner ſuitable to its nature, it can ſcarcely be imagined, that the ſame exactneſs and uniformity ſhould equally prevail in this as in compoſitions of a nature leſs extenſive and complex.

After all, though the Compilers are conſcious of having done their utmoſt to render this Work as extenſively and generally uſeful as poſſible, yet, ſince no human production, even from the origin of literature, to the preſent period, has ever been found perfect in its kind, it would be cruel, if not unjuſt, to expect abſolute perfection in the preſent attempt. From every candid and benevolent enquirer after truth they hope that the merit of their intention, and the utility of their plan, will, in a great meaſure, atone for ſuch trivial or unavoidable faults as may be found in its execution. When the nature of a work ſo extenſive and multiform is duly conſidered, it will immediately occur to every reader of candour and indulgence, how eaſy it is for the utmoſt care and aſſiduity to fall in ſome inſtances. Theſe, however, it is hoped, will be found few, and of little importance; the Work, during its whole progreſs, having been ſuperintended with unremitting vigilance and aſſiduity.

The arduous taſk of compiling a dictionary, and the toil and fatigue attending on it, can only be credited by thoſe who have made the experiment. Its difficulties are very juſtly deſcribed by Dr. Johnſon, who obſerves, that "among the many unhappy mortals is the compiler of a dictionary; whom mankind have conſidered, not as the pupil, but the ſlave, of ſcience, the pioneer of literature, doomed only to remove rubbiſh, and clear obſtructions, from the paths through which Learning and Genius preſs forward to conqueſt and glory, without beſtowing a ſmile on the humble drudge that facilitates their progreſs. Every other author may aſpire to praiſe; the lexicographer can only hope to eſcape reproach, and even this negative recompenſe has been yet granted to very few."

Amidſt theſe diſcouraging circumſtances, the Editors have dared to brave all difficulties, being determined to perſevere, and exert every effort in their power, to form a complete Work, and thereby merit the approbation of the candid and judicious; nor can they fully expreſs the ſecret ſatisfaction they felt in preparing it for the preſs. Being actuated by a love of the arts and ſciences, and a deſire of promoting the ſtudy, and diffuſing the knowledge, of ſubjects ſo worthy the purſuit of intelligent and rational beings, they undertook this laborious taſk, and have exerted their utmoſt abilities to remove every difficulty, and ſmooth the path that leads to the acquiſition of knowledge; and flatter themſelves that the great pains taken, and the conſiderable time ſpent, in compoſing and perfecting their Work, will perpetuate its fame to future times.

The numerous repreſentations of quadrupeds, birds, inſects, &c. are arranged according to the Linnæan method of claſſification; not in a confuſed heterogeneous manner, intermixing various and oppoſite animals, and frequently extraneous ſubjects, in one plate, but placed in their regular claſſes and orders, ſo that the different kingdoms of nature are ſcientifically arranged, which is a plan never before adopted in any other dictionary of arts and ſciences, or in any ſyſtem of natural hiſtory, however extenſive. In addition to this arrangement, under each repreſentation are engraved the claſs, order, genus, ſpecies, and varieties, peculiar to each reſpective animal, which exhibit the relative affinity, and connecting chain, that runs through the whole animal kingdom, and thereby conſiderably facilitate the knowledge of this much ſtudied and entertaining branch of ſcience.

The whole of the engravings which embelliſh this Work are not, as in other dictionaries of arts and ſciences, copied from preceding works of the ſame kind; as the editors of them have not paid a due regard to new improvements and diſcoveries, which are ſtrabſolutely eſſential in a work of this kind. Therefore, to obviate this objection, the public are preſented in this Work with engravings from original drawings, deſigned by the moſt ingenious artiſts, and comprehending all the new diſcoveries both in the ſciences and mechanic arts. As this eſſential particular has not been attended to in any other dictionary of arts and ſciences whatever, it is preſumed it will be conſidered as an object that will give this Work a decided preference to any other of a ſimilar nature, and more particularly as each plate contains a greater diverſity of ſubjects, and thoſe delineated with the utmoſt accuracy. In ſhort, it has been the joint endeavour of the Proprietor, Editors, and Artiſts, to blend novelty with utility, and to render this Work, from its diſtinguiſhed ſuperiority, juſtly deſerving the patronage and recommendation of the Public.

*** *The Editors have been much aſſiſted, and highly gratified, by the hints and communications which they have received, both in converſation and writing, for the improvement of the Work; and think themſelves under peculiar obligations to the friendſhip of thoſe Gentlemen who have formed Syſtems and Treatiſes on various ſubjects. Several flattering teſtimonies of approbation, from unknown correſpondents, demand alſo their reſpectful acknowledgements; as they have contributed to animate their aſſiduity and perſeverance in the proſecution of an undertaking which required reſolution, patience, and every effort that could combine to eſtabliſh their reputation, and gratify the wiſhes and expectations of the Public.*

PREFACE TO THE NEW EDITION.

As the importance and utility of a Dictionary of Arts and Sciences have been so fully investigated, and so clearly defined, in the Preface to the first Edition of this Work, it would be needless in the present to trespass on the time of the reader, by entering into a detail of a subject which is there rendered so demonstrably evident.

The distinguished patronage which has sanctioned the first Edition of this Work, has induced the Proprietor to publish a second Edition, in which the errors of the former are corrected, and the defects supplied; new and different lights are progressively thrown upon many important subjects; and the prediction of an eminent philosopher, that "a new age, a new race of men, would produce new discoveries," is in a great variety of instances fully verified, and to which the highly improved state of the arts in Great Britain has essentially conduced.

The universal taste that prevails in the present day for the cultivation of the polite arts, naturally produces rapid advances in improvement. A critical discrimination has been observed in expunging obsolete Hypotheses, exploded Systems, and useless Theories, which gave place to subjects of novelty and utility. The descriptions are drawn clear and intelligible, without scholastic pedantry, uninteresting prolixity, or unmeaning brevity. By thus introducing real *practical Knowledge*, and exploding *useless Theory*, we preserve more real information in *three* volumes than we could otherwise have done in *six*. By means of investigation, many subjects have been traced which were barely hinted at before; and many points fully discussed, and finally settled, which had long continued unascertained. The Proprietor, therefore, apprised of the rapid progress of science, is anxious that a work, in the reputation and success of which he is so much interested, might be a comprehensive repository of all the *modern* discoveries and improvements. To promote this design, the superintendence of this second Edition was entrusted to the conduct of one of the Editors, who, having assisted in the latter part of the first, had frequent occasions to take a retrospect of the preceding parts; and being thereby generally acquainted with the contents, and not altogether ignorant of their excellencies and defects, was therefore better qualified to select and arrange the materials for the present Edition.

That a judgment may be formed of the advantages resulting from this Edition, it is necessary to point out the principal amendments which it has received, and the additions which it has been thought necessary to introduce.

Independent of the alterations and additions which have taken place in the Alphabetical part of the new Edition, entire new Systems have been introduced, to the total exclusion of the former; and others have undergone considerable improvements and enlargements, as will appear in the following instances.

AEROLOGY. Many additions have been made to this System, and a variety of new experiments introduced, to demonstrate the nature and different species of air, with their properties, phenomena and uses. The System has also been divided into Sections, in order that more direct references might be made from the Alphabet to the several parts to which the respective articles particularly relate.

AGRICULTURE. Many essential alterations have not only been made, but additional sheets have been given in this System, in order to introduce extracts from the most recent experiments and observations contained in Young's Annals, the Bath Papers, and other Productions of Agricultural Societies, instituted for the purpose of promoting the theoretical and practical knowledge of a Science, of all others the most useful to mankind.

BOTANY. An entire new System is given in this Edition, in order to enlarge upon this kingdom of nature, the knowledge of which is equally useful and entertaining: and for the purpose of rendering it more complete, we have rejected the System of Tournefort, as totally exploded by modern botanists; by which means, together with the addition of eight pages, we have been enabled to introduce the Linnæan method of classification, now universally adopted throughout Europe by the most eminent botanists; also a copious explanation of the various botanical terms; together with a key to the Sexual System; and an accurate systematic arrangement and illustration of the several orders, classes and genera. The representations illustrative of the introductory principles of botany, are taken from the basis of the unrivalled fabric of Linnæus, and are regularly arranged from the Fundamenta and Philosophia Botannica; and farther illustrations are also introduced from the Sexual System of Mr. John Miller, representing all the classes and orders, with his judicious discrimination of the fructification of plants, together with other new and improved productions. To these particulars we have subjoined philosophical remarks, and other important observations, so as to comprize, in the whole, a concise though perfect display of the theory of this exhaustless and entertaining science.

COMPARATIVE ANATOMY. This System has been considerably improved; a new arrangement formed; and, in order that justice may be done to the subject, additional letter-press has been introduced, for the purpose of enlarging on what was before too concise, and affording space for the introduction of the Comparative Anatomy of Aqueous Animals, Insects, and other particulars highly interesting to the curious and speculative mind, as tending to shew the wonders of creation as displayed in the Animal System.

CHYMISTRY. This System in the New Edition has been greatly improved and enlarged, as well as arranged upon a plan totally different from the former. It contains the essence of the works of the most approved writers on the subject, and explains, in the clearest and most intelligible manner, the nature, properties and uses of the several articles comprised in the Science, whether they relate to the Vegetable, Mineral, or Animal Systems, besides a number of experiments illustrative of the same.

MINERALOGY, which in the former Edition was barely hinted at, has in the present been introduced as a regular System, which, though concise, exhibits the relative connection Mineralogy bears to Botany and Chymistry: And as it forms one of the three kingdoms of Nature, it was thought too important to be passed over without a regular arrangement and classification; though, as we have been very copious on those parts which bear affinity to Chymistry, as well in the System as in the Alphabet, we have not entered into a detail of them, but referred them as they occurred in this System to the System of Chymistry and the Alphabet for further discussion and explanation.

It must be obvious to those who will take the pains to review works in some degree similar to this, that they abound not only with words that are exploded, but such as do not in the remotest construction appertain either to art or science. Indeed, the present Editor cannot but observe, that too many useless words are admitted into the first Edition; hence his utmost circumspection and attention have been exerted in detecting and expunging such parts as were not sufficiently instructive or entertaining, to afford space for articles which tend to explain and illustrate subjects that may with propriety be comprised in a library of universal knowledge.

Many of the original articles have been abridged or enlarged, as their respective nature and importance required; new articles have been inserted in alphabetical order, most of which do not occur in any dictionary the Editor has had an opportunity of consulting, but were by him selected from detached works, procured for his use, as well as valuable libraries to which he had access; so that it would not be an easy task, if it were thought necessary or useful, to recount the alterations which the first Edition has undergone, and the additions introduced in the second Edition. It may be observed in general, that the number of the new articles is larger, that some of them are of considerable length; that many of them comprehend subjects of moment; and that the least important were thought too interesting to be omitted.

It may appear rather extraordinary, that there should be such a material increase of Letter-press in the second Edition, without an increase of expence; but a desire to render this Work as universally beneficial as possible, as well as to enhance the reputation the first Edition had acquired, induced the Proprietor to cause the second to be enlarged by the addition of near an hundred and fifty pages, without any view to emolument. By this means the improvements and discoveries made since the publication of the former Edition have been incorporated in the present; and further, to effect the design of inserting every thing that is valuable and interesting; the less important articles have been abridged; and those which appeared useless, expunged; so that scope has been afforded for much valuable matter, as well as for the introduction of the various communications from our correspondents, with which we have been favoured during the course of the publication.

Another material advantage peculiar to the second Edition is, that it affords opportunity for making more correct references from the Alphabet to the Systems and Treatises, and from the Systems and Treatises to the Alphabet, so that they are thereby rendered explanatory the one to the other, both in a detached and collective point of view. From this advantage the first Edition was in a great measure precluded, as the references in it could not have been so complete, or made with that precision and exactness as in the second; the Editor having in the latter had the opportunity of recurring to the Systems, Treatises and detached Articles in the first, which tended to facilitate his search, and to ascertain the propriety of the references in the second.

The Editor rests on the candour of the Public, hoping that the errors and defects which may have escaped the most diligent attention, will not be thought very considerable by those who are disposed to judge liberally of the execution, from unavoidable difficulties attending it; and that the numerous corrections and additions in the various departments of science, which this second Edition contains, will be regarded as important and valuable improvements.

THE NEW ROYAL ENCYCLOPÆDIA;

OR, COMPLETE MODERN UNIVERSAL DICTIONARY OF ARTS AND SCIENCES.

A MAY be conſidered, I. as a *letter*; II. as a *word*; and III. as an *abbreviation*.

I. A, as a *letter*, or the mark of a vocal ſound, is the moſt ſimple, and that which the dumb are moſt eaſily taught to utter. To pronounce it clearly, we need only open the mouth wider than for any other ſound, and then emit the air from our lungs. It is the firſt letter of the alphabet in all the known languages of the world, except in that of the Ethiopians; in which, according to Ludolphus, it is the thirteenth. We muſt ſeek the origin of this, and the reſt of our letters, in the oriental languages. (See ALPHABET and LETTERS.) In the Engliſh language, the character A is the mark of three different ſounds, which are termed by our grammarians the *broad* A, the *open* A, and the *ſlender* A. 1. Our *broad* A reſembles the ſound marked by the German A, and is found in many of our monoſyllables, as *all*, *wall*, *malt*, *ſalt*, &c. where it is pronounced as *au* in *cauſe* and *fault*; or as *aw* in *law*. It is probable that this *broad* ſound was that which our Saxon anceſtors expreſſed by the character A, as it is ſtill almoſt uniformly retained in the ruſtic pronunciation and northern dialects of our language; as *taulk* for *talk*, *maun* for *man*, *haund* for *hand*, &c. 2. The *open* A of the Engliſh is not unlike the A of the Italians, and is the ſound marked by this letter in *father*, *rather*, &c. 3. The *ſlender* ſound marked by the character A is peculiar to the Engliſh language, and reſembles the ſound of the French *e* maſculine, or of their diphthong *ai* in *pais*: perhaps it is a middle ſound between them, or between the *a* and *e*. Such we have in the words *place*, *face*, *waſte*; and in all thoſe that terminate in *ation*; as *ſalvation*, *preſervation*, &c.

The ſounds of which A is the character in our language, are ſometimes ſhort; as in the words *glaſs*, *graſs*, *braſs*, &c. at other times long; as in *glaze*, *graze*, &c. Their length is commonly denoted by an *i* immediately ſubjoined to the *a*; as in *plain*, *vain*, &c. or by an *e* added at the end of the word; as in *plane*, *crane*, &c. Some contend that there are four, others that there are five, diſtinct ſounds denoted by the character A in the Engliſh language. There are, perhaps, little variations and diſtinctions in the ſounds marked by the character A, as well as by the other vowel letters in our alphabet; but they are ſo vocal or arbitrary, or, after all, ſo nice and ſubtle, that they entirely eſcape the notice of foreigners, and are hardly diſtinguiſhable by the natives. Thoſe who deſire to enter more deeply into the firſt formation of ſounds, and to ſee the elementary principles of ſpeech treated with philoſophical accuracy, will find ſatisfaction in the ingenious treatiſes of Wallis and Holder. Mr. Sheridan's ſcheme of ſounds is too complex to be of any real utility. As to the performances of others, they are too trivial to be critically examined. To treat minutely on the variety of ſounds in which this letter occurs, would be incompatible with our plan, as it would run into an unintereſting prolixity that could anſwer no intention whatever. In our calendar, A is the firſt of the *dominical* letters, which were introduced in imitation of the eight *nundinal* letters of the Romans, of which their A was one.

II. A is a *word*. The firſt ſimple ſound is uſed in our language to expreſs moſt of the vehement emotions of the ſoul. We naturally uſe it on all ſudden occaſions of admiration, joy, anguiſh, apprehenſion of danger, &c. and where the emotion is very great, the A is enforced by adding an aſpirate to it, as *ah!* It is ſometimes a noun; for we ſay great A and little *a*; but it is moſt commonly a definite or indefinite article. It is *definite*, and denotes the number *one*; as, *a man is coming*; that is *no more than one*. It is alſo uſed as an *indefinite* article; ſo we ſay, *a man may come this way*; that is, *any man*. A, uſed as an article, has no plural ſignification; before a word beginning with a vowel, *y* and *w* excepted, and before a ſilent *h* preceding a vowel, it is written *an*, of which *a* is the contraction; as *an* harbour, *an* ox, *an* hour, &c. A ſeems to be a true and genuine prepoſition in the three following caſes. 1. When it is put before a participle or participle noun, denoting ſome action not yet accompliſhed; as, I am *a* writing. 2. When it is placed before local ſurnames; as, Thomas *a* Becket. 3. When it is uſed in compoſition, v. g. aſloot, aſleep, &c. It is alſo ſometimes redundant, as in the words, *ariſe*, *awake*, &c. which are not different in ſignification from *riſe*, *wake*, &c. Dr. Wallis ſuppoſes it to be a contraction of *at*; but Dr. Lowth thinks that it is the prepoſition *on*, and ſometimes *of*. *At*, he ſays, has relation chiefly to *place*; *on* has a more general relation, and may be applied to *action*, and many other things as well as *place*. In ſome inſtances A has a peculiar ſignification, denoting the proportion of one thing to another; as ſuch income *a* year; ſo many hours *a* day; ſo much *a* man, &c. A, in literary compoſition, has ſometimes the power of the French *a*, in theſe phraſes, *a droit*, *a gauche*, &c. and ſometimes to be contracted from *at*, as, *aſide*, *aſlope*, *aſtoſt*, *aſleep*, *aware*; of which the following extracts are examples.

> And now a breeze from ſhore began to blow,
> The ſailors ſhip their oars, and ceaſe to row:
> Then hoiſt their yards *atrip*, and all their ſails
> Let fall, to court the wind, and catch the gales.—DRYDEN.

> A little houſe with trees *arow*,
> And, like its maſter, very low.—POPE.

A is ſometimes added afterwards in burleſque poetry; in which caſe it only makes an additional ſyllable without any alteration of the ſenſe, as the interjection O very often does in our ballads.

III. A is alſo an *abbreviation*. A, put to bills of exchange, is in England an abbreviation for *accepted*, and in France for the word *accepté*. It is likewiſe uſual among merchants to mark their ſets of books with the letters A, B, C, &c. inſtead of the numbers 1, 2, 3, &c. A, in the ancient inſcriptions of marbles, &c. occaſionally ſtands for *Auguſtus*, *ager*, *aiunt*, &c. When doubled, it denotes *Auguſti*; when triple, *aurum argentum*, *æs*; and ſometimes its meaning can only be known by the reſt of the inſcription. Iſidore adds, that when it occurs after the word *miles* (ſoldier) it denotes him young. On the reverſe of ancient medals, it denotes them ſtruck by the city of Argos, ſometimes by that of Athens; but on coins of modern date, it is the mark of Paris. A. M. ſtands for *Artium Magiſter*, Maſter of Arts; and A. B. for *Artium Baccalaureus*, Bachelor of Arts.

The Romans, in their trials, uſed their A to denote abſolution; whence Cicero calls it *littera ſalutaris*, or *the ſaving letter*. Their manner was this. Three ballots were given to each judge, marked one with an A, for *abſolvo*; I abſolve; a ſecond with a C, for *condemno*; I condemn; and the third with N. L. which ſtood for *non liquet*; Is not clear. One or other of theſe each judge, according to his judgment, put into an urn; and the prætor acquitted or condemned the criminal, as the one or other of theſe letters were the moſt numerous. If the ſuffrages for acquitting and condemning were equal, the accuſed was always acquitted. The Romans alſo made uſe of the letter A in collecting their ſuffrages in caſes of legiſlation. When a new law was propoſed, or an amendment of an old one was in agitation, each voter had two ballots put into his hand; the one marked A, ſignifying *antiqua*, q. d. *antiquam volo*; I like the old way; and the other was marked U. R. for *uti regas*; As you deſire; and his ſuffrage was given, by putting the one, or the other, into the urn. A, in the days of Roman barbariſm, was one of the numeral letters, and ſignified five hundred; but when written with a dath over it, thus $\overline{\text{A}}$, it denoted five thouſand.

The letter A is uſed by chronologers, &c. as an abbreviation for *anno*; ſo they put A. M. for *anno mundi*, A. D. for *anno Domini*, &c. The Romans dated from the building of Rome; and in their writings A. U. C. ſtands for *anno ab urbe condita*. The Greeks uſed A, *a*, prefixed to a word, as a private particle. With them it was alſo a numeral letter, denoting unit. A is an abbreviature uſed with different intentions; viz. in logic, A denotes an univerſal affirmative propoſition, according to the verſe——*Aſſerit* A, *negat* E, *verum univerſaliter ambo*.

Thus in the firſt figure, a ſyllogiſm conſiſting of three univerſal affirmative propoſitions, is ſaid to be in Bar-ba-ra; the A, thrice repeated, denoting the number of the propoſitions to be univerſal. See the Syſtem of Logic, Part III. Sect. IV.

In Algebra, A or *a*, and the firſt letters of the alphabet, repreſent known quantities; and the laſt letters repreſent quantities

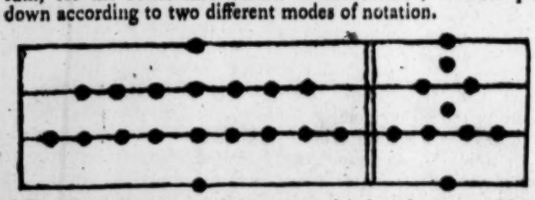
that are *unknown*. See the SYSTEM, Sect. 1. In the preſcriptions of phyſicians, A, or *a*, or *ā ā*, denotes equal parts of the ingredients ſpecified, and is a contraction of the prepoſition ἀνὰ, which is uſed in the ſame ſenſe by medicinal writers in the Greek tongue. Among chymiſts, A A A ſignifies an *amalgama*, or the operation of amalgamating.

AAVORA, in natural hiſtory, the fruit of a ſort of large palm tree in the Weſt Indies, and in Africa. It is of the ſize of an hen's egg, and included with ſeveral more, in a large ſhell. In the middle of the fruit there is an hard nut, about the ſize of a peach-ſtone, which contains a white almond, very aſtringent, and proper to check a diarrhœa.

AB, the eleventh month of the civil year of the Hebrews, and the fifth of their eccleſiaſtical year, which begins with the month Niſan. It anſwers to the moon of July; that is, to part of our month of the ſame name, and to the beginning of Auguſt: it conſiſts of thirty days. The Jews faſt on the firſt of this month, in memory of Aaron's death; and on the ninth, becauſe on that day, both the temple of Solomon, and that erected after the captivity, were burnt; the former by the Chaldeans, and the latter by the Romans. The ſame day is alſo remarkable among that people for the publication of Adrian's edict, wherein they were forbid to continue in Judea, or even to look back, when at a diſtance from Jeruſalem, in order to lament the deſolation of that city. The 18th of the ſame month is alſo a faſt among the Jews, becauſe the lamp in the ſanctuary was that night extinguiſhed in the time of Ahaz.

ABACA, a kind of flax, or hemp, gathered in ſome of the Manillas, or Philippine Iſlands. This plant is ſown every year: being gathered, it is ſteeped in water, and beaten as hemp is. It is of two kinds, the white and the grey. The white *abaca* is uſed for making very fine linen; but the grey is employed for nothing but cordage.

ABACUS, an inſtrument for facilitating the operation of arithmetic. It is almoſt as ancient and extenſive as the art of arithmetic itſelf. If it be later than the methods of computing by the fingers, and by *lapilli*, or ſtones, (which obtained among the Egyptians,) it is at leaſt much prior to the uſe of numeral letters, or figures wrought with the pen. Herod. lib. 2. We find it in uſe, under ſome variations, among the Greeks, Romans, Chineſe, Germans, French, &c. It excels in point of facility and cleanlineſs of operation, as working without any ſtrokes or blots of the pen, or waſte of paper; ſome alſo give it the preference in point of expedition. The *abacus* is variouſly contrived; that chiefly uſed in European countries is made by drawing any number of parallel lines, at pleaſure, at a diſtance from each other, equal to twice the diameter of a *calculus*, or counter. Here a counter, placed on the firſt or lowermoſt line, ſignifies 1; on the ſecond, 10; on the third, 100; on the fourth, 1000; on the fifth, 10,000; and ſoon. In the ſpaces between the lines, the ſame counters ſignify half of what they ſignify on the next upper or ſuperior line; viz. in the ſpace between the firſt and the ſecond lines, 5; between the ſecond and third, 50; between the third and fourth, 500; and ſo on. Thus the counters on the *abacus*, in the figure here ſubjoined, make the ſum of 1791, which ſum, for the better information of our readers, we have put down according to two different modes of notation.



The Grecian *abacus*, ἄβαξ, or counting board, was an oblong frame, divided by ſeveral braſs-wires, ſtretched parallel to one another, and mounted with an equal number of little ivory balls, like the beads of a necklace. By the arrangement of theſe balls, diſtinguiſhing the numbers into different claſſes, and obſerving the relations of the lower to the upper, all kinds of computations were eaſily performed. Mahudel, in Hiſt. Acad. R. Inſcr. t. iii. p. 309.

The Roman *abacus* was much the ſame with the Grecian, except that, inſtead of ſtrings or wires, and beads, in the Roman we find pins, and grooves for them to ſlide in. It is deſcribed by ſeveral authors; but, notwithſtanding all theſe deſcriptions, we ſhould have had a very obſcure idea of the ancient manner of reckoning, had there not been figures of it found among the ancient marbles. Phil. Tranſ. No. 180.

The Chineſe *abacus* conſiſts, like the Grecian, of ſeveral ſeries of beads, ſtrung on braſs wires, extended from the top to the bottom of the inſtrument, and divided in the middle by a croſs piece from ſide to ſide; ſo that in the upper row each ſtring has two beads, which are each reckoned for five; and in the lower row, each ſtring has five beads of different values; the firſt being reckoned as 1; the ſecond as 10; the third as 100; &c. as among us. Add, that, inſtead of four pins, for digits or units, in the Roman *abacus*, the Chineſe has five beads. We have two different figures, and deſcriptions, of the Chineſe *abacus*; one given by F. Martinius, who had lived many years in China; the other by Dr. Hook, who copied it from a Chineſe dictionary of the court-language. See SHWAN-PAN

ABACUS, or ABACISCUS, in architecture, is the uppermoſt member of the capital of a column; ſerving as a kind of crowning both to the capital and the whole column. Many of our dictionary writers very erroneouſly make the *abacus* to be the capital itſelf. Vitruvius, and others after him, who gave the hiſtory of the orders, tells us, the *abacus* was originally intended to repreſent a ſquare tile laid over an urn, or rather over a baſket. An Athenian old woman happening to place a baſket thus, covered over the root of an acanthus, that plant, ſhooting up the following ſpring, encompaſſed the baſket all around, till meeting with the tile, it curled back in a kind of ſcroll. Callimachus, an ingenious ſculptor, paſſing by, took the hint, and immediately executed a capital on this plan; repreſenting the tile by the *abacus*, the leaves by the volutes, and the baſket by the vaſe, or body of the capital. There is ſome difference in the form of the *abacus* in different orders. In the Tuſcan, Doric, and ancient Ionic, it is a flat ſquare member, well enough repreſenting its original tile; whence the French call it *tailloir*, or *trencher*. For the repreſentation, ſee Plate VI. in the Syſtem of ARCHITECTURE. In the richer orders it loſes its native form; its four ſides, or faces, being arched, or cut inwards, with ſome ornament, as a roſe or other flower, or a fiſh's tail, in the middle of each arch. See CORINTHIAN and COMPOSITE ORDERS, and Plate VI. But ſome architects take other liberties with the *abacus*, both in reſpect of its name, place, and office. Thus, in the Tuſcan order, where it is the largeſt and moſt maſſive, as taking up one third of the height of the whole capital, it is ſometimes called the *dye of the capital*. In the Doric it is not always the uppermoſt member of the capital, a *cymatium* being frequently placed over it. In the Ionic, ſome make it a perfect ogee, and crown it with a fillet. The proportion of the *abacus*, as preſcribed by Vitruvius, is, that its diagonal (from corner to corner) be twice its height. A rule which the moderns make no difficulty of diſpenſing with.

ABACUS LOGISTICUS is a rectangled triangle, whoſe ſides forming the right angle, contain the number from 1 to 60, and its area the product of each two of the oppoſite numbers. This is called a *canon* SEXAGESIMALIS.

ABADDON is the name which St. John in the Revelations gives to the king of the locuſt, the angel of the bottomleſs pit. The inſpired writer ſays this word is Hebrew, and in Greek ſignifies Ἀπολλύων, i. e. a *deſtroyer*. That angel-king is thought to be Satan, or the devil: but Mr. le Clerk thinks with Dr. Hammond, that by the locuſts which came out of the abyſs, may be underſtood the zealots and robbers who miſerably afflicted the land of Judea, and laid it in a manner waſte, before Jeruſalem was taken by the Romans; and that Abaddon, the king of the locuſts, may be John of Giſchala, who having treacherouſly left that town a little before it was ſurrendered to Titus, came to Jeruſalem, where he ſoon headed a part of the zealots, who acknowledged him as their king, whilſt the reſt would not ſubmit to him. This ſubdiviſion of the zealot party brought a thouſand calamities on the Jews.

ABARTICULATION, in anatomy, a ſpecies of articulation admitting of a maniſeſt motion; called alſo *diarthroſis* and *dearticulatio*, to diſtinguiſh it from that ſort of articulation which admits of a very obſcure emotion, and is called *ſynarthroſis*. See ARTICULATION. See alſo the SYSTEM, Part I. Sect. I.

ABASED, ABAISSE, in heraldry, is applied to the vol, or wings of eagles, &c. when the tip, or angle, looks downward towards the point of the ſhield; or when the wings are ſhut; the natural way of bearing them being ſpread, with the tip pointing to the chief, or the angles. A chevron, a pale, bend, &c. are alſo ſaid to be *abaſed*, when their points terminate in or below the centre of the ſhield. Again, an ordinary is ſaid to be *abaſed*, when below its due ſituation. For the repreſentation, ſee the SYSTEM, Plate V.

ABATE, in law, ſignifies to throw down; as, *to abate a nuiſance*. It is uſed, by the writers of the Engliſh common law, both in an active and neutral ſenſe; as *to abate a writ*, is, by ſome exception, to defeat or overthrow it. *A ſtranger abateth*: that is, entereth upon a houſe or land, void by the death of him that laſt poſſeſſed it, before the heir takes poſſeſſion, and ſo keepeth him out; wherefore, as he that putteth out him in poſſeſſion is ſaid to diſſeize, ſo he that ſteppeth in between the former poſſeſſor and his heir is ſaid to abate. In the neuter ſignification thus: *the writ of the demandant ſhall abate*; that is, ſhall be diſabled, fruſtrated, or overthrown: *the appeal abateth by covin*; that is, the accuſation is defeated by deceit.

ABATEMENT, in law, is the fruſtrating or ſetting aſide a ſuit, on account of ſome fault either in the matter or proceeding thereof. Thus, *Plea in abatement* is ſome exception alledged either againſt the plaintiff's writ, as wanting due form, or againſt his count or declaration, as being inſufficient, or varying from the writ, ſpecialty, or record; or againſt the matter of either, as inſufficient, or being before another court; or againſt the allegations, as being uncertain, on account of ſome miſnomer; or the death of one of the parties; or the marriage of the plaintiff, being a woman; to which ſome add diſability. Upon any of theſe, the defendant prays, that the plaintiff's writ or plaint may abate, i. e

that his ſuit may ceaſe from that time. If it be granted, all writs and proceſſes muſt begin *de novo*. The death of a plaintiff did in all caſes *abate* the writ before judgment, until the ſtatute 8 and 9 W. III. c. 11. by which neither the death of the plaintiff or defendant ſhall *abate* it, if the action might be originally proſecuted by and againſt the executors or adminiſtrators of the parties; and if there are two or more plaintiffs or defendants, and one, or more, die, the writ or action ſhall not *abate*, if the cauſe, or action, ſurvives to the ſurviving plaintiff, againſt the ſurviving defendant, &c. It alſo denotes an irregular entry upon lands.

ABATEMENT, in heraldry, ſomething added to a coat-armour, to diminiſh its proper value and dignity, and note ſome diſhonourable action or ſtain in the character of the perſon who bears it. It may be made by reverſion or diminution. Reverſion is either turning the whole eſcutcheon upſide down, or the adding another eſcutcheon, inverted, in the former. Diminution is the blemiſhing any part, by adding a ſtain, or mark of diminution: ſuch are the delf, a point dexter, a point champaign, a plain point, a gore ſiniſter, and a guſſet. See the SYSTEM, Sect. VI. Art. I. It may be added, that theſe marks muſt always be either tawney or murrey; otherwiſe, inſtead of diminutions, they become additions of honour. The laſt editor of Guillim diſcards the whole notion of *abatements* as a chimæra. He alledges, that no one inſtance is to be met with of ſuch bearing; and that it implies a contradiction to ſuppoſe it. Arms being *inſignia nobilitatis & honoris*, cannot admit any mark of infamy without ceaſing to be arms, and becoming badges of diſgrace, which all would covet to lay aſide. Add, that, as no hereditary honour can be actually diminiſhed, ſo neither can the marks thereof. Both, indeed, may be forfeited, as in the caſe of treaſon, where the eſcutcheon is totally reverſed, to intimate a total ſuppreſſion of the honour. Some inſtances, however, are produced to the contrary, by Columbiere, and others. But theſe, though they may ſhew ſome extraordinary reſentments of princes for offences committed in their preſence, do not amount to a proof of ſuch cuſtom or practice; much leſs authoriſe the bearing the badges in the hands of inferior officers, as kings at arms. In a word, as arms are rather the titles of the dead than of the living, it would ſeem that they can neither ſuffer *diminution* or *abatement*; for thus an equal indignity would be put upon the anceſtor and the deſcendant. Diminution, therefore, and abatement, can only affect arms lately granted, and ſolely when the perſon who obtained them is yet alive, and has tarniſhed his former glory by his after miſbehaviour. Even in this caſe, where abatement may properly take place, it can only be made by the ſuppreſſion of ſome honourable badge, and not by the introduction of any degrading emblem.

ABATEMENT, in the cuſtoms, is an allowance made upon the duty of goods, when the quantum damaged is determined by the judgment of two merchants upon oath, and aſcertained by a certificate from the ſurveyor and land-waiter. For *abatement* in commerce ſee DISCOUNT. For Abatement as it relates to Intereſt, ſee the Syſtem of ARITHMETIC, Chap. XV.

ABBA, in the Syriac and Chaldee languages, literally ſignifies *a father*; and, figuratively, a ſuperior, reputed as a father in reſpect of age, dignity, or affection. It is more particularly uſed in the Syriac, Coptic, and Ethiopic churches, as a title given to the biſhops. The biſhops themſelves beſtow the title *abba* more eminently on the biſhop of Alexandria, which occaſioned the people to give him the title of *baba*, or *papa*; that is, *grandfather*; a title which he bore before the biſhop of Rome. It is a Jewiſh title of honour, given to certain rabbins, called *tanaites*; and it is alſo particularly uſed, by ſome writers of the middle age, for the ſuperior of a monaſtery, uſually called *abbot*.

ABBE', in a monaſtic ſenſe, the ſame with ABBOT. Abbé, in a modern ſenſe, is the name of a curious popular character in France, very much mentioned, but very little known, in Britain. The term is not to be rendered in our language, as the exiſtence of the being which it denominates is poſterior to the reformation, and no ſuch character was known among the Romaniſts till about a century and a half ago. Abbés, according to the ſtricteſt definition, are perſons who have not yet obtained any preciſe or fixed ſettlement in church or ſtate, but moſt heartily wiſh for, and would accept of, either, juſt as it may happen. In the mean while, their privileges are many. They are admiſſible in all companies, and no degradation to the beſt, notwithſtanding they are ſometimes found in the worſt. Their dreſs is rather that of an academic, or of a profeſſed ſcholar, than of an eccleſiaſtic; and never varying in colour, is no encumbrance on the pocket. Theſe abbés are very numerous, and no leſs uſeful. They are, in colleges, the inſtructors of youth; in private families, tutors of young gentlemen: and many procure a decent livelihood by their literary and witty compoſitions of all kinds, from the profoundeſt philoſophy to the moſt airy romances. They are, in ſhort, a body of men who poſſeſs a fund of univerſal talents and learning, and are inceſſantly employed in the cultivation of every various branch of literature and ingenuity. No ſubject whatever eſcapes them; ſerious or gay, ſolid or ludicrous, ſacred or profane; all pay tribute to their reſearches; and as they are converſant in the loweſt as well as the higheſt topics, their fame is equally great in the learned and in the ſcribbling world. A diſtinguiſhing part of their character, too, though we ſhall but ſlightly touch it, is their devotion to the fair ſex, whoſe favourites, in return, they have the honour of being in the moſt enviable degree; the wit and ſmartneſs for which they are uſually remarkable, being juſt the very thing that ſuits the French ladies. In fine, theſe abbés are ſought after by moſt people on various accounts; as they are equally men of buſineſs and pleaſure; not leſs expert in the moſt ſerious tranſactions, than fond of enjoying their ſhare in whatever occupies the gay world. Hence they diligently frequent all public ſpectacles, which are thought incomplete without them; as they compoſe the moſt intelligent part of the company, and are the moſt weighty approvers or condemners of what paſſes in almoſt all places.

ABBESS, the ſuperior of an abbey or convent of nuns. The abbeſs has the ſame rights and authority over her nuns that the abbots regularly have over their monks. The ſex, indeed, does not allow her to perform the ſpiritual functions annexed to the prieſthood, wherewith the abbot is uſually inveſted; but there are inſtances of ſome abbeſſes who have a right, or rather a privilege, to commiſſion a prieſt to act for them. They have even a kind of epiſcopal juriſdiction, as well as ſome abbots who are exempted from the viſitation of their dioceſans. Martene, in his Treatiſe on the Rights of the Church, obſerves, that ſome abbeſſes have formerly confeſſed their nuns. But he adds, that their exceſſive curioſity carried them ſuch lengths, that there aroſe a neceſſity of checking it.

ABBEY, a monaſtery or religious houſe, governed by a ſuperior under the title of *abbot* or *abbeſs*. In our ancient ſtatutes the word is ſometimes alſo written *abbathy*. By 31 H. VIII. c. 13. *abbathies* are given to the king.

Abbeys differ from *Priories*, in that the one are under the direction of an abbot, and the other of a prior; but abbot and prior (we mean a prior conventual) are much the ſame thing, and differ in little but the name. One third of the beſt beneflces in England were anciently, by the pope's grants, appropriated to *abbeys*, and other religious houſes; which, upon their diſſolution under king Henry VIII. became lay-fees. For an eſtimate of the number and value of religious houſes aboliſhed and ſurrendered in this reign, ſee MONASTERY.

Fauchet obſerves, that, in the early days of the French monarchy, dukes and counts were called *abbots*, and duchies and counties *abbeys*. Even ſome of their kings are mentioned in hiſtory under the title of *abbots*. Philip I. Louis VI. and afterwards the duke of Orleans, were called *abbots of the monaſtery of St. Aignan*. The dukes of Aquitain were called *abbots of the monaſtery of St. Hilary*; and the earls of Anjou, of *St. Aubin*, &c. At the Revolution in France, *Abbeys* were either demoliſhed, or converted to public uſes; and the monaſtic orders were totally aboliſhed, ſo far as the authority of the National Convention extended; while they continued in the original form, according to the firſt inſtitution, in La Vendée, amongſt the Chouans, and others attached to the cauſe of Royalty; and theſe inſtitutions were continued to the Chouans, under Charette, in 1795, upon their declaration of ſubmiſſion to the laws of the Republic one and indiviſible, which therefore confirmed them in the free exerciſe of their religion.

Monaſteries were at firſt nothing more than religious houſes, whither perſons retired from the buſtle of the world to ſpend their time in ſolitude and devotion. But they ſoon degenerated from their original inſtitution, and procured large privileges, exemptions, and riches. They prevailed greatly in Britain before the Reformation, particularly in England; and as they increaſed in riches, ſo the ſtate became poor; for the lands which theſe regulars poſſeſſed were in *mortua manu*, i. e. could never revert to the lords who gave them. This inconvenience gave riſe to the ſtatutes againſt gifts in *mortmaine*, which prohibited donations to theſe religious houſes: and Lord Coke tells us, that ſeveral lords, at their creation, had a clauſe in their grant, that the donor might give or ſell his land to whom he would, *exceptis viris religioſis & Judæis*: excepting monks and Jews.

Theſe places were wholly aboliſhed in England at the time of the Reformation; Henry VIII. having firſt appointed viſitors to inſpect into the lives of the monks and nuns, which were found in ſome places very diſorderly; upon which the abbots, perceiving their diſſolution unavoidable, were induced to reſign their houſes to the king, who by that means became inveſted with the abbey-lands: theſe were afterwards granted to different perſons, whoſe deſcendants enjoy them at this day: they were then valued at 2,853,000*l.* per annum, an immenſe ſum in thoſe days. Though the ſuppreſſion of religious houſes, even conſidered in a political light only, was of a very great national benefit, it muſt be owned, that, at the time they flouriſhed, they were not entirely uſeleſs. Abbeys or monaſteries were then the repoſitories, as well as the ſeminaries, of learning: many valuable books and national records, as well as private evidences, have been preſerved in their libraries; the only places wherein they could have been ſafely lodged in thoſe turbulent times. Many of thoſe, which had eſcaped the ravages of the Danes, were deſtroyed, with more than Gothic barbarity, at the diſſolution of the abbeys. Theſe ravages are pathetically lamented by John Bale, in his Declaration upon Leland's Journal, 1549. "Covetouſneſs (ſays he) was at that time ſo buſy about private commodity, that public

wealth, in that moſt neceſſary reſpect, was not any where regarded. A number of thoſe who purchaſed theſe ſuperſtitious manſions, reſerved many of the library books, ſome to ſerve their jacks, ſome to ſcour the candleſticks, and ſome to rub their boots; ſome they ſold to the grocer and ſoap-ſeller; and ſome they ſent over ſea to the book-binders, not in ſmall numbers, but in whole ſhips full: yea, the univerſities of this realm are not clear of ſo deteſtable a fact. I know a merchant that bought the contents of two noble libraries for 40s. price; a ſhame it is to be ſpoken! This hath he occupied inſtead of grey paper, for the ſpace of more than theſe ten years, and yet he hath ſtore enough for as many years to come. I ſhall judge this to be true, and utter it with heavineſs, that neither the Britons, under the Romans and Saxons, nor yet the Engliſh people, under the Danes and Normans, had ever ſuch damage of their learned monuments as we have ſeen in our time." In theſe days every abbey had at leaſt one perſon whoſe office it was to inſtruct youth; and the hiſtorians of this country are chiefly beholden to the monks for the knowledge they have of former national events. In theſe houſes alſo the arts of painting, architecture, and printing, were cultivated. The religious houſes alſo were hoſpitals for the ſick and poor; affording likewiſe entertainment to travellers at a time when there were no inns. In them the nobility and gentry, who were heirs to their founders, could provide for a certain number of ancient and faithful ſervants, by procuring them corodies, or ſtated allowances of meat, drink, and clothes. They were likewiſe an aſylum for aged and indigent perſons of good family. The neighbouring places were alſo greatly benefited by the fairs procured for them, and by their exemption from foreſt-laws; add to which, that the monaſtic eſtates were generally let at very eaſy rents, the fines given at renewals included.

ABBOT, or ABBAT, the ſuperior of a monaſtery of monks erected into an abbey or prelacy. The name *Abbot* is originally Hebrew, where it ſignifies *father*. The Jews called *father*, in their language, *Ab*; whence the Chaldeans and Syrians formed *Abba*; thence the Greeks ἀββᾶς, which the Latins retained, *Abbas*; and hence our *Abbot*, the French *Abbé*, &c. St. Mark and St. Paul uſed the Syriac *Abba* in the Greek, by reaſon it was then commonly known in the ſynagogues and the primitive aſſemblies of the Chriſtians; adding to it, by way of interpretation, the word *father*. ἀββᾶ ὁ πατήρ, "Abba, father; *q. d.* Abba, that is to ſay, Father. But the name Ab, or Abba, which at firſt was a term of tenderneſs and affection in the Hebrew and Chaldee, became at length a title of dignity and honour. The Jewiſh doctors affected it; and one of their moſt ancient books, containing the ſayings or apophthegms of divers of them, is intitled Pirke *Abboth*, or Avoth; *i. e.* Chapters of the Fathers. It was in alluſion to this affectation, that Jeſus Chriſt forbad his diſciples to call any man their father on earth; which word St. Jerome turns againſt the ſuperiors of the monaſteries of his time, for aſſuming the title of *Abbots*, or Fathers. The name *Abbot*, then, appears as old as the inſtitution of monks itſelf. The governors of the primitive monaſteries aſſumed indifferently the titles of *Abbots* and *Archimandrites*. They were really diſtinguiſhed from the clergy, though frequently confounded with them, becauſe a degree above laymen. In thoſe early days, the abbots were ſubject to the biſhops and the ordinary paſtors. Their monaſteries being remote from cities, built in the fartheſt ſolitudes, they had no ſhare in eccleſiaſtical affairs. They went on Sundays to the pariſh-church with the reſt of the people; or, if they were too remote, a prieſt was ſent them to adminiſter the ſacraments; till at length they were allowed to have prieſts of their own body. The abbot, or archimandrite, himſelf, was uſually the prieſt; but his function extended no farther than to the ſpiritual aſſiſtance of his monaſtery; and he remained ſtill in obedience to the biſhop. There being among the abbots ſeveral perſons of learning, they made a vigorous oppoſition to the riſing hereſies of thoſe times; which firſt occaſioned the biſhops to call them out of their deſarts, and fix them about the ſuburbs of cities, and at length in the cities themſelves; from which æra their degeneracy is to be dated. The abbots now ſoon wore off their former plainneſs and ſimplicity, and began to be looked on as a ſort of little prelates. They aſpired at being independent of the biſhops; and became ſo inſupportable, that ſome ſevere laws were made againſt them at the Council of Chalcedon. Notwithſtanding this, in time, many of them carried the point of independency, and got the appellation of *lord*, with other badges of the epiſcopate, particularly the mitre. Hence aroſe new ſpecies of diſtinctions of *abbots; mitred*, and *not mitred; crozjered*, and *not crozjered; œcumenical abbots, cardinal abbots*, &c. Thoſe were termed *mitred* abbots, who were privileged to wear the mitre, and exerciſe epiſcopal authority within their reſpective precincts, being exempted from the juriſdiction of the biſhop. Among us, the mitred abbots were lords of parliament; and called *abbots-ſovereign*, and *abbots-general*, to diſtinguiſh them from the other abbots. And as there were lords abbots, ſo there were alſo lords priors, who had exempt juriſdiction, and were likewiſe lords of Parliament. Some reckon 26 of theſe lords abbots and priors that ſat in parliament. Sir Edward Coke ſays, that there were 27 parliamentary abbots and two priors. In the parliament 20 Rich II. there were but 25 abbots and two priors; but in the ſummons to parliament *anno* 4 Ed. III. more are named. Thoſe who were *not mitred* were ſubject to the *dioceſan*. Others were called *crozjered abbots*, from their bearing the croſier or paſtoral ſtaff. Others were ſtiled *œcumenical* or *univerſal abbots*, in imitation of the patriarch of Conſtantinople; while others were termed *cardinal abbots*, from their ſuperiority over all other abbots. *Abbots* were likewiſe diſtinguiſhed into *abbots elective* and *abbots preſentative*; but are now chiefly diſtinguiſhed into *regular* and *commendatory*.

Regular ABBOTS are real monks, or religious, who have taken the vows, and wear the habit of the *order*.

ABBOTS *in commendam* are ſeculars; though they have undergone the tonſure, and are obliged, by their bulls, to take orders when they come of age. Though the term *commendam* inſinuates, that they have only the adminiſtration of their abbeys for a time, yet they do hold and reap the fruits of them for ever, as well as the regular *abbots*. Their *bulls* give them a full power *tam in ſpiritualibus quam in temporalibus*; and yet it is true, that the commendatory *abbots* do not perform any ſpiritual offices; nor have they any ſpiritual juriſdiction over their monks. So that the phraſe *in ſpiritualibus* is rather ſomething of the Roman ſtyle than a reality.

The ceremony whereby *abbots* are created, is properly called benedictions; or ſometimes, though abuſively, conſecration. It anciently conſiſted in cloathing him with the habit called *cuculla, a cowl*; putting the paſtoral ſtaff in his hand; and the ſhoes called *pedales*, or *pedules*, on his feet. Theſe particulars we learn from the *Ordo Romanus* of Theodore, archbiſhop of Canterbury.

Abbot is alſo a title which has been given to certain biſhops, becauſe their ſees had originally been abbeys; and they were even elected by the monks: ſuch are thoſe of Catanea and of Montreal in Sicily.

Abbot is alſo an appellation ſometimes given to the ſuperiors or generals of ſome congregations of regular *canons*, as that of St. Genevieve at Paris.

Abbot is alſo a title borne by ſeveral magiſtrates, and other layperſons. Among the Genoeſe, one of their principal magiſtrates was called the *abbot* of the people. In France, particularly about the time of Charlemagne, there were ſeveral lords and courtiers, who, having the ſuperintendency of certain abbeys committed to them, were ſtyled *abbacomites*, or *abbey-counts*.

ABBREVIATION, ABBREVIATURE, a contraction of a word, or paſſage, made by dropping ſome of the letters, or by ſubſtituting certain marks, or characters, in their place. Lawyers, phyſicians, &c. uſe abundance of *abbreviatures*; partly for the ſake of expedition, and partly for that of myſtery. For a liſt of the principal *abbreviatures* in the ſeveral arts and faculties, ſee the Article CHARACTER. See alſo the Plate of CHYMICAL CHARACTERS. Of all people, the Rabbins are the moſt remarkable for this practice; ſo that their writings are unintelligible, without an explication of the Hebrew *abbreviatures*. The Jewiſh authors and copyiſts do not content themſelves to abbreviate words, like the Greeks and Latins, by retrenching ſome of the letters or ſyllables thereof, but they frequently take away all but the initial letters. Thus ר ſtands for *rabbi*, and ר for רב or רבן or רבי according to the place it is found *in*. But ſtill farther, they frequently take the initial letters of ſeveral ſucceeding words, join them together, and adding vowels to them, make a barbarous ſort of word, repreſentative of all the words thus abridged. Thus, *Rabbi Schelemoh Jarchi*, in the jargon of Hebrew *abbreviatures*, is called *Raſi*; and *Rabbi Moſes Ben Maimon*, is *Rambam*. Mercerus, David de Pomis, Schindler, Buxtorf, &c. have given explications of ſuch *abbreviatures*. The moſt copious collection of Roman *abbreviatures* is that of Sertorius Urſatus: *Sertorii Urſati, equitis, de notis Romanorum commentarius*.

ABBREVIATOR, in a general ſenſe, a perſon who abbreviates any large book into a narrow compaſs. It is more particularly uſed for an officer in the court of Rome, appointed as aſſiſtant to the vice-chancellor, for drawing up the pope's briefs, and reducing petitions, when granted by the pontiff, into proper form, for being converted into bulls. The *abbreviators* are ſuppoſed, by Clampini, to be the ſucceſſors either of the *cancellarii* in the imperial houſhold, or of the ſeven *notarii*, ſaid to have been placed by pope Clement I. in the ſeven quarters of Rome, to write down the acts of the martyrs within their reſpective diſtricts. They are ſaid to have taken their name, either from their writing the *breves, briefs*, or ſhort epiſtles of the pope; or from their making uſe of *notæ*, or abbreviations in writing. The latter opinion may ſeem the more probable, becauſe the name is ſometimes uſed by writers of the ſixth age, as ſynonymous with *notarii*, or *abbreviatores*. The *abbreviators* at preſent make a college of ſeventy-two perſons, divided into two ranks; one called *abbreviatores de parco majore*, who are twelve in number, all prelates; the other *abbreviatores de parco minore*, called alſo *examinatores*, who may be laymen. Clampini has two volumes on the inſtitution, offices, privileges, ceremonies, &c. of the *abbreviators*.

ABDALS, in the eaſtern countries, a kind of ſaints, ſuppoſed to be inſpired to a degree of madneſs. The word comes, perhaps, from the Arabic *Abdallah*, the Servant of God. The Perſians call them *devaneh khoda*, ſimilar to the Latins way of ſpeaking of their prophets and ſybils, *q. d. furentes dei*, raging with the god. They are often carried by exceſs of zeal, eſpecially in the Indies, to run about the ſtreets, and kill all they meet

of a different religion; of which travellers furnish many instances. The English call this *running a muk*, from the name of the instrument, a sort of poniard, which they employ on those desperate occasions. If they are killed, as it commonly happens, before they have done much mischief, they reckon it highly meritorious; and are esteemed, by the vulgar, martyrs for their faith.

ABDEST, among the Mahometans, a peculiar manner of washing, before prayer, entering the mosque, or reading the Alcoran; practised with some difference both by Turks and Persians. See ABLUTION.

ABDICATION, ABDICATIO, derived from *abdicare*, to renounce, the act whereby a magistrate, or person in office, renounces and gives up the same, before the legal term of service is expired. *Abdication* is frequently confounded with *resignation*; but, strictly speaking, there is a difference; *abdication* being done purely and simply; whereas *resignation* is done in favour of some other person. In this sense, Diocletian is said to have *abdicated* the crown; but Philip IV. of Spain, *resigned* it. It is said to be a renunciation, quitting, and relinquishing, so as to have nothing further to do with a thing; or the doing of such actions as are inconsistent with the holding of it.

The parliament of England voted king James's violation of the laws, and his quitting the kingdom, without providing for the due administration of affairs in his absence, to import an *abdication* of the crown. The lords would have the word *desertion* made use of; but the commons thought it was not comprehensive enough, because the king might then have the liberty of returning. The Scots called it a *forfeiture* of the crown, from the verb *forisfacio*. Among the Roman writers it is more particularly used for the act whereby a father disowned or disclaimed his son, and expelled him the family. It is distinguished from *exheredatio*, or disinheriting, in that the former was done in the father's lifetime; the latter, by will at his death: so that whoever was abdicated, was also disinherited; but not *vice versa*.

ABDITÆ *Causæ* are the secret or remote causes of distempers, which physicians of the dogmatic, or rational sect, affirmed, were necessary to be known, in order to establish a right method of cure.

ABDOMEN, in anatomy, the belly, or lower venter; or that part of the body comprehended between the *thorax* and the hips. Anatomists usually divide the body into three regions, or venters; the head, the thorax, or breast, and the *abdomen*, which makes the lowest part of the trunk; being terminated by the diaphragm above, and by the *inguen* or *pubis* below. The *abdomen* is lined internally with a thin, soft membrane, which investing all the *viscera* above mentioned, contains and keeps them in their place: this is called the *peritonæum*; upon a rupture or dilatation whereof, they are apt to fall, and form those tumours called *herniæ*. It is covered and defended with five pair of muscles; which not only defend the *viscera*, but, by their alternate relaxations, and contractions, in respiration, promote the action of digestion, and the extrusion of the *fæces* and urine. By their contraction, the cavity of the *abdomen* is straitened, and the descent of the contents of the *viscera* through the intestines is promoted. They are the proper antagonists to the sphincters of the *anus* and bladder, and forcibly expel the excrements of those parts, as also the *fœtus* in parturition. These muscles are the *obliqui descendentes* and *ascendentes*, the *rectus transversalis* and *pyramidalis*. See the SYSTEM, Part II. Table, Art. 15.

The cavity of the abdomen, formed by the parts already mentioned (all which are covered by the skin and membrana adiposa) is lined on the inside by a particular membrane, called *peritonæum*. It is separated from the cavity of the thorax by the diaphragm, and terminated below by the *musculi levatores ani*. This cavity contains the stomach and the intestines, which are commonly divided into three small parts, named duodenum, jejunum, and ilium; and three larger, called cæcum, colon, and rectum. It contains, likewise, the mesentery, mesocolon, omentum, liver, gall-bladder, spleen, pancreas, glands of the mesentery, vasa lactea, receptaculum chyli, kidneys, renal glands, ureters, bladder, and the internal parts of generation in both sexes.—For a more copious account of the abdomen, and its several parts, see the System of ANATOMY, Part. III. Sect. I. to X. For representation, see Plate V.

Diseases of the ABDOMEN, are inflammations, suppurations, *schirrus*, indurations, inflations, *tympanies*, &c. Hence the *abdomen* becomes the seat of divers operations; as perforations, sutures, sections, &c.

Wounds of the ABDOMEN may be considered as of four kinds. 1. Such as affect the integuments only. 2. Such as affect the muscles, together with the integuments, without penetrating the *peritonæum*. 3. Such as with the integuments penetrate into the cavity, without wounding any of its contents. 4. Such as penetrating into the cavity, wound some or other of its contents. The first sort, or superficial wounds of the *abdomen*, are not esteemed dangerous, and require no treatment different from other wounds. However, Aræus (lib. ii. cap. 4.) and Vigo (lib. iii. cap. 11.) agree in pronouncing those more liable to bad accidents, which are received within two or three fingers breadth of the navel. The second sort are distinguished from the two last by the probe; for if the patient is carefully placed in the situation he was in when the wound was given, and the probe be introduced, it will generally pass into the cavity of the *abdomen*, if the *peritonæum* is perforated. Another way of distinguishing these wounds is by injecting warm water into them; and if it returns immediately, there is reason to believe the wound to be only muscular; but if any considerable quantity remains in the wound, the cavity is certainly penetrated. If the wound is large, great skill is required in the surgeon, especially if it is made in a transverse or oblique direction; for in this case the suture is necessary to keep the gaping lips of the wound together. Having taken these precautions to preserve the intestines and *peritonæum* in their natural situation, the wound is to be dressed with vulnerary balsams, and an adhesive plaster: the patient must also be enjoined abstinence, must have rest, and his bowels must be kept open. In wounds of the *abdomen* that penetrate into its cavity, the surgeon is first to examine very carefully, whether any of its contents partake of the injury. It will be found that this is not the case, if there is no great degree of weakness, hæmorrhage, pain, fever, &c. If, on laying the patient upon the wounded side, there is no discharge of chyle, gall, excrement, or urine; if milk, being injected warm, returns without any alteration in its colour; if the inflicting instrument has not been very sharp; and lastly, if there is no vomiting or discharge of blood by the mouth, stool, or urine, nor swelling or hardness of the belly. We have some very valuable remarks on the hydropical tumors of the *abdomen* in the Medical Essays of Edinburgh, vol. v. art 50.

The muscles of the belly are subject to inflammation, which have been mistaken for inflammation in the liver. Hernius says, that these muscles have a very thick membrane, which will not readily admit of the exit of pus when it is formed; he therefore advises to open them by incision, sooner than is usual in other instances of abscesses. The rheumatism sometimes affects the muscles of the belly, and the case is mistaken for a colic, or for an inflammation of some of the viscera within: in this case, however, the usual symptoms of inflamed viscera are absent, and the medicines which are useful in the colic are without effect in this case.

There is a *sinus* on each side of the *cartilago xiphoides*, between the muscles called *recti* and *transversalis*, into which, on the left side, by violent vomiting, the stomach is sometimes ruptured. This occasions excessive pain, which is greater when the patient is up, and suspended by his lying in an horizontal posture: this circumstance is the pathognomic sign of the disease, to remove which, in case of its continuing obstinate, the place must be laid open, and the rupture reduced in the ordinary manner.

ABDOMINALES, in the Linnæan system of ichthyology, an order of fish, having the ventral fins placed behind the pectoral in the abdomen, and comprehending seventeen genera, and one hundred and twenty-seven species. For the generic descriptions and classification, see the SYSTEM, Order V.

ABDUCTION, in logic, a kind of argumentation, by the Greeks called *apagoge*; wherein the greater extreme is evidently contained in the medium, but the medium not so evidently in the lesser extreme as not to require some further medium, or proof, to make it appear. It is called *abduction*, from *ab*, from, and *ducere*, to draw; because, from the conclusion, it draws us on to prove the proposition assumed. Thus, in the syllogism, "All whom God absolves are free of sin; but God absolves all who are in Christ; therefore, all who are in Christ are free of sin;" the major is evident; but the minor, or assumption, is not so, without some other proposition to prove it; as "God received satisfaction for sin by the suffering of Jesus Christ." See the System of Logic, Part III. Section I, II, III, and IV.

ABDUCTION, in surgery, denotes a species of *fracture*, wherein the bone near the joint is so divided transversely, that the extremities recede from each other.

ABDUCTOR, or ABDUCENT, in anatomy, a name common to several muscles, whose action is the withdrawing, opening, or pulling back, the parts they are fixed to. The name is compounded of *ab*, from, and *ducere*, to draw. Their antagonists are called ABDUCTORES.—For a copious and particular account of the origin, insertion, and uses of the several muscles, as they appertain to the upper and lower extremities, see the SYSTEM, Part IV. Section II. Table of Muscles, Art. 25 and 27.

ABERRATION, in astronomy, a small apparent motion of the fixed stars, discovered by the late Dr. Bradley. The discovery was made by accident in the year 1725, when Mr. Molyneux and Dr. Bradley began to observe the bright star in the head of *Draco*, marked γ by Bayer, as it passed near the zenith, with an instrument made by Mr. Graham, in order to discover the parallax of the earth's annual orbit; and, after repeated observations, they found this star, about the beginning of March, 1726, to be 20″ more southerly than at the time of the first observation. It now indeed seemed to have arrived at its utmost limit southward: because, in several trials made about this time, no sensible difference was observed in its situation. By the middle of April, it appeared to be returning back again towards the north; and, about the beginning of June, it passed at the same distance from the zenith as it had done in December, when it was first observed. In September following, it appeared 39″ more northerly than it was in March, just the contrary way to what it ought to appear by the annual parallax of the stars. This unexpected phenomenon perplexed the observers very much; and Mr. Molyneux died before

fore the true cauſe of it was diſcovered. After this, Dr. Bradley, with another inſtrument, more exact, and accurately adapted to this purpoſe, obſerved the ſame appearances, not only in that but many other ſtars; and, by the great regularity that appeared in a ſeries of obſervations made in all parts of the year, the Doctor was fully ſatisfied with regard to the general laws of the phenomena, and therefore endeavoured to find out the cauſe of them. He was already convinced that the apparent motion of the ſtars was not owing to a nutation of the earth's axis. The next thing that offered itſelf, was an alteration in the direction of the plumb-line, with which the inſtrument was conſtantly rectified; but this, upon trial, proved inſufficient. Then he had recourſe to what refraction might do, but here alſo nothing ſatisfactory occurred. At laſt this acute aſtronomer found, that the phenomena in queſtion proceeded from the progreſſive motion of light, and the earth's annual motion in its orbit: for he perceived, that if light was propagated in time, the apparent place of a fixed object would not be the ſame when the eye is at reſt, as when it is moving in any other direction than that of the line paſſing through the eye and object; and that, when the eye is moving in different directions, the apparent place of the object would be different. As we have introduced in the work a *complete ſyſtem of* ASTRONOMY, it would be incompatible with our plan to enlarge further on this article in the alphabet; we ſhall therefore avoid the error which prevails in other works, and refer our readers to the SYSTEM, Sect. II. and Plate IV. for a *copious* illuſtration of the ſubject.

ABERRATION, in optics, is uſed to denote that error or deviation of the rays of light, when inflected by a lens or ſpeculum, whereby they are hindered from meeting or uniting in the ſame point, called the *geometrical focus*; it is either lateral or longitudinal. The lateral *aberration* is meaſured by a perpendicular to the axis of the ſpeculum, produced by the focus, to meet the reflected or refracted ray: the longitudinal *aberration* is the diſtance of the focus from the point in which the ſame ray interſects the axis. If the focal diſtance of any lenſes be given, their apertures be ſmall, and the incident rays homogeneous and parallel, the longitudinal *aberrations* will be as the ſquares, and the lateral *aberrations* as the cubes, of the linear apertures.

There are two ſpecies of *aberration*, diſtinguiſhed by their different cauſes; one ariſing from the figure of the glaſs or ſpeculum; the other from the unequal refrangibility of the rays of light. The ſecond ſpecies of *aberration* is ſometimes called the Newtonian, from the name of its inventor. The former ſpecies of *aberration* is altogether inconſiderable, compared with the latter; inſomuch, that if the object glaſs of a teleſcope be plano-convex, and the plane ſide be turned toward the object, and the diameter of the ſphere, to which the convex ſide of the glaſs is ground, be 100 feet, the ſemidiameter of the aperture be two inches, and the ratio of the ſine of incidence out of glaſs into air be to that of refraction as 20 to 31, the diameter of the circle of *aberrations* will in this caſe be only $\frac{961}{7200000}$ parts of an inch. But the diameter of the little circle, through which the ſame rays are ſcattered by unequal refrangibility, will be about the 55th part of the breadth of the aperture of the object-glaſs, which is here four inches; and therefore the error ariſing from the ſpherical figure of the glaſs is to the error ariſing from the different refrangibility of the rays, as $\frac{961}{7200000}$ to $\frac{4}{55}$; that is, as 1 to 5449. See Newton's Optics. p. 83. or Smith's Optics, book ii. cap. 6. where this propoſition is demonſtrated. In conſequence of this diſcovery, and the apprehenſion, that equal refractions muſt produce equal divergencies in every ſort of medium, it was imagined that all ſpherical object-glaſſes of teleſcopes would be equally affected by the different refrangibility of light in proportion to their aperture, of whatever materials they were conſtructed; and therefore, that the only improvement of which refracting teleſcopes were capable, was that of increaſing their length. On this account Sir Iſaac Newton, and others after him, deſpairing of ſucceſs in the manufacture and uſe of refracting lenſes, directed their chief attention to the conſtruction of reflecting teleſcopes. However, in 1747, Mr. Euler applied himſelf to the ſubject of refraction, and, purſuing a hint ſuggeſted by Sir Iſaac Newton, formed a ſcheme of making object-glaſſes with two lenſes of glaſs, incloſing water between them; hoping that, by conſtructing them of different materials, the refractions would balance one another, and prevent the uſual *aberration*. Mr. Dollond examined this ſcheme, and found that Mr. Euler's principles were unſatisfactory. M. Clairaut likewiſe concurred in opinion, that his ſpeculations were more ingenious than uſeful.

This controverſy, which promiſed to be of great importance in the ſcience of optics, engaged the attention of M. Klingenſtierna of Sweden, and induced him carefully to examine the eighth experiment in the ſecond part of Newton's Optics, with the concluſions which he draws from it. He found that the rays of light, in the circumſtances there ſuppoſed, did not loſe their colour, as Sir Iſaac Newton imagined. This hint of the Swediſh philoſopher led Mr. Dollond to re-examine the ſame experiment; and it appeared, after accurate trials, that different ſubſtances made the light to diverge very differently, in proportion to their general refractive power; therefore, in the year 1757, he procured wedges of different kinds of glaſs, and applied them together, ſo that the refractions might be made in contrary directions, in order to diſcover whether the refraction and divergency of colour would vaniſh together. The reſult of his firſt trials encouraged him to perſevere; for he diſcovered a difference far beyond his hopes in the refractive qualities of different kinds of glaſs, with reſpect to their divergency of colours. The Venice glaſs, and the Engliſh crown glaſs, were found to be nearly allied in this reſpect; the common Engliſh plate glaſs made the light diverge more, and the Engliſh flint glaſs moſt of all. Without enquiring into the cauſe of this difference, he proceeded to adapt wedges of crown glaſs, and of white flint glaſs, ground to different angles, to each other, ſo as to refract in different directions; and the refracted light was intirely free from colours. Having meaſured the refractions of each wedge, he found that of the white glaſs to be to that of the crown glaſs nearly as *two* to *three*: and he deduced this general concluſion, that any two wedges, made in this proportion, and applied together ſo as to refract in contrary directions, would refract the light without any *aberration* of the rays.

Mr. Dollond's next object was to make ſimilar trials with ſpherical glaſſes, of different materials; and, in order to obtain a refraction of light in contrary directions, one muſt be concave, and the other convex. The latter, which was to refract the moſt, that the rays might converge to a real focus, was made of crown glaſs, and the former of white flint glaſs: and the refractions of ſpherical glaſſes being an inverſe ratio of their focal diſtances, it was neceſſary that the focal diſtances of the two glaſſes ſhould be inverſely as the ratios of the refractions of the wedges; for, being thus proportioned, every ray of light that paſſes through this combined glaſs, at any diſtance from its axis, will conſtantly be refracted, by the difference between two contrary refractions, in the proportion required; and therefore the different refrangibility of the light will be intirely removed. But in the applications of this admirable diſcovery to practice, many difficulties occurred. At length, however, by repeated trials, and reſolute perſeverance, Mr. Dollond ſucceeded ſo far as to conſtruct refracting teleſcopes much ſuperior to any that had before been uſed, repreſenting objects with great diſtinctneſs, and in their true colours. M. Clairaut, who intereſted himſelf betimes in this diſcovery, endeavoured to aſcertain the principles of Mr. Dollond's theory, and to lay down rules for facilitating the conſtruction of theſe new teleſcopes. With this view he made ſeveral experiments, in order to determine the refractive powers of different kinds of glaſs, and the proportion in which they ſeparated the rays of light; and from theſe experiments he deduced ſeveral theorems and problems of general uſe. M. D'Alembert likewiſe made a great variety of calculations to the ſame purpoſe; and ſhewed how to correct the errors to which theſe teleſcopes are ſubject, by placing the object-glaſſes, in ſome caſes, at a ſmall diſtance from one another; and ſometimes by uſing eye-glaſſes of different refractive powers. But though foreigners were hereby ſupplied with the moſt accurate calculations, they were very defective in practice. The Engliſh teleſcopes, made, as they imagined, without any exact rule, were greatly ſuperior to the beſt of their conſtruction.

Mr. Euler, who firſt gave occaſion to this important and uſeful enquiry, was very reluctant in admitting Mr. Dollond's improvements, becauſe they militated againſt a pre-conceived theory of his own. At laſt, however, convinced of their reality and importance by M. Clairaut, he aſſented; and ſoon after received farther ſatisfaction from the experiments of M. Zeiher, of Peterſburgh, who demonſtrated, that it is the *lead* in the compoſition of glaſs which gives it this remarkable property: that, while the refraction of the mean rays is nearly the ſame, that of the extreme rays conſiderably differs; and by increaſing the lead, he produced a kind of glaſs, which occaſioned a much greater ſeparation of the extreme rays than the flint glaſs which Mr. Dollond had made uſe of, and at the ſame time conſiderably increaſed the mean refraction. M. Zeiher, in the courſe of his experiments, made glaſs of minium and flint, with a mixture of alkaline ſalts; and found that this mixture greatly diminiſhed the mean refraction, without making hardly any change in the diſperſion; and at length obtained a kind of glaſs greatly ſuperior to the flint glaſs of Mr. Dollond for the conſtruction of teleſcopes; ſince it occaſioned *three* times as great a diſperſion of the rays as the common glaſs, whilſt the mean refraction was only as 1.61 to 1.

In 1758, Mr. Dollond made a farther improvement in teleſcopes, by introducing two object glaſſes of crown glaſs, and one of flint. See Phil. Tranſ. vol. l. p. 735, 743; and vol. lv. p. 56. Hiſt. Ac. Par. 1756. p. 183. 624. Ditto 1767. p. 197. Swed. Mem. vol. xvi. p. 300. Ac. Berl. 1762 and 1766.—For a farther account of Mr. Dollond's new refracting or achromatic teleſcopes, ſee the Article TELESCOPE.

Crown of ABERRATION, is a luminous circle, ſurrounding the real diſk of the ſun, and depending on the *aberration* of the ſolar rays, whereby his apparent diameter is enlarged.

ABESTA, or AVESTA, the name of one of the ſacred books of the Perſian Magi; which they attribute to their great founder Zoroaſter, or Zeduſht. The Abeſta is a commentary or expoſition of two other of their religious books, called Zend and Pazend: the three together include the whole ſyſtem of the *Ignicolæ*, or Worſhippers of Fire. D'Herbel. Bibl. Orient. p. 11. Hyde de Rel. vet. Perſ. c 2. According to Du Perron, the *Avesta* ſignifies

ſignifies the language of the oriental text of Zoroaſter's works. Hiſt. Ac. Sc. Par. 1762.

ABETTOR, or ABETTOR, in law, one who incites or encourages another to perform ſomething criminal; or by ſome way aſſiſts him in the performance itſelf. Thus thoſe who procure others to ſue out falſe appeals of felony, or murder, againſt men, to render them infamous, are particularly denominated *abettors*. So *abettors* in *murder* are ſuch as adviſe or procure a murder to be committed, or are acceſſary thereto. There are *abettors* in *felony*, but not in *treaſon*; the law looking on all thoſe concerned in treaſon as principals.

ABEYANCE, or ABBAYANCE, in law, the expectancy of an eſtate: e. g. if lands are leaſed to one perſon as tenant for life, with reverſion to another for years, the remainder for years is in abeyance till the death of the leſſee. It is a maxim in law, that of every land, either there is a fee ſimple in ſomebody, or it is in *abeyance*. If a church become vacant by the death of a parſon, the freehold is ſaid to be in *abeyance* till a new parſon be inducted: for the patron has not the fee, but only the right of preſenting to it, the freehold itſelf being in the incumbent thus preſented, and therefore till ſuch preſentation in nobody.

ABGAR, or ABGARUS, a name given to ſeveral of the kings of Edeſſa, in Syria. The moſt celebrated of them is one who, it is ſaid, was contemporary with Jeſus Chriſt; and who, having a diſtemper in his feet, and hearing of Jeſus's miraculous cures, requeſted him by letter to come and cure him. Euſebius, who believed that this letter was genuine, and alſo an anſwer our Saviour is ſaid to have returned to it, has tranſlated them both from the Syriac, and aſſerts that they were taken out of the archives of the city of Edeſſa. The firſt is as follows: "Abgarus, prince of Edeſſa, to Jeſus the holy Saviour, who hath appeared in the fleſh in the confines of Jeruſalem, greeting. I have heard of thee, and of the cures thou haſt wrought without medicines or herbs. For it is reported thou makeſt the blind to ſee, the lame to walk, lepers to be clean, devils and unclean ſpirits to be expelled, ſuch as have been long diſeaſed to be healed, and the dead to be raiſed; all which, when I heard concerning thee, I concluded with myſelf, That either thou waſt a God come down from heaven, or the Son of God ſent to do theſe things. I have therefore written to thee, beſeeching thee to vouchſafe to come unto me, and cure my diſeaſe. For I have alſo heard that the Jews uſe thee ill, and lay ſnares to deſtroy thee. I have here a little city, pleaſantly ſituated, and ſufficient for us both. ABGARUS." To this letter, Jeſus is ſaid to have returned an anſwer by Annanias, Abgarus's courier, which was as follows: "Bleſſed art thou, O, Abgarus, who haſt believed in me whom thou haſt not ſeen; for the ſcriptures ſay of me, They who have ſeen me have not believed in me, that they who have not ſeen, may, by believing, have life. But whereas thou writeſt to have me come to thee, it is of neceſſity that I fulfil all things here for which I am ſent; and having finiſhed them, to return to him that ſent me: but when I am returned to him, I will then ſend one of my diſciples to thee, who ſhall cure thy malady, and give life to thee and thine. JESUS." After Jeſus's aſcenſion, Judas, who is alſo named Thomas, ſent Thaddeus, one of the ſeventy, to Abgarus, who preached the goſpel to him and his people, cured him of his diſorder, and wrought many other miracles; which was done, ſays Euſebius, A. D. 43. Though the above letters are acknowledged to be ſpurious by the candid writers of the church of Rome, ſeveral Proteſtant authors, as Dr. Parker, Dr. Cave, and Dr. Grabe, have maintained that they are genuine, and ought not to be rejected.

ABIANS, anciently a people of Thrace, or (according to ſome authors) of Scythia. They had no fixed habitations, but led a wandering life. Their houſes were waggons, which carried all their poſſeſſions. They lived on the fleſh of their herds and flocks, on milk, and cheeſe, chiefly on that of mare's milk. They were unacquainted with commerce. They only exchanged commodities with their neighbours. They poſſeſſed lands, but they did not cultivate them. They aſſigned their agriculture to any who would undertake it, reſerving only to themſelves a tribute; which they exacted, not with a view to live in affluence, but merely to enjoy the neceſſaries of life. They never took arms, but to oblige thoſe to make good a promiſe to them by whom it had been broken. They paid tribute to none of the neighbouring ſtates. They deemed themſelves exempt from ſuch an impoſition; for they relied on their ſtrength and courage, and conſequently thought themſelves able to repel any invaſion. The Abians, we are told, were a people of great integrity. This honourable eulogium is given them by Homer. (Strabo.)

ABIB, ſignifying an ear of corn, a name given by the Jews to the firſt month of their eccleſiaſtical year, afterwards called *Niſan*. It commenced at the vernal equinox; and, according to the courſe of the moon, by which their months were regulated, anſwered to the latter part of our March and beginning of April.

ABIDING by WRITINGS, in Scots law. When a perſon founds upon a writing alledged to be falſe, he may be obliged to declare judicially, whether he will ſtand or abide by it as a true deed.

ABILITY is uſed, in law, for a capacity of doing certain things, relating either to the acquiſition of property, or the tranſferring of it. *Ability* in this ſenſe coincides with *capacity*; and ſtands oppoſed to *diſability* or *non-ability*. Every perſon is ſuppoſed to be *able*, i. e. to have the power of taking and diſpoſing of effects, whom the law does not diſable. The king's iſſue are of *ability* to inherit in England wherſoever born; and children of ſubjects born beyond ſea may inherit, if their birth were within the allegiance of the king.

AB-INTESTATE, in the civil law, is applied to a perſon who inherits from one who died inteſtate.

ABJURATION, in a general ſenſe, the act of denying or renouncing a thing in a ſolemn manner, and even with an oath. *Abjuration* is more particularly uſed for a ſolemn recantation or renunciation of ſome doctrine, or opinion, as falſe and pernicious. In our own laws, to *abjure* a perſon, is to renounce all authority or dominion of ſuch a perſon. By the *oath of abjuration*, a perſon binds himſelf not to own any regal authority in the perſon called the pretender, or even to pay him the obedience of a ſubject. 1 W. and M. 13 W. III. 1 Geo. I. The refuſers of the oath enjoined by theſe ſtatutes are liable to ſundry penalties, forfeitures, &c.—The oath of *abjuration* by the 6th G. III. cap. 53. "I, A. B. do truly and ſincerely acknowledge, profeſs, teſtify, and declare, in my conſcience, before God and the world, that our ſovereign lord king George is lawful and rightful king of this realm, and all other his majeſty's dominions thereunto belonging. And I do ſolemnly and ſincerely declare, that I do believe, in my conſcience, that not any of the deſcendants of the perſon who pretended to be prince of Wales during the life of the late king James the Second, and ſince his deceaſe pretended to be, and took upon himſelf the ſtyle and title of, king of England, by the name of James the Third, or of Scotland, by the name of James the Eighth, or the ſtyle and title of king of Great Britain, hath any right or title whatſoever to the crown of this realm, or any other the dominions thereunto belonging. And I do renounce, refuſe and abjure any allegiance or obedience to any of them. And I do ſwear, that I will bear faith and true allegiance to his majeſty king George, and him will defend to the utmoſt of my power, againſt all traiterous conſpiracies, and attempts whatſoever, which ſhall be made againſt his perſon, crown, and dignity. And I will do my utmoſt endeavour to diſcloſe and make known to his majeſty, and his ſucceſſors, all treaſons and traiterous conſpiracies which I ſhall know to be againſt him or any of them. And I do faithfully promiſe, to the utmoſt of my power, to ſupport, maintain, and defend the ſucceſſion of the crown againſt the deſcendants of the ſaid James, and againſt all other perſons whatſoever; which ſucceſſion, by an act, intitled, *An act for the further limitation of the crown, and better ſecuring the rights and liberties of the ſubject*, is and ſtands limited to the princeſs Sophia, electreſs and ducheſs dowager of Hanover, and the heirs of her body, being Proteſtants. And all theſe things I do plainly and ſincerely acknowledge and ſwear, according to theſe expreſs words by me ſpoken, and according to the plain and common ſenſe and underſtanding of the ſame words, without any equivocation, mental evaſion, or ſecret reſervation whatſoever. And I do make this recognition, acknowledgment, *abjuration*, renunciation; and promiſe heartily, willingly, and truly, upon the true faith of a Chriſtian. So help me God."—Though the deſcendants of James the Second, who abdicated the crown of theſe realms, are all extinct, this form of abjuration is ſtill retained to this day.

Abjuration is alſo uſed in our ancient cuſtoms, for an oath taken by a perſon guilty of felony; who, flying to a place of ſanctuary, would ſwear to forſake the realm for ever in lieu of other puniſhments. We alſo find inſtances of *temporary abjuration*, viz. for three years, for one year and a day, and the like. This, in ſome caſes, was admitted from criminals in lieu of death. The devotion for the church was ſo warm, from the time of Edward the Confeſſor to the Reformation, that if a man, having committed felony, could recover a church, or church-yard, before he was apprehended, it was an aſylum from which he could not be brought to take his trial at law; but confeſſing his crime to the juſtices, or coroner, and *abjuring* the kingdom, he was at liberty. By ſtat. 21 Jac. I. all uſe of ſanctuaries, and conſequently of *abjuration*, is taken away.

ABLACTATION, (from *ab*, and *lacte*, the taking a child from the milk of the breaſt,) the weaning of a child from the breaſt. When the mother wants health or ſtrength; hath two ſmall nipples, or ill formed ones; when the infant will not take the breaſt; when the mother's milk is bad, or in two ſmall a quantity; when the mother hath weak nerves, or apt eaſily to be ſurprized; theſe defects ſpoil the milk: if the child is ſuddenly taken ill, from the effects of the mother's fright, or anxiety; if the milk is often dried up quickly, when perhaps the infant hath the moſt occaſion for it; in ſuch like caſes, it is adviſeable to wean the child; yea, often abſolutely neceſſary. It can never be neceſſary to continue the breaſt more than eight or nine months; but generally, if a child is favoured with a good ſupply by ſucking, during his firſt three or four months, and is in a tolerable healthy ſtate, he will rarely be the worſe for weaning at this early period; ſo that if he is not rather weakly, and if difficulties attend his being ſuckled, there need not be any heſitation about taking him from the breaſt. If he feeds tolerably with the ſpoon, and is free from diſorder in his bowels, a tendency to convulſions, &c. weaning may be attempted at any time. But if feeding with the ſpoon is difficult; if the child is much ſubject to the gripes, &c. another nurſe ſhould be

ſought

ſought for, and weaning muſt be deferred until more favourable circumſtances attend. In general, the ſooner a child is weaned, the more eaſily it parts with the breaſt. Prudence directs to accuſtom a child to early feeding with the ſpoon, and to continue the ſame until the breaſt be wholly omitted.

Children, if healthy, may be weaned at any age; but as, in general, their digeſtion grows ſtrong enough at about nine or ten months, they ſhould only be fed once in ſix hours at the moſt, during the firſt two months; ſhould be entirely weaned from the breaſt as ſpeedily as is convenient, and alſo from all feeding in the night: for night feeding bloats them: and if they were not uſed to it in the firſt week, they would never want it. If they are not diſturbed from their birth, in a week or two, the child will be formed to a habit of ſleeping moſt of the night very quietly, awaking only when wet, on which occaſion it ſhould be laid dry.

The food ſhould be ſimple and light; not ſpoiled with ſugar, wine, and ſuch like additions; for they produce the diſeaſes that children are moſt troubled with. Unfermented flour makes a viſcid food, that turns ſour before it digeſts; and well fermented bread ſoon turns ſour; but if this latter is made into freſh panada every night and morning, or, in cool weather, every morning, the inconvenience of ſouring is prevented. To prevent acidity in the child's ſtomach by a daily uſe of vegetable food, give now and then a little freſh broth, made from either veal, mutton, or beef, once or twice in the day. Suppoſe, for example, a mixture of the equal parts of the gravy which is diſcharged in cutting a joint that is brought hot on the table, and warm water, to which may be added a little ſalt, and thus an excellent broth is readily made. This is ſaid to fill children with humours; it is true; but the humours are only of the moſt nouriſhing kind. Cow's milk, a little diluted with water, is an excellent ſubſtitute for the mother's; yet, as it is apt to turn ſour, add to it a little Liſbon ſugar. Rice is not ſo apt to turn ſour as wheat bread is; it therefore would be a more convenient food for children, and deſerves to be attended to. Toaſted bread, boiled in water till it is almoſt dry, then mixed with freſh milk, not boiled, is an agreeable change. As the teeth advance, the diet may increaſe in its ſolidity.

As to the quantity, let the appetite be the meaſure of it; obſerving to ſatisfy hunger, but no more, which may be thus managed: feed the child no longer than it eats with a degree of eagerneſs. In feeding, let the child be held in a ſitting poſture, and thus continue it until the ſtomach has nearly digeſted its contents. The too common practice of violently dancing and ſhaking the child ſhould be avoided.

Keep the child awake until it breaks wind after each time it is fed: divert it during the day as much as you can; and thus it will ſoon lay quiet all the night. Never awaken a child when it is aſleep, for thus ſickneſs and peeviſhneſs are often produced. As ſoon as teeth appear, give the child now and then a piece of fleſh meat in its hand to chew, but never give it any confectionaries. Muss *on the Management and Nurſing of Children.*

ABLACTATION, in the ancient agriculture, is a method of engrafting; wherein the eyon of one tree, being united for ſome time to the ſtock of another, is afterwards cut off, and as it were weaned from its mother-tree. Among the modern writers, *ablactation* is more uſually called INARCHING, or GRAFTING *by approach*.—For copious directions reſpecting this branch of gardening, ſee the SYSTEM, FRUIT GARDEN, MONTH OF FEBRUARY.

Ablactation is only practicable where the ſtock to be grafted on, and the tree from which the graft is to be taken, ſtand ſo near, that the branch or eyon may be applied without cutting off. Hence it is chiefly uſed on plants that grow in caſes; as orange, lemon, pomegranate trees, vines, jaſmine, &c. The ſeaſon is April or May. To perform it, the uſual method is, to take the branch intended for the graft, and pare it away, both the rind and wood, through the length of three inches; then paring likewiſe the ſtock, ſo that they may join cloſely to each other, they are bound together, and covered over with clay or grafting wax. As ſoon as they are found well incorporated together, the head of the ſtock is to be cut off four inches above the binding; and the ſpring following the graft, leaving the ſtock to ſubſiſt by itſelf. Or, the operation may be done by cutting off the head of the ſtock at firſt, and leaving the top a little ſloped, and applying the graft thereto, as in *ſhoulder*-GRAFTING. But this method is not found equally ſucceſsful.

Ablactation alſo ſignifies any thing extracted from its original ſtate, and ſupported by ſome new ſource, ſo as to make its nature partake of another means to preſerve life than that it originally poſſeſſed. This, however, is only to be applied to the botanical ſyſtem.

ABLATIVE, in grammar, the ſixth caſe of Latin nouns. The word is formed from *auferre*, to take away. Priſcian alſo calls it the *comparative caſe*; as ſerving, among the Latins, for comparing as well as taking away. The *ablative* is oppoſite to the *dative*; the firſt expreſſing the action of taking away, and the latter that of giving. The *ablative* hardly anſwers to the juſt idea of a caſe: at leaſt it is the moſt vague of all others. The Engliſh, and other modern tongues, have properly no ſuch thing as CASES; unleſs we except the nominative and genitive or poſſeſſive, which are the only caſes that admit of different termination. See the SYSTEM, Part I. Chap I. Sect. I.

But even in the ancient languages, from which the notion of caſes is borrowed, it is ſuggeſted, that the *ablative* is only a ſort of ſupernumerary, or ſupplement to the reſt. The five proper caſes not being found ſufficient to expreſs all the relations of things to each other, recourſe was had to an expedient; viz. the putting a prepoſition before ſome of the other caſes; and this made the *ablative*. It may be added that, in the plural number, the *ablative* is ſtill more obſcure, as being only the *dative* repeated. In Engliſh, French, &c. there is no preciſe mark whereby to diſtinguiſh the *ablative* from other caſes; and we only uſe the term in analogy to the Latin. Thus, in the two phraſes, *the magnitude of the city*, and, *he ſpoke much of the city*, we ſay that *of the city* in the firſt is *genitive*, and in the latter *ablative*; becauſe it would be ſo if the two phraſes were expreſſed in Latin.

The queſtion concerning the Greek *ablative* has been the ſubject of a famous literary war between two great grammarians, Friſchlin and Cruſius; the former of whom maintained, and the latter oppoſed, the reality of it. The diſpute is not decided to this day. Sanctius, and the Port-Royaliſts, ſtill maintain the affirmative; Perizonius the negative. The chief reaſon alledged by Sanctius is, that the Roman writers often joined Greek words with the Latin prepoſitions, which govern *ablative* caſes, as well as with nouns of the ſame caſe. To which Perizonius anſwers, that the Latins anciently had no *ablative* themſelves; but, inſtead thereof, made uſe, like the Greeks, of the dative caſe; till at length they formed an *ablative*, governed by prepoſitions, which were not put before the dative: that, at firſt, the two caſes had always the ſame termination, as they ſtill have in many inſtances; but that this was afterwards changed in certain words. It is no wonder then, that the Latins ſometimes join prepoſitions which govern an *ablative* caſe, or nouns in the *ablative* caſe, with Greek datives, ſince they were originally the ſame; and that the Greek *dative* has the ſame effect as the Latin *ablative*.

ABLATIVE *Abſolute*, in grammar, is a detached phraſe, independent of the reſt of a diſcourſe; and is much the ſame with the Engliſh parentheſis; e. g. *Juvante Deo*, (with God's aſſiſtance.) It is called *abſolute*, becauſe governed by no other word.

ABLUENTS, ABLUENTIA, in medicine, a name which ſome authors give to a ſort of diluting remedies, better known by the name of ABSTERGENTS.

ABLUTION, from *abluo*, quaſi *ab & lavo*, I waſh away, in antiquity, a religious ceremony in uſe among the Romans; being a ſort of purification, performed by waſhing the body before they entered on ſacrifice. Sometimes they waſhed their hands and feet, ſometimes the head, and oftentimes the whole body; for which purpoſe, at the entrance into their temples, were placed marble veſſels filled with water. The Romans uſed to waſh the feet of new-married women, as an emblem of the purity required of them in marriage. If a man committed murder, or any other act of violence, he was not allowed to approach the altar till he had waſhed himſelf. Ovid juſtly ridicules this notion:

Ah nimium faciles, qui triſtia crimina cædis
Fluminea tolli poſſe putatis aquâ!
Ah credulous! who think, when blood is ſhed,
The running ſtream can waſh away the guilt.

But ablution was not always performed by bathing; they ſometimes made uſe of aſperſion, or ſprinkling with water, which was done with a branch of olive, laurel, or an inſtrument made on purpoſe, and named, from its uſe, *aſpergillum*.

Idem ter ſocios purâ circumtulit undâ,
Spargens rore levi, & ramo felicis Olivæ.
Old Charinus compaſs'd thrice the crew,
And dipp'd an olive branch in holy dew,
Which thrice he ſprinkled round.—— DRYDEN.

But the more auguſt myſteries, ſuch as thoſe of Ceres, required *ablution*, or dipping of the whole body: and the oracles of Trophonius could not be conſulted, till a man had firſt dipped himſelf ſeveral times in the river Hercyna. Æneas dared not handle ſacred things till he had purged himſelf by a proper *ablution*.

Tu, genitor, cape ſacra manu patriſque Penates;
Me, bello è tanto digreſſum, & cæde recenti,
Attrectare nefas, donec me flumine vivo
Abluero.

Thou, thou, my ſire, our gods and relics bear:
Theſe hands, yet horrid with the ſtains of war,
Refrain their touch, unhallow'd, till the day
When the pure ſtream ſhall waſh the guilt away.

Ablutions appear to be as old as any ceremonies, and external worſhip itſelf. The Jewiſh religion required continual ablutions or waſhings; and we read that the Lord commanded Moſes "to make a laver of braſs for Aaron and his ſons to waſh their hands and their feet in, when they went into the tabernacle of the congregation." But as people accuſtom themſelves to regard things appointed for ſacred uſes with a kind of ſuperſtitious awe, this very practice, which was only intended as a ſign of inward purity, at length became the eſſential part of their religion; an error with which Jeſus Chriſt reproached the Jews. Thus it appears that Moſes enjoined ablutions: the heathens adopted them, and Mahomet and his followers have continued them: thus they have got footing among moſt nations, and make a conſiderable part of

moſt

moſt eſtabliſhed religions. The Egyptian prieſts had their diurnal and nocturnal ablutions: the Grecians, their ſprinklings: the Romans, their luſtrations and lavations: the Jews, their waſhing of hands and feet, beſides their baptiſm: the ancient Chriſtians had their ablutions before communion, which the Romiſh church ſtill retain before their maſs, ſometimes after: the Syrians, Cophts, &c. have their ſolemn waſhings on Good Friday: the Turks, their greater and leſſer ablutions, their gaſt and wodon, their aman, tabarut, guſul, abdeſt, &c.

The Indians practiſe ablution, and have a high veneration for the waters of the Ganges. But as they cannot at all times be near enough to waſh themſelves in its ſacred waters, the Bramins tell them that all other waters will have the ſame virtue, if, whilſt they are bathing, they pronounce theſe words; 'O Ganges, purify me.'

No doubt ablutions might be deſigned to repreſent inward purity; but they were at the ſame time calculated for the preſervation of health. However whimſical theſe waſhings may appear to ſome, few things would tend more to prevent diſeaſes than a proper attention to many of them. Were every perſon, for example, after viſiting the ſick, handling a dead body, or touching any thing that might convey infection, to waſh before he went into company, or ſat down to meat, he would run leſs hazard either of catching the infection himſelf, or of communicating it to others.

Frequent waſhing not only removes the filth and ſordes which adhere to the ſkin, but likewiſe promotes the perſpiration, braces the body, and enlivens the ſpirits. How refreſhed, how chearful and agreeable does one feel on being ſhaved, waſhed and ſhifted, eſpecially when theſe offices have been neglected longer than uſual! The cuſtom of waſhing the feet, though leſs neceſſary in this country, is nevertheleſs a very agreeable piece of cleanlineſs, and contributes greatly to the preſervation of health. The ſweat and dirt with which theſe parts are frequently covered, cannot fail to obſtruct the perſpiration. This piece of cleanlineſs would often prevent colds and fevers. Were people careful to bathe their feet and legs, in luke-warm water, at night, after being expoſed to cold or wet through the day, they would ſeldom experience the ill effects which often proceed from theſe cauſes.

Ablution is particularly uſed, in the Romiſh church, for a ſup of wine and water, which the communicants anciently took after the hoſt, to waſh it down, and help to digeſt it. The ſame term alſo ſignifies the water which ſerves to waſh the hands of the prieſts who conſecrated it.

ABLUTION, in pharmacy, is a preparation which divers remedies undergo, by waſhing them in water, or ſome other fluid, proper to cleanſe and free them of their impurities, and ſo to exalt their powers. The uſual way of doing this is by *cohobation*, or pouring the liquor diſtilled from the body upon it again; and repeating this as often as is neceſſary. *Ablution* is ſometimes alſo uſed, though with leſs propriety, for the waſhing or infuſing certain medicines in water, to freſhen them, and diſſolve their ſalts.

ABOLITION, ABOLISHING, in a general ſenſe, the act of deſtroying a thing, or reducing it to nothing. Some derive the word from *aboſtere*, ex *ab* & *alo*; and others from the Greek ἀναλῶ, *I deſtroy*.

In our laws, the *abolition* of a law, ſtatute, or cuſtom, is the abrogating or repealing it. The leave given by a prince, or judge, to a criminal accuſer, to deſiſt from further proſecution of the accuſed, is peculiarly called *abolition*. Vide 21 H. VIII. c. 21. *Abolition* is particularly uſed among civilians for remitting the puniſhment of a crime.

ABOMASUS, ABOMASUM, or ABOMASIUM, in comparative anatomy, one of the ſtomachs or ventricles of animals of the ruminating kind. See RUMINANT and RUMINATION. Beaſts that chew the cud are found to have four ſtomachs; viz. the *rumen*, or *magnus venter*, or *ſtomach*, properly ſo called, the *reticulum*, *omaſus*, and *abomaſus*. The *abomaſus*, properly called the *maw*, is the laſt of the four, being the place where the chyle is formed, and from which the food deſcends immediately into the inteſtines. It is full of a ſort of leaves like the *omaſus*; but its leaves have this peculiarity, that, beſides the membranes they conſiſt of, they contain a great number of glands, not found in any of the firſt. It is in the *abomaſus* of calves and lambs that the rennet, or earning, is formed, wherewith houſewives curdle their milk. See Syſtem of COMPARATIVE ANATOMY, Chap. I. Sect. IV.

ABOMINATION, a term uſed in ſcripture with regard to the Hebrews, who, being ſhepherds, are ſaid to have been an abomination to the Egyptians, becauſe they ſacrificed the ſacred animals of that people, as oxen, goats, ſheep, &c. which the Egyptians eſteemed as abominations, or things unlawful. The term is alſo applied, in the ſacred writings, to idolatry and idols, becauſe the worſhip of idols is in itſelf an abominable thing; and, at the ſame time, ceremonies obſerved by idolaters were always attended with licentiouſneſs, and other odious and abominable actions. The *abomination of deſolation*, foretold by the prophet Daniel, is ſuppoſed to imply the ſtatue of Jupiter Olympus, which Antiochus Epiphanes cauſed to be placed in the temple of Jeruſalem. And the *abomination of deſolation*, mentioned by the Evangeliſts, ſignifies the enſigns of the Romans, during the laſt ſiege of Jeruſalem, by Titus, on whom the figures of their gods and emperors were embroidered, and placed upon the temple after it was taken.

ABORIGINES, or ABERRIGINES, in geography, a name ſometimes given to the primitive inhabitants of a country, or thoſe who had their original therein; in contradiſtinction to colonies, or new races of inhabitants, derived from other places. The term *Aborigines* is famous in antiquity. Though now an appellative, it was originally a proper name given only to a certain people in Italy. *Aborigines* then denoted a nation in Italy, which inhabited the ancient Latium, or country now called Romania, or Campagna di Roma. In this ſenſe the *Aborigines* are diſtinguiſhed from the *Janigenæ*, who, according to the falſe Beroſus, inhabited the country before them; from the Siculi, whom they expelled; from the Grecians, from whom they deſcended; from the Latins, whoſe name they aſſumed, after their union with Æneas and the Trojans; and laſtly, from the Auſonii, Volſci, Oenotrii, &c. neighbouring nations in other parts of the country. Whence this people came by the appellation, is much diſputed. St. Jerome ſays, they were ſo called, as being *abſque origine*, the primitive planters of the country after the flood. Dion of Halicarnaſſus accounts for the name, as denoting them the founders of the race of inhabitants of that country. Others think them ſo called, as being originally Arcadians, who claimed to be earth-born, and not deſcended from any people. Aurelius Victor ſuggeſts another opinion, viz. that they were called *Aborigines*, q. d. *Aberrigines*, from *ab*, "from," and *errare*, "to wander;" as having been before a wandering people. Pauſanias rather thinks they were thus called ἀπ' ὀρέων, from "mountains;" which opinion ſeems confirmed by Virgil, who, ſpeaking of Saturn, the legiſlator of this people, ſays,

Is genus indocile ac diſperſum montibus altis
Compoſuit, legeſque dedit.———

The Aborigines were either the original inhabitants of the country, ſettled there by Janus, as ſome imagine, or by Saturn, or Cham, as others, not long after the diſperſion, or even, as ſome think, before it; or they were a colony ſent from ſome other nation, who, expelling the ancient inhabitants, the Siculi, ſettled in their place. About this mother-nation there is a great diſpute. Some maintain it to be the Arcadians, parties of whom were brought into Italy at different times: The firſt under the conduct of Oenotrius, ſon of Lycaon, 450 years before the Trojan war; a ſecond from Theſſaly; a third under Evander, 60 years before the Trojan war; beſides another under Hercules; and another of Lacedæmonians, who fled from the ſevere diſcipline of Lycurgus; all theſe uniting, are ſaid to have formed the nation or kingdom of the Aborigines. Others will have them of barbarian rather than Grecian origin, and to have come from Scythia; others from Gaul. Laſtly, others will have them to be Canaanites, expelled by Joſhua.

ABORTION, from *ab*, and *oriri*, to be born, is uſed, in medicine, for the unſeaſonable exclusion of an imperfect human *fœtus*, either alive or dead, before the natural time of delivery. In this ſenſe *abortion* amounts to the ſame with what we popularly call *miſcarriage*; the Latins *abortus*, and ſometimes *abactus*. If abortion happens before the ſecond month of pregnancy, it is called a *falſe conception*. Abortions are ſeldom dangerous in the firſt five months; but a frequent habit of miſcarriage debilitates the ſyſtem, ſhatters the conſtitution, and lays the foundation of chronic diſeaſes of the moſt obſtinate and dangerous nature. In the advanced months, the prognoſis will be more or leſs favourable, according to the patient's former ſtate of health. The proximate cauſe of abortion is the ſame with that of real travail, namely, a contracting effort of the uterus, and abdominal muſcles, aſſiſted by the other expulſive powers. The remote cauſes cannot be explained with preciſion, as many circumſtances, with regard to the nature of impregnation and connection of the fœtus with the placenta and uterus, are ſubjects involved in many difficulties; ſo that the general maxims which follow, are the heads that require particular attention. 1. Whatever interrupts the regular circulation between the uterus and placenta. 2. Every thing that excites the ſpaſmodic contraction of the uterus, or other aſſiſting powers. 3. All accidents, or occaſions, that deprive the fœtus of life.

The ancient Greek legiſlators, Solon and Lycurgus, prohibited the practice of creating *abortion*. Whether or no it was permitted among the Romans has been much diſputed between two learned modern civilians. It is certain the practice, which was by them called *viſceribus vim inferre*, was frequent enough: but whether there was any penalty on it before the emperor Severus and Antonine, is the queſtion. Noodt maintains the negative; and farther, that thoſe princes only made it criminal in one particular caſe; viz. of a married woman's practiſing it out of reſentment againſt her huſband, in order to defraud him of the comfort of children: this was ordered to be puniſhed by a temporary exile: *ſiqua prægnans vim viſceribus ſuis intulerit ne inimico marito filium procrearet, temporali exilio coerceatur*. He adds, that there was no general prohibition of the practice before Gratian and Valens. It is true, we find in Cicero an earlier inſtance of a woman puniſhed for this fact; but it was in Meſia, a country not ſubject to the Roman laws. Bynkerſhoeck, however, denies that a woman was allowed to drink the *poculum abortionis, impune*; and the reaſon he gives, is, that the womb was the huſband's property, who was

declared by the laws the sole *custos* of it, to prevent his being imposed on in the children he was to bring up. But then this does not affect women who had been impregnated by others than their husbands. The foundation on which the practice is said to have been allowed, was, that the *fœtus*, while *in utero*, was reputed as a part of the mother, ranked as one of her own viscera, over which she had the same power as over the rest; besides, that it was not reputed as a man, *homo*; nor to be alive, otherwise than as a vegetable; consequently, the crime amounted to little more than plucking unripe fruit from the tree. Vide Juven. Sat. 6. v. 592. Seneca Consolat. ad Helviam Matrem, c. 16. This last cited author represents it as a peculiar glory of Helvia, that she had never, like other women, whose chief study is their beauty and shape, destroyed the *fœtus* in her womb. *Nunquam te fecunditatis tuæ quasi exprobravit ætatem puduit; nunquam mare alienarum quibus omnis commendatio ex forma petitur, tumescentem uterum abscondisti quasi indecens onus, nec inter viscera tua conceptus spes liberorum elisisti.*

The primitive fathers, Athenagoras, Tertullian, Minutius Felix, Augustin, &c. declaimed loudly against the practice, as virtual murder: *Homicidii festinatio est, prohibere natos; nec refert, natum quis eripiat animam, an nascentum disturbet.* Several councils have declared against it. Yet we are told that the modern Romish ecclesiastical laws allow of dispensations for it. Egane mentions the rates at which a dispensation for it may be had.

The practice of artificial abortion is chiefly in the hands of women and nurses, rarely in that of physicians; who, in some countries, are not admitted to the profession without abjuring it. Hippocrates, in the oath he would have enjoined on all physicians, includes their not giving the *pessus abortivus*; though elsewhere he gives the formal process, whereby he himself procured a maid to miscarry. The time for it is presently after impregnation; at least, within the third or fourth month of gestation. The manner of effecting it is chiefly by medicines of the purgative and deobstruent kind. Roman authors speak of the *poculum abortionis*, or abortive draught, frequent among them. External violences are also sometimes had recourse to; as leaping from a stool, prescribed by Hippocrates. Obstinate fastings, and vehement evacuations, have been frequently practised for the same end. Yet all the powers of medicine often fail to procure abortion, by reason of the naturally close contraction of the orifice of the uterus; which has been known to hold out against the most malignant fevers, dysenteries, salivations, and the like; against the strongest aperients and evacuants; against the distilled oil of juniper, savin, succinum; against large quantities of *crocus metallorum, artemisia*, myrrh, mercury, the farina of *muscus terrestris*, &c. The most fatal method is by punctures of the uterus, with a pointed instrument for the purpose; too often used among us, and not unknown to the ancients. Parin mentions a midwife hanged at Paris, for killing a *fœtus*, in the womb, by running a stilletto or kind of bodkin, up the vagina, through the orifice of the uterus; by which a miscarriage was produced, but with such ill success, that the mother was seized with convulsions, and died miserably. The criminal confessed she had treated many before in the same manner with good effect. Our own age and country affords a parallel instance, a woman having been some years ago executed among us for the like fact. Tertullian has a passage, which shews the same was practised in those days: *est etiam æneum spiculum, quo jugulatio ipsa dirigitur cæco latrocinio* μηχανορακτον *appellant, utique viventis infantis peremptorium.* The operation, considering the tenderness of the part, must be of the utmost danger. Brendelius gives an account of what he observed in dissecting a girl at Norimberg, in 1714, who died of the operation which she had performed on herself: the neck of the uterus appeared exceedingly distended, the vessels lacerated and mortified, the uterus itself inflamed and putrified, &c.

Abortion may be produced by whatever immediately affects the child, the placenta, the membrane, or the mother. When the time of miscarriage is just at hand, the pains are much the same as those of labour. Abortion is dangerous where the time of pregnancy is far advanced, so that the *fœtus* must be large; where the cause is very violent, or the patient strongly convulsed; and where a large hæmorrhage precedes, or ensues, or the *fœtus* is putrified, &c. Under other circumstances it rarely proves mortal. Abortion is also used somewhat abusively, for a *fœtus* which, dying in the womb, continues there beyond the natural term; sometimes several years, and even during the whole life of the mother.

How to prevent Abortion.

Every pregnant woman is more or less in danger of abortion. This should be guarded against with the greatest care, as it not only weakens the constitution, but renders the woman liable to the same misfortune afterwards. Every mother who procures an abortion does it at the hazard of her life; yet there are not a few who run the risk merely to prevent the trouble of bearing and bringing up children. It is surely a most unnatural crime, and cannot, even in the most abandoned, be viewed without horror; but in the decent matron it is still more unpardonable. Those wretches who daily advertise their assistance to women in this business, deserve the most severe of all human punishments. Abortion may happen at any period of pregnancy, but it is most common in the second or third month. Sometimes, however, it happens in the fourth or fifth. If it happens within the first month, it is usually called a false conception: if after the seventh month, the child may be often kept alive by proper care. The common causes of abortion are, the death of the child; weakness or relaxation of the mother; great evacuations; violent exercise; raising great weights; reaching too high; running, jumping, or stepping from an eminence; vomiting; coughing; convulsion fits; blows on the belly; falls; fevers; disagreeable smells; excess of blood; indolence; high living, or the contrary; violent passions or affections of the mind, as fear, grief, &c. Abortion is also owing to a plethora, and is most frequent with young plethoric women in the first months of their pregnancy. There are, however, several other causes which concur to it; such are, an habitual and great discharge at the time of the menses, a high seasoned diet, with much wine or strong liquors; the taking of strong purges, or violent emetics; diarrhœas, especially when of long continuance, and of the aromatic kind, as they drain off the nourishment from the fœtus; a tenesmus, or violent motion to stool; and hence the use of stimulating clysters may also bring on an abortion. A too frequent use of venery may also occasion it; as may also the effect of strong emmenagogues, copious bleeding in the foot, the smell of burning oil, or any other stinking substance, nephritic complaints, cachexies, a fluor albus, or other disorders of the womb, the taking opiates, and the death or great debility of the fœtus while in the womb. A miscarriage may also be occasioned either by too great a stricture or an extreme relaxation of the uterus.

The signs of approaching abortion are, pain in the loins, or about the bottom of the belly; a dull heavy pain in the inside of the thighs; a slight degree of coldness or shivering; sickness, palpitation of the heart; the breasts become flat and soft; the belly falls; and there is a discharge of blood or watery humours from the womb.

The best methods of preventing abortion, are the use of the attemperating, and particularly the nitrous, medicines, after every commotion of the blood; bleeding at proper times, corroborating medicines, and the milder carminatives; and to these are to be added a temperance in diet, placid motion of the body, and cheerfulness of mind. Egg-shells are by some greatly recommended, and by others the stones of raisins, which are indeed manifestly astringent. Women of a weak relaxed state should avoid excess in the use of tea or other weak and watery liquors; use solid food; rise early, and go to bed soon; shun damp houses; take frequent exercise in the open air; and shun, as much as possible, damp foggy weather. Women of a full habit ought to use a spare diet, avoiding strong liquors, and every thing that may tend to heat the body, or increase the quantity of blood. Their diet should be of an opening nature, consisting principally of vegetable substances. Every woman with child ought to be kept chearful and easy in her mind. Her appetite, even though depraved, ought to be indulged as far as prudence will permit. When any signs of abortion appear, the woman ought to be laid in bed on a mattress, with her head low. She should be kept quiet, and her mind soothed and comforted. She ought not to be kept too hot, nor to take any thing of a heating nature. Her food should consist of broths, rice and milk, jellies, gruels made of oatmeal, and the like, all of which ought to be taken cold. If she be able to bear it, she should lose at least half a pound of blood from the arm. Her drink ought to be barley-water, sharpened with juice of lemon; or she may take half a drachm of powdered nitre, in a cup of warm gruel, every five or six hours. If the woman be seized with a violent looseness, she ought to drink the decoction of calcined hartshorn prepared. If she be affected with vomiting, let her take frequently two table-spoonfuls of the saline mixture. In general, opiates are of service; but they should always be given with caution.

Sanguine robust women, who are liable to miscarry at a certain time of pregnancy, ought always to be bled a few days before that period arrives. By this means, and observing the regimen above prescribed, they might often escape that misfortune. Though we recommend due care for preventing abortion, we would not be understood as restraining pregnant women from their usual exercises. This would generally operate the quite contrary way. Want of exercise not only relaxes the body, but induces a plethora, or too great a fulness of the vessels, which are the two principal causes of abortion. There are, however, some women of so delicate a texture, that it is necessary for them to avoid almost every kind of exercise during the whole period of pregnancy.

ABORTION, among gardeners, signifies such fruits as are produced too early, and never arrive at maturity.

ABORTIVE *flux, fluxus abortivus*, is sometimes used among the ancients as synonimous with abortion or effluxion; viz. where the embryo loses its hold, and slips away. In this sense, the eagle-stone is celebrated for stopping abortive fluxes; for which end it was to be hung to the arm, *jubnexus sperm uteri defendit a fluxibus abortivis.*

Among modern physicians, abortive fluxes are chiefly understood of a kind of hæmorrhages, which sometimes precede, and bring on, abortion; at other times burst forth in the act of exclusion. The cause is a violent separation of the secundines from the uterus; which may arise from a vehement fit of passion, or motion

of

of the body; a fall, fright, or the like. Thunder, lightning, hot liquor, a too liberal uſe of deobſtruents, or the navel-ſtring being too ſhort, ſometimes occaſions an *abortive* hæmorrhage.

ABORTIVE *corn*, a diſtemper of corn mentioned by M. Tillet, and ſuſpected to be occaſioned by inſects. It appears long before harveſt, and may be known by a deformity in the ſtalk, the leaves, the ear, and even the grain. For a copious account of the cauſes of diſtempered corn, ſee the Syſtem of AGRICULTURE, Sect. III.

ABRASA, ulcers attended with abraſion of part of the ſubſtance; or ulcers where the ſkin is ſo tender and lax, as to be ſubject to abraſion.

ABRASION is ſometimes uſed, among medicinal writers, for the act of wearing away the natural *mucus*, which covers the membranes, and particularly thoſe of the ſtomach and inteſtines, by ſharp corroſive medicines or humours. The word is compoſed of the Latin, *ab*, and *rado*, to ſhave, or ſcrape off.

ABRAUM, in natural hiſtory, a name given by ſome writers to a ſpecies of red clay, uſed in England by the cabinet-makers, &c. to give a red colour to new mahogany wood: we have it from the Iſle of Wight; but it is alſo found in Germany and Italy.

ABRAXAX, or ABRAXAS, the ſupreme god of the Baſilidian heretics. It is a myſtical word, compoſed of the Greek numerals α, β, ρ, α, ξ, α, ς, which together make up the number CCCLXV. For Baſilides taught, that there were 365 heavens between the earth and the empyrean; each of which heavens had its angel or intelligence, which created it; each of which angels likewiſe was created by the angel next above it; thus aſcending by a ſcale to the Supreme Being, or firſt Creator. The Baſilidians uſed the word *Abraxas* by way of charm or amulet.

ABRAXAS is alſo uſed, among antiquaries, for a ſpecies of graven gem, on which the word *abraxas* is uſually inſcribed; ſuppoſed to have been worn by the ancient Gnoſtics, Baſilidians, and Carpocratians, as an amulet or taliſman againſt diſeaſes. Abraxas, in this ſenſe, is ſynonimous with *Baſilidian ſtones*, a name by which ſome authors call theſe antiques, or *abraxean ſtone*, as they are denominated by others. Abraxaſes are of divers figures and ſizes; ſometimes in that of rings to be worn on the finger.

Abraxaſes are frequent in the cabinets of the curious: a collection of them, as complete as poſſible, has been much deſired by ſeveral. There is a fine one in the abbey of St. Genevieve, which has occaſioned much inquiry. They are chiefly of the third century; moſt of them ſeem to have come from Egypt, whence they become of conſiderable uſe for explaining the antiquities of that country.

ABREAST, (a ſea-term,) ſide by ſide, or oppoſite to: a ſituation in which two or more ſhips lie, with their ſides parallel to each other, and their heads equally advanced. This term more particularly regards the line of battle at ſea, where, on the different occaſions of attack, retreat, or purſuit, the ſeveral ſquadrons or diviſions of a fleet are obliged to vary their diſpoſitions, and yet maintain a proper regularity, by ſailing in right or curved lines. When the line is formed *abreaſt*, the whole ſquadron advances uniformly, the ſhips being equally diſtant from and parallel to each other, ſo that the length of each ſhip forms a right angle with the extent of the ſquadron or line abreaſt. The commander in chief is always ſtationed in the center, and the ſecond and third in command in the centers of their reſpective ſquadrons. *Abreaſt*, within the ſhip, implies on a line with the beam or by the ſide of any object aboard; as, "the frigate ſprung a leak *abreaſt* of the main hatch-way;" *i. e.* on the ſame line with the main hatch-way, croſſing the ſhip's length at right angles, in oppoſition to *afore* or *abaft* the hatch-way. "We diſcovered a fleet *abreaſt* of Beachy-head;" *i. e.* off or directly oppoſite to it. See the Treatiſe of NAVAL AFFAIRS, Part I. Section II. throughout.

ABRIDGING, in algebra, is the reducing a compound problem, or equation, to its more ſimple expreſſion. See PROBLEM and EQUATION. To prevent the mind being diſtracted with attending to known quantities, concerning which nothing farther is required, and to keep the attention entire from the reſt, mathematicians uſe to *abridge* their equations, by expreſſing all the known quantities of the ſame term by a ſingle letter. For an inſtance, to *abridge* the equation

$$\begin{array}{rrrr} x^3 & -axx & +abx & -abc = 0 \\ & -b & +ac & \\ & -c & +bc & \end{array}$$

All the known quantities $-a-b-c$ of the ſecond term are ſuppoſed equal to one ſingle letter $-n$: all the known quantities $+ab+ac+bc$ of the third term, equal to another letter $+p$; and all the known quantities $-abc$ of the fourth term, equal to a ſingle letter $-q$. By which means we have $x^3-nxx+px-q=0$, inſtead of the equation propoſed. An equation thus abridged is called a *formula*. See FORMULA. See alſo the Syſtem of ALGEBRA, Sect. I.

ABRIDGEMENT, in law, is particularly uſed for the ſhortening a count or declaration, ſubtracting ſome of the ſubſtance of it. A man is to *abridge his plaint* in aſſize, or a woman her demand in an action of dower, when having put any lands therein which are not in the tenure of the tenant or defendant; and non-tenure, or the like, is pleaded to that land in the abatement of the writ: they are brought to *abridge*, *i. e.* to deſiſt from, and leave that parcel out of the demand; and pray that the tenant may anſwer to the reſt, to which he has not yet pleaded any thing. Though the demandant has *abridged* his plaint, or demand, yet the writ ſtill remains good for the reſt. The reaſon is, that ſuch writs run in general, and do not ſpecify particulars.

ABRIDGEMENT, in literature, a term ſignifying the reduction of a book into a ſmaller compaſs. The art of conveying much ſentiment in few words is the happieſt talent an author can be poſſeſſed of. This talent is peculiarly neceſſary in the preſent ſtate of literature; for many writers have acquired the dexterity of ſpreading a few critical thoughts over ſeveral hundred pages. When an author hits upon a thought that pleaſes him, he is apt to dwell upon it, to view it in different lights, to force it in improperly, or upon the ſlighteſt relations. Though this may be pleaſant to the writer, it tires and vexes the reader. There is another great ſource of diffuſion in compoſition. It is a capital object with an author, whatever be the ſubject, to give vent to all his beſt thoughts. When he finds a proper place for any of them, he is peculiarly happy. But, rather than ſacrifice a thought he is fond of, he forces it in by way of digreſſion or ſuperfluous illuſtration. If none of theſe expedients anſwer his purpoſe, he has recourſe to the margin, a very convenient apartment for all manner of pedantry and impertinence. There is not an author, however correct, but is more or leſs faulty in this reſpect. An abridger, however, is not ſubject to theſe temptations. The thoughts are not his own; he views them in a cooler and leſs affectionate manner; he diſcovers an impropriety in ſome, a vanity in others, and a want of utility in many. His buſineſs, therefore, is to retrench ſuperfluities, digreſſions, quotations, pedantry, &c. and to lay before the public only what is really uſeful. This is by no means an eaſy employment; to abridge ſome books, requires talents equal, if not ſuperior, to thoſe of the author. The facts, manner, ſpirit, and reaſoning muſt be preſerved; nothing eſſential, either in argument or illuſtration, ought to be omitted. The difficulty of the taſk is the principal reaſon why we have ſo few good abridgements: Wynne's Abridgement of Locke's Eſſay on the Human Underſtanding is, perhaps, the only unexceptionable one in our language.

Theſe obſervations relate ſolely to ſuch abridgements as are deſigned for the public. But, when a perſon wants to ſet down the ſubſtance of any book, a ſhorter and leſs laborious method may be followed. It would be foreign to our plan to give examples of abridgements for the public: but as it may be uſeful, eſpecially to young people, to know how to abridge books for their own uſe, after giving a few directions, we ſhall exhibit an example or two, to ſhew with what eaſe it may be done.

Read the book carefully; endeavour to learn the principal view of the author; attend to the arguments employed. When you have done ſo, you will generally find, that what the author uſes as new or additional arguments, are, in reality, only collateral ones, or extenſions of the principal argument. Take a piece of paper, or a common place book, put down what the author wants to prove, ſubjoin the argument or arguments, and you have the ſubſtance of the book in a few lines. For example. In the Eſſay on Miracles, Mr. Hume's deſign is to prove, That miracles, which have not been the immediate objects of our ſenſes, cannot reaſonably be believed upon the teſtimony of others. Now his argument (for there happens to be but one) is,

"That experience, which in ſome things is variable, in others uniform, is our only guide in reaſoning concerning matters of fact. A variable experience gives riſe to probability only; an uniform experience amounts to a proof. Our belief of any fact from the teſtimony of eye-witneſſes, is derived from no other principle than our experience in the veracity of human teſtimony. If the fact atteſted be miraculous, here ariſes a conteſt of two oppoſite experiences, or proof againſt proof. Now, a miracle is a violation of the laws of nature; and as a firm and unalterable experience has eſtabliſhed theſe laws, the proof againſt a miracle, from the very nature of the fact, is as complete as any argument from experience can poſſibly be imagined; and if ſo, it is an undeniable conſequence, that it cannot be ſurmounted by any proof whatever derived from human teſtimony."

In Dr. Campbell's Diſſertation on Miracles, the author's principal aim is to ſhew the fallacy of Mr. Hume's argument, which he has done moſt ſucceſsfully by another ſingle argument, as follows: "The evidence ariſing from human teſtimony *is not ſolely* derived from experience; on the contrary, teſtimony hath a natural influence on belief antecedent to experience. The early and unlimited aſſent given to teſtimony by children, gradually contracts as they advance in life: it is, therefore, more conſonant to truth, to ſay, that our *diffidence* in teſtimony is the reſult of experience, than that our *faith* in it has this foundation. Beſides, the uniformity of experience, in favour of any fact, is not a proof againſt its being reverſed in a particular inſtance. The evidence ariſing from the ſingle teſtimony of a man of known veracity will go farther to eſtabliſh a belief in its being actually reverſed: if his teſtimony be confirmed by a few others of the ſame character, we cannot withhold our aſſent to the truth of it. Now, though the operations of nature are governed by uniform laws, and though we have not the teſtimony of our ſenſes in favour of any *violation* of them; ſtill, if, in particular inſtances, we have the teſtimony of *thouſands* of our fellow creatures, and thoſe men of ſtrict integrity, ſwayed by no motives of ambition or intereſt, and governed by the principles of common

ſenſe, that they were actually eye-witneſſes of theſe violations, the conſtitution of our nature obliges us to believe them."

Theſe two examples contain the ſubſtance of about 400 pages. Making private abridgements of this kind has many advantages; it engages us to read with accuracy and attention; it fixes the ſubject in our minds; and if we ſhould happen to forget, inſtead of reading the books again, by glancing a few lines, we are not only in poſſeſſion of the chief arguments, but recal, in a great meaſure, the author's method and manner.

Abridging is peculiarly uſeful in taking the ſubſtance of what is delivered by profeſſors, &c. It is impoſſible, even with the aſſiſtance of ſhort-hand, to take down, *verbatim*, what is ſaid by a public ſpeaker. Beſides, although it were practicable, ſuch a talent would be of little uſe. Every public ſpeaker has circumlocutions and redundancies, lumber which deſerve not to be copied. All that is really uſeful may be comprehended in a ſhort compaſs. If the plan of the diſcourſe, and arguments employed in ſupport of the different branches, be taken down, you have the whole. Theſe you may afterwards extend in the form of a diſcourſe, dreſſed in your own language. This would not only be a more rational employment, but would likewiſe be an excellent method of improving young men in compoſition; an object too little attended to in our univerſities.

ABROGATION, from the Latin *abrogo*, "I repeal," the act of aboliſhing a law by authority of the maker. In which ſenſe the word is ſynonimous with *abolition*, *repealing*, and *revocation*. *Abrogation* ſtands oppoſed to *rogation*. It is diſtinguiſhed from *derogation*, which implies the taking away only ſome part of a law; from *ſubrogation*, which denotes the adding a clauſe to it; from *obrogation*, which implies the limiting or reſtraining it; from *diſpenſation*, which only ſets it aſide in a particular inſtance; and from *antiquation*, which is the refuſing to paſs a law.

ABSCESS, in ſurgery, a kind of inflammatory tumor, containing purulent matter, pent up in a fleſhy part, and corrupting and conſuming the fibres, and other ſubſtance thereof. *Abſceſs* is the ſame with what the Greeks call *apoſtemas*, and the Engliſh *impoſthume*, or *impoſthumation*. Almoſt all *abſceſſes* are the conſequences of inflammation. The ripening of *abſceſſes* is promoted by poultices, &c. *Abſceſſes* are opened either by cauſtic or inciſion; but the latter way is in moſt caſes preferable. *Abſceſſes* ariſe often in women after delivery; and though dangerous in themſelves, yet they often appear to be the *criſis* of the diſeaſe that gave riſe to them. For the cure, if they cannot be diſcuſſed, i. e. carried off by proper artificial evacuations, as phlebotomy, purging, &c. with the occaſional uſe of calomel, and gentle perſpirative ſolutes, liniments, and cataplaſms, recourſe is to be had to the contrary method, and they muſt be brought to ſuppuration.

Mr. Bell, in his late Treatiſe on Surgery, obſerves, that when an abſceſs increaſes, and is attended with great pain, heat, and pulſation; when the fever perſiſts obſtinately, and theſe ſymptoms continue for three days, notwithſtanding all endeavours for a reſolution, that intention is to be entirely laid aſide; becauſe, if ſuch applications, as are proper to reſolve a humour, are continued, when reſolution is no longer poſſible, the moſt fluid parts of the obſtructed humours will be diſſipated, and the more groſs and inactive particles dried and hardened, ſo as to prevent ſuppuration, or at leaſt to render it difficult; in conſequence of which, a troubleſome induration of the part will remain; or, if glandulous, a ſchirrus will be formed. Very different methods, therefore, ſhould be uſed, and the humour brought to maturation with the utmoſt expedition. The proper medicines for promoting this intention are ſuch as increaſe the motion in the part, and have the tendency to excite a gentle fever; as fomentations and ſtimulating medicines. Such compoſitions alſo as confine the heat exerted in the part affected, by preventing an exceſſive perſpiration, are alſo proper. The ſimple aromatic gums, and the emolient relaxing and moiſtening medicines, are therefore proper for maturing the pus This method muſt be purſued till the abſceſs has acquired a ſufficient degree of ripeneſs, which may be known by the ſoftneſs of the part, and the fluctuation of matter in the tumor when preſſed, its whiteneſs and remiſſion of pain, heat, redneſs, tenſion, pulſation and fever. The pointed aſpect of the tumor, and a ſenſation of weight, ſucceeding the pain, are alſo ſigns that the pus is ſufficiently formed, and fit for evacuation. When theſe ſigns indicate the maturity of the tumor, the knife is to be introduced into its ſofteſt, whiteſt, and moſt prominent part, till the pus flowing out, evinces that a ſufficient penetration is made: then let the knife be raiſed equally upwards, ſo as to make an inciſion ſufficiently large, or forcing its point through the oppoſite part of the abſceſs; let the intermediate integuments be divided, taking care to avoid the nerves and large veſſels. The inciſion being made, and the pus evacuated, let the abſceſs be cured by cleanſing, ſuppurating, digeſtive, and deterſive medicines, which muſt be varied according to the ſtate of the part.

Dr. Buchan obſerves, in the laſt edition of his Domeſtic Medicine, 1795, page 308, "If an abſceſs, or impoſthume, is formed in the liver, all methods ſhould be tried to make it break, and diſcharge itſelf outwardly; as by fomentations, the application of poultices, ripening cataplaſms, &c. Sometimes, indeed, the matter of an abſceſs comes away in the urine, and ſometimes it is diſcharged by ſtool; but theſe are efforts of nature, which no means can promote. When the abſceſs burſts into the cavity of the abdomen at large, death muſt enſue: nor will the event be more favourable when the abſceſs is opened by an inciſion, unleſs in caſes where the liver adheres to the peritoneum, ſo as to form a bag for the matter, and prevent it from falling into the cavity of the abdomen; in which caſe, opening the abſceſs by a ſufficiently large inciſion, will probably ſave the patient's life. A chirurgical profeſſor remarks, in a treatiſe on this ſubject, that he had a patient who had ſeveral abſceſſes in the liver opened, and afterwards became a ſtrong healthy man, and lived to be eighty years of age.

"If the diſorder, in ſpite of all endeavours to the contrary, ſhould end in a ſchirrus, the patient muſt be careful to regulate his diet, &c. in ſuch a manner as not to aggravate the diſeaſe. He muſt not indulge in fleſh, fiſh, ſtrong liquors, or any highly ſeaſoned or ſalted proviſions, but ſhould, for the moſt part, live on mild vegetables, as fruits and roots; taking gentle exerciſe; and drinking whey, barley-water, or butter-milk. If he takes any thing ſtronger, it ſhould be fine mild ale, which is leſs heating than wine or ſpirits.

"From whatever cauſe an inflammation proceeds, it muſt terminate either by diſperſion, ſuppuration, or gangrene. Though it is impoſſible to foretel, with certainty, in which of theſe ways any particular inflammation will terminate, yet a probable conjecture may be formed, with regard to the event, from the patient's age and conſtitution. Inflammations happening in a ſlight degree upon colds, and without any previous indiſpoſition, will moſt probably be diſperſed: thoſe which follow cloſe upon a fever, or happen to perſons of a groſs habit of body, will generally ſuppurate; and thoſe which attack very old people, or perſons of a dropſical habit, will have a ſtrong tendency to gangrene.

"If the inflammation be ſlight, and the conſtitution ſound, the diſperſion ought always to be attempted. This will be beſt promoted by a ſlender, diluting diet, plentiful bleedings, and repeated purges. The part itſelf muſt be fomented; and if the ſkin be very tenſe, it may be embrocated with a mixture of three-fourths of ſweet oil, and one fourth of vinegar, and afterwards covered with a piece of wax plaſter.

"If, notwithſtanding theſe applications, the ſymptomatic fever increaſes, and the tumor becomes larger, with violent pain and pulſation, it will be proper to promote ſuppuration. The beſt application for this purpoſe is a ſoft poultice, which may be renewed twice a day. If the ſuppuration proceeds but ſlowly, a raw onion, cut ſmall, or bruiſed, may be ſpread upon the poultice. When the abſceſs is ripe for opening, which may eaſily be known from the thickneſs of the ſkin in the moſt prominent part of it, a fluctuation of matter, which may be felt under the finger, and, generally ſpeaking, an abatement of the pain, it may be opened either with a lancet, or by means of a cauſtic.

"Theſe obſervations include the treatment of all thoſe diſeaſes which, in different parts of the country, go by the names of *biles*, *impoſthume*, *whitlows*, &c. They are all abſceſſes in conſequence of a previous inflammation, which, if poſſible, ought to be diſcuſſed; but when this cannot be done, the ſuppuration ſhould be promoted, and the matter diſcharged by an inciſion. If neceſſary, afterwards the ſore may be dreſſed with yellow baſilicon, or ſome other digeſtive ointment."

ABSCISSE, Abscissa, in conics, a part of the diameter or tranſverſe axis of a conic ſection, intercepted between the vertex, or ſome other fixed point, and a ſemiordinate. In the parabola the abſciſſe is a third proportional to the parameter and ſemiordinate; and the parameter a third proportional to the abſciſſe and ſemiordinate. In the ellipſis, the ſquare of the ſemiordinate is equal to the rectangle of the parameter into the abſciſſe, ſubſtracting another rectangle of the ſame abſciſſe, into a fourth proportional to the axis, parameter, and abſciſſe. In the hyperbola, the ſquares of the ſemiordinates are to each other as the rectangles of the abſciſſe into another line, compoſed of the abſciſſe and the tranſverſe axis. See Conic Sections, in the Syſtem of Geometry, Part II.

ABSCISSION, from *abſciſſio*, in rhetoric, a figure of ſpeech, whereby the ſpeaker ſtops ſhort in the middle of his diſcourſe; ſo that an auditor is left to form his own conſtruction, or make what inference he pleaſes; e. g. "one of her ſex, age, and beauty, to be ſeen at ſuch an hour, in ſuch a place, with a man of his character! But I ſay no more."

Abſciſſion is a ſpecies of ellipſis, or ſuppreſſion. Scaliger diſtinguiſhes it from præciſion and ſuſpenſion.

Abscission, in ſurgery, denotes the act of taking away ſome morbid or ſuperfluous part of an edged inſtrument. In this ſenſe abſciſſion amounts to the ſame with the Greek ἀποκοπη. Cowper ſpeaks of the abſciſſion of a leg, which is more properly called *amputation*. The abſciſſion of the præpuce makes what we call circumciſion. Abſciſſion of the ears is a kind of legal puniſhment, inflicted on perjury. In ſome countries they alſo practiſe abſciſſion of the noſe on traitors in an army, a puniſhment reputed worſe than death.

Abſciſſion is more properly uſed for the operation of cutting away ſome ſoft part of the body, when depraved or grown hurtful. In which ſenſe abſciſſion differs from amputation, in that the latter is of a ſolid or bony part, the former of a fleſhy or membranous one; yet they are ſometimes confounded. We ſay the abſciſſion of a nerve, lip, cheek, or the like. Mr. Shipton gives an inſtance of the abſciſſion of a portion of the inteſtines not being mortal. Phil. Tranſ. No. 283.

ABSCONSA, a dark lantern, uſed by the monks at the ceremony of burying their dead.

ABSOLUTE, in a general ſenſe, ſomething that ſtands free or independent. In metaphyſics it denotes a being whoſe whole eſſence does not conſiſt in a mere habitude or relation to another. In which ſenſe abſolute ſtands oppoſed to relative or reſpective. Abſolute is more particularly underſtood of a thing which does not proceed from any cauſe, or does not ſubſiſt by virtue of any other being, conſidered as its cauſe. In which ſenſe God alone is abſolute. Abſolute in this ſenſe is ſynonymous with independent, and ſtands oppoſed to dependent. Abſolute alſo denotes a thing's being free from conditions or limitations. In this ſenſe the word is ſynonymous with unconditional. We ſay, an abſolute decree, abſolute promiſe, abſolute obedience. The covenant with Noah was abſolute, and without conditions; that under the goſpel, on condition of faith and obedience. The Antinomians alſo hold the goſpel-covenant abſolute, and that Chriſt has purchaſed our ſalvation, without any conditions to be performed by us.

ABSOLUTE *Government*, that wherein the prince is left ſolely to his own will, being not limited to the obſervance of any laws, except thoſe of his own diſcretion. See GOVERNMENT.

ABSOLUTE *Number*, in algebra, is the known quantity or number which poſſeſſes one entire ſide or part of an equation; being the rectangle or ſolid whoſe root or value is to be found. Thus, in the equation $aa+16a=36$, the abſolute number is 36; which is equal to a multiplied by itſelf, and added to 16 times a.

ABSOLUTE *Equation*, in aſtronomy, is the aggregate of the optic and eccentric equations. The apparent inequality of a planet's motion ariſing from its not being equally diſtant from the earth at all times, is called its optic equation, and would ſubſiſt even if the planet's real motion were uniform. The eccentric inequality is cauſed by the planet's motion being uniform. To illuſtrate which, conceive the ſun to move, or to appear to move, in the circumference of a circle, in whoſe centre the earth is placed. It is manifeſt, that, if the ſun moves uniformly in this circle, it muſt appear to move uniformly to a ſpectator on the earth, and in this caſe there will be no optic nor eccentric equation: but ſuppoſe the earth to be placed out of the centre of the circle, and then, though the ſun's motion ſhould be really uniform, it would not appear to be ſo, being ſeen from the earth; and in this caſe there would be an optic equation, without an eccentric one. Imagine farther, the ſun's orbit to be not circular, but elliptic, and the earth in its focus; it will be as evident that the ſun cannot appear to have an uniform motion in ſuch ellipſe: ſo that his motion will then be ſubject to two equations, the optic and the eccentric. See Syſt. of ASTRONOMY, Sect. XII. Prop. III.

ABSOLUTION, *Abſolutio*, in the civil law, &c. a definitive ſentence, whereby a perſon accuſed of any crime is acquitted, and declared innocent. Among the Romans, the ordinary method of pronouncing judgment was this: after the cauſe had been pleaded on both ſides, the præco uſed the word *dixerunt*, q. d. they have ſaid what they had to ſay: then three ballots were diſtributed to each judge marked; and as the majority fell of either mark, the accuſed was abſolved or condemned, &c. If he were abſolved, the prætor diſmiſſed him with *videtur non feciſſe*, or *jure videtur feciſſe*.

ABSOLUTION, in the canon law, is a juridical act, whereby a prieſt, as a judge, remits the ſins of ſuch as, upon confeſſion, appear to have the conditions requiſite thereto. The Romaniſts hold abſolution a part of the ſacrament of penance. The Council of Trent, ſeſſ. xiv. cap. iii. and that of Florence, in the decrees *ad Armenos*, declare the form or eſſence of the ſacrament to lie in the words of abſolution, 'I abſolve thee of thy ſins.' The formula of abſolution, in the Romiſh church, is abſolute: in the Greek church it is deprecatory; and in the churches of the reformed, declarative.

Archbiſhop Tillotſon has given his opinion of the uſe and intent of ABSOLUTION as follows: "Upon this miraculous gift of knowing the ſecrets of mens hearts, it ſeems to be very probable, that that which is commonly called *the Power of the Keys* did depend. I mean the power of remitting or retaining ſins: for they who had the privilege of knowing mens hearts, might do this upon certain grounds, and were ſecured from miſtake in the exerciſe of their power upon particular perſons, which the prieſts and miniſters of the church now are not, nor can be; becauſe they cannot ſee into mens hearts, whether they be truly penitent, and qualified for forgiveneſs, or not. For I cannot eaſily believe, but that thoſe words of our Saviour, *Whoſe ſins ye remit, they are remitted; and whoſe ſins ye retain, they are retained*; were intended to ſignify ſomething more than a mere declaration of the promiſes and threatenings of the goſpel, which any man might make, as well as the apoſtles and miniſters of the church. For that God will forgive the penitent, and that he will not pardon the ſinner, except he repent, is as true from any man's mouth as from an apoſtle's. And as to the abſolution of this or that particular perſon, though a miniſter, by the ſkill and knowledge of his profeſſion, is ordinarily and reaſonably preſumed, by virtue of his office, to be a better judge of a man's repentance than other perſons are, and therefore may, with more authority, and ſatisfaction to the penitent, declare his judgment and opinion concerning him; yet, not being able to ſee into his heart, he may be miſtaken concerning him; and if he be, his declaring his ſins to be forgiven (that is his abſolution of him) will do him no good; and on the other hand, his refuſal to abſolve him, if he be truly penitent, will do him no harm; as the judgment of a ſkilful lawyer is of greater authority, and more ſatisfactory to us, concerning our title to an eſtate, than the opinion of another man, who is not of the profeſſion, nor preſumed to have the like ſkill: but yet, for all this, his judgment does not alter the caſe; and if, in truth, the law be otherwiſe, our title is bad, notwithſtanding the ſkilful man's opinion of the goodneſs of it."

The Archbiſhop ſays farther, "That Proteſtants do not make the abſolution of the prieſt at all neceſſary to the forgiveneſs of ſins, but only convenient for the ſatisfaction and comfort of the penitent. For which reaſon our church does not require a formal abſolution to be given to the dying penitent, unleſs he himſelf deſires it; which is a certain argument that, in the judgment of our church, the abſolution of the prieſt is not neceſſary to the forgiveneſs and ſalvation of the penitent."

The *form* of *abſolution* which the Pope gives to crowned heads, who have been excommunicated, is briefly this. The Pope is ſeated on a high pontifical throne, erected before St. Peter's church, attended by the apoſtolical court. The ambaſſadors of the excommunicated princes appear before this aſſembly, and throw themſelves at his holineſs's feet, aſking pardon in the names of their maſters, and deſiring abſolution. Then they lay their hands on the maſs book, and ſwear by the holy goſpels, and the holy crucifix, obedience to the church. Then the Pope and twelve cardinal prieſts ſing the *Miſerere*, obſerving to ſtrike the ambaſſadors on the ſhoulder at the beginning of each verſe. The ceremony ends with prayers, and the impoſition of a penance proportionable to the crime of the perſon abſolved.

ABSOLUTISM, the dogma of God's acting abſolutely in the affair of ſalvation; maintained by the Calviniſts, for which, among other doctrines, the Lutherans refuſe all union them.

ABSORBENTS, in a general ſenſe, is uſed for ſuch things as have the faculty of abſorbing or ſwallowing up others. Aſhes are an abſorbent in reſpect of water, though not in the degree ſuppoſed by Ariſtotle, from whom we derive a vulgar error, that a pot full of aſhes will ſtill abſorb as much water as if empty. Cloves are ſo violent an abſorbent of moiſture, that we are told, if care be not taken in the importing, to keep all water, wine, and the like at a good diſtance from them, they will drain a conſiderable quantity of liquid from a caſk.

M. Homberg has a diſcourſe on a quantity of acids abſorbed by terreſtrial alkalies, wherein he ſhews how much acid any known alkali will retain. M. de la Hire gives an experiment for aſcertaining the quantity of water abſorbed by plants. Mem. R. Acad. Scienc. an. 1700, p. 81.

ABSORBENTS, in medicine, remedies which, by the ſoftneſs or poroſity of their component parts, become proper to ſheathe the aſperities of ſharp pungent humours; or to imbibe, or dry away, as with a ſponge, ſuperfluous moiſtures; and are of divers kinds, ſimple, compound, ſaline, cinnabarine, marine, fixed, earthy, acid, alkaline, &c. In the Pharmacopœias we meet with ſeveral forms of abſorbents; ſuch as the teſtaceous powders, hartſhorn, coral, crab's eyes and claws, calcined bones, burnt ivory, terra ſigillata, and even iron itſelf: alſo divers woods; as ſanders, maſtic, guaiacum, ſaſſafras; and divers roots, as china, ſarſaparilla, &c.

Abſorbents, ſays Juncker, conſume the humours without fuſing them, and have ſometimes the effect of ſtrengtheners, ſometimes of purgatives; but oftener of calmers, to allay fermentations. They are of uſe for tempering acrimonies; and, after emollients and attenuants, for healing tumors. Some hold them neceſſary for preventing the ill effects of bitters. They are good in cardialgias, or heats of the ſtomach, and hiccups. They are alſo given in hectics, and other chronical caſes, as coughs, though with great caution and reſerve. Abſorbents have alſo their ill effects, eſpecially if too lavishly given, being liable to many congeſtions in the viſcera. They are hurtful in the itch, bilious fevers, dyſenteries, hypochondriacal and hyſteric caſes, quartans, &c. They are generally proſcribed as the only remedy for the acute diſeaſes of infants, though held by others rather hurtful to children, by loading their tender viſcera, and creating obſtructions in the capillaries. Particular kinds of abſorbents have their particular effects: old oyſter-ſhells are preferred for children: magiſteries and precipitates are leaſt ſuitable, as being already ſurcharged with acids. Abſorbents, ſaturated with acid juices, as of citrons, are good in coughs and catarrhs; prepared with cinnabar, in iſchurias; with aſtringents, in the diabetes; ſaline, in the itch; marine, in chronical diſeaſes of the breaſt; in which laſt caſe the earthy are hurtful. They are ſometimes applied to ulcers: but it is to be obſerved, that the inſipid terreſtreous abſorbents, ſuch as coral, &c. put into an ulcer, where a bone is carious, can have little other effect than to imbibe the matter of the ulcer: if they fall into any cavernulæ of the corrupted bone, they may remain ſo long there, that the matter they imbibe may become acrid. Lint is an abſorbent which has not this diſadvantage. Monro, in Med. Eſſ. Edinb. vol. v. art. 24.

The taking of an immoderate quantity of crab's eyes, and other abſorbents, for the heart-burn, has ſometimes been attended with fatal conſequences. See Phil. Tranſ. N° 459. Sect. II.

Van Swieten, in his Comment on Boerhaave's Aphoriſms, obſerves, that theſe abſorbent powders ought not to be ground too fine, but rather left ſomewhat coarſe, as they will be leſs apt to concrete, and prove dangerous. It is a neceſſary caution to drink diluting liquors with them; alſo to take gentle purges, as well for ſome time after they are left off, as during the uſe of them. Abſorbents are much the ſame with what we otherwiſe call driers and ſweeteners. Latin writers alſo uſe the word as ſynonymous with *imbibentia* and *ſaturantia*. The term abſorbent is frequently confounded with alkali; alkalies having really the effect of abſorbents with reſpect to acids.

ABSORBENT *Veſſels*, a minute kind of veſſels found in animal bodies, which attract and imbibe the nutritious and other matters brought near their mouths. Theſe are ſometimes called reſorbent veſſels, and ſometimes abſorbent pores. Abſorbent veſſels are found in all parts of the body, eſpecially where the membranes lie open to cavities, as in the mouth, œſophagus, ſtomach, inteſtines, &c. A late author computes no leſs than 7,000,000,000 in one ſquare foot of the ſurface of the ſtomach. By theſe, mercury, plaſters, and the like medicines, externally applied, enter the habit of the body. To theſe are alſo owing the inſtantaneous effects of ſpirits, drams, water, &c. upon the body. The like veſſels are alſo numerous in the ſkin, where they are ſuppoſed to imbibe the fluid matter floating in the ambient air, and convey them into the body. Mortimer. Exerg. Inaug. de Ingreſ. Humor. in Corp.

It has been ſaid that there are no abſorbent veins, and that abſorption is performed entirely by the valvular lymphatics. But if this were the caſe, we ſhould be continually ſubject to a hydrocephalus; becauſe in the head no valvular lymphatics are found.

It is plain that there are abſorbent veins that open into the cavities of the body, becauſe in the aſcites the extravaſated water is frequently received into the circulation, and diſcharged by urine or ſtool. Dr. Hunter aſcertains it by the following experiment on a living dog: an opening was made in the cavity of his belly, and three quarts of warm water injected and ſecured: ſix hours after he was examined, and not above four ounces of the water remained. For farther ſatisfaction on this ſubject, conſult Hunter's Commentaries, and Dr. Garney's Obſervations on them, in the Medic. Muſ. vol. ii. p. 229; and alſo Dr. Wilkinſon, ibid. p. 117. &c.

Abſorbent veſſels are more particularly uſed for thoſe lacteals which open into the ſides of the inteſtinal tube, to imbibe the chyle in its deſcent from the ſtomach, and convey it into the meſenteric veins. Naturaliſts, as Malphigi, Leewenhoeck, De la Hire, &c. ſpeak of the like abſorbents in plants, the fibrous or hairy roots of which are conſidered as a kind of *vaſa abſorbentia*, which attract and imbibe the nutritious juices from the earth. For a copious account of theſe veſſels, ſee the Syſtem of ANATOMY, Part III. Sect. XIV. For the courſe and diſtribution of theſe veſſels, ſee Plate VI.

ABSORBING, the act of ſucking up or imbibing another body. Sir Iſaac Newton ſhews that black bodies abſorb all the rays they receive, and that thoſe rays of light, which impinge againſt the ſolid particles of bodies, are abſorbed and loſt; but it appears from ſome later experiments and obſervations of M. Bouguer, that this effect is to be attributed, not to the impact of light on the ſolid parts of bodies, but to the action of ſome power diffuſed over their ſurfaces. He found, by repeated trials on the reflection of light, from the ſurface of water, and of different pieces of cryſtal, that a conſiderable quantity of light, when the angles of incidence were ſmall, was actually extinguiſhed. This effect, he obſerved, was diminiſhed by increaſing the incidence; ſo that at an inclination to cryſtal of above 49° 49', a very ſmall part of the rays was abſorbed; though ſome few were loſt, when they fell perpendicularly on the reflecting ſurface. See his Traite d'Optique. Paris 1760.

ABSORPTION, in the animal œconomy, is uſed for that power whereby the ſmall open orifices of veſſels imbibe liquors lodged in the cavities of animal bodies. This, according to Dr. Munro, is obſerved to increaſe or diminiſh proportionably to the ſtrength or weakneſs of the creature. Med. Eſſ. Edinb. vol. iii. p. 189.

Fluids applied to the ſurface of the body are alſo abſorbed through the minute pores of the ſkin, and the mouths of a ſet of veſſels appropriated for this action; which, beſide the property of capillary tubes, poſſeſs alſo a contractile power from irritation.

ABSORPTION *of the Earth*, a term uſed by Kircher and others, for the ſinking in of large tracts of land, by means of ſubterranean commotions, and many other accidents. Pliny tells us, that in his time the mountain Cymbotus, with the town of Eurites, which ſtood on its ſide, were wholly abſorbed into the earth, ſo that not the leaſt trace of either remained; and he records the like fate of the city Tantalis, in Magneſia; and after it of the mountain Sypelus; both thus abſorbed by a violent opening of the earth. Galanis and Garnatus, towns once famous in Phœnicia, are recorded to have ſhared the ſame fate; and the vaſt promontory, called Phlegium, in Æthiopia, after a violent earthquake, in the night-time, was not to be ſeen in the morning, the whole having diſappeared, and the earth cloſed over it. Theſe and many other hiſtories, atteſted by the authors of greateſt credit among the ancients, abundantly prove the fact in the earlier ages; and there have not been wanting too many inſtances of more modern date. Kircher's Mund. Subter. p. 77. See EARTH and EARTHQUAKES.

The mountain Picus, in one of the Molucca Iſles, was ſo lofty, that it appeared at a great diſtance as an immenſe column reared erect in the air, and ſerved as a land-mark to ſailors: an earthquake in this iſland deſtroyed it; at one inſtant the whole mountain was abſorbed into the bowels of the earth, and no mark of its place remained, but a vaſt lake of water, exactly anſwering to the ſhape of the baſe of the mountain. A like accident, but of a more terrible kind, happened in China, in the year 1556, when a whole province of the mountainous parts of that kingdom was in one moment abſorbed into the earth, and all the towns buried, the whole number of the inhabitants ſinking with it, and an immenſe lake of water remaining in its place to this time. Of much later date is the deſtruction of a city in the confines of Switzerland: but this, though generally ſaid to have been ſwallowed up into the earth, was not properly an abſorption, for the whole city was buried by the fall of a mountain upon it.

The burning mountains Veſuvius and Strongylus, both once very high, have, in length of time, loſt half their height, the upper part having been undermined by the burning, and having fallen into, and been abſorbed by, the under part. And in the year 1646, during a terrible earthquake in the kingdom of Chili, ſeveral whole mountains in the Andes diſappeared, and were one after another wholly abſorbed into the earth. Theſe, and a thouſand other accidents of the like kind, prove the truth of abſorptions in general; ſome of them leaving level ground in the place of the things abſorbed, ſome immenſe chaſms and cracks, and ſome lakes of freſh or ſalt water; and it may be that many immenſe lakes were formed in ages, of which we have no hiſtories, by the like abſorptions.

There are inſtances of iſlands being produced, though we cannot affirm them to have appeared in the place of any which have been abſorbed. In the year 1688 an iſland was raiſed near St. Michael's, in the Atlantic Ocean, by ſubterranean fires, which threw up ſtones, and other ſubterranean productions, in ſuch quantities, that they formed an iſland of five miles in length. The mountain raiſed, in one night, in the ſea near Puzzoli, is another inſtance of this ſudden production of theſe mountains: this appeared after one night's violent ſubterranean conflict, and ſtill keeps its place, and is known by the name of Mons Sanctus.

ABSTEMIOUS is properly underſtood of a perſon who refrains abſolutely from all uſe of wine. It is compounded of *abs*, from, and *temetum*, wine. The hiſtory of Mr. Wood, in the Medic. Tranſ. vol. ii. p. 261. art 18. is a very remarkable exemplification of the very beneficial alterations which may be effected on the human body by a ſtrict courſe of abſtemiouſneſs. The Roman ladies, in the firſt ages of the republic, were all enjoined to be abſtemious; and that it might appear, by their breath, whether or no they kept up to the injunction, it was one of the laws of the Roman civility, that they ſhould kiſs their friends and relations whenever they accoſted them.

ABSTERGENTS, or ABSTERSIVE MEDICINES, more uſually called, among phyſicians, detergents, are cleanſing medicines of a ſaponaceous nature, capable of diſſolving concretions formed of earth and oil, which water ſimply, as an abluent, cannot effect.

ABSTINENCE, in a general ſenſe, implies the act or habit of refraining from ſomething which we have a propenſity to, or find a pleaſure in. The world is derived from *abſtinere*, formed of *abs*, from, and *tenere*, to hold.

The Jewiſh law ordained that the prieſts ſhould abſtain from the uſe of wine during all the time of their being employed in the ſervice of the temple. The ſame abſtinence was enjoined the Nazarites, during the time of their Nazariteſhip, or ſeparation. The Jews was commanded to abſtain from ſeveral ſorts of animals, viz. all ſuch as have not the hoof parted, and do not chew the cud. The fat of all ſorts of animals, that were ſacrificed, was forbidden to be eaten; and the blood of every animal in general was prohibited under pain of death. Neither did they eat the ſinew, which is upon the hollow of the thigh, though it be otherwiſe pure, becauſe the angel, who wreſtled with Jacob, at Mahanaim, touched the hollow of his thigh, which occaſioned the ſinew to ſhrink. They abſtained likewiſe from thoſe animals which had been taken by a devouring and impure beaſt, ſuch as a dog, a wolf, a boar, &c. and from ſuch as died of themſelves. Fiſh that have neither fins or ſcales were to be abſtained from as impure. Some are of opinion that this diſtinction of animals, into clean and unclean, was intended to denote the moral purity or impurity which the Hebrews were to endeavour after, or avoid. A hog, for inſtance, ſignifies gluttony; a hare, laſciviouſneſs; and ſo of others. Again, a ſheep denotes gentleneſs; a pigeon, ſimplicity; and the like. But many commentators are of opinion, that

that ſeveral animals were declared unclean, and therefore to be abſtained from, only becauſe of ſome qualities in them naturally hurtful or pernicious to health.

Among the primitive Chriſtians, ſome denied themſelves the uſe of ſuch meats as were prohibited by the law: others looked upon this abſtinence with contempt. St. Paul has given his opinion in this manner: 'One believeth that he may eat all things; another, who is weak, eateth herbs. Let not him that eateth deſpiſe him that eateth not. And let not him that eateth not judge him that eateth.' Rom. xiv. 1, 2, 3; and 1 Cor. viii. 7. and 10. The Council of Jeruſalem, which was held by the apoſtles, enjoined the Chriſtian converts to abſtain from meats ſtrangled, from blood, from fornication, and from idolatry. Abſtinence, as preſcribed by the goſpel, is intended to mortify and reſtrain the paſſions, to humble our vicious natures, and by that means raiſe our minds to a due ſenſe of prayer and devotion. But there is another ſort of abſtinence, which may be called ritual, and conſiſts in abſtaining from particular meats at certain times and ſeaſons.

The Jews are obliged to abſtain from their wives at certain ſeaſons. The ſame is enjoined in the apoſtolical conſtitutions on all faſts and meagre days. The church of England recommends certain days of faſting and abſtinence. Abſtinence from fleſh has been enjoined by ſtatute ever ſince the Reformation, particularly on Fridays and Saturdays, and on the vigils, and all commonly called fiſh-days. Vide 2 and 3 Edw. VI. cap. 19. The like injunctions were renewed under Queen Elizabeth; but at the ſame time it was declared, that this was done not out of motives of religion, as if there were any difference in meats, but in favour of the conſumption of ſea-fiſh, and to multiply the number of fiſhermen and mariners, as well as ſpare the flocks of ſheep. Vide 5 Eliz. cap. 13. "The great faſt (ſays St. Auguſtin) is to abſtain from ſin."

Several writers are of opinion, that, before the flood, mankind abſtained from wine and fleſh; becauſe the Scriptures expreſsly mention that Noah, immediately after the deluge, began to plant the vine, and that God permitted him to make uſe of animal food; whereas he had given to Adam nothing more than the fruits and plants of the earth. This opinion, however, is not univerſal; many learned interpreters maintain the contrary, and believe that mankind, before the deluge, did not deny themſelves the pleaſures of either wine or animal food.

The Phœnicians and Aſſyrians, who were neighbours to the Jews, had their ſacred faſts. The Egyptians, according to Herodotus, ſacrificed a cow to Iſis, after they had prepared themſelves by faſting. He alſo attributes the ſame cuſtom to the women of Cyrene. Among the Athenians, the Eleuſinian feaſts, as well as the Thermophores, were attended with rigorous faſtings, eſpecially among the women, who paſſed a whole day ſitting on the ground in a mourning habit, and without taking the leaſt ſuſtenance. The Romans had alſo ſettled faſts in honour of Jupiter. Hiſtorians alſo mention thoſe of Julius Cæſar, Auguſtus, Veſpaſian, Marcus Aurelius, &c. The Pythagoreans (at leaſt thoſe among them who profeſſed the greateſt perfection, and gloried in having attained to the higheſt degree of their maſter's theory) never eat either fleſh or fiſh; their abſtaining from whatever had life was a conſequence of the metempſychoſis; though it is not eaſy to diſcover the cauſe from whence Pythagoras imbibed that averſion he always had to beans, mallows, wine, &c. He might, indeed, abſtain from eggs, becauſe chickens were produced from them; but upon what foundation could he build his argument, that the bean was a ſacred plant? His opinion that the gods patronized it, could flow only from ſuperſtition: and his belief that the mallow had any qualities repugnant to health, could only be the effect of ignorance, or at leaſt the want of experience.

In the brute creation we ſee extraordinary inſtances of long abſtinence; many of the ſpecies paſs four, five, or ſix months, every year, without either food or water. The ſerpent, land tortoiſe, dormouſe, &c. are obſerved to retire regularly, at certain ſeaſons, to their reſpective cells, and conceal themſelves from ſight: ſome hide themſelves in the caverns of rocks, or ruins; ſome dig holes in the earth; while others retire to the woods, and lay themſelves up in the clefts of trees. Several ſpecies of birds, and almoſt the whole tribe of inſects, are capable of ſubſiſting the whole winter, not only without food, but even without reſpiration. This particular furniſhes us with an admirable inſtance of the wiſdom of the Creator; the proper food of theſe creatures, particularly thoſe of the inſect tribe, being then wanting, proviſion is made for them to live without it. When the fields are diveſted of their flowery furniture, and the trees and plants are ſtripped of their fruits, what would become of creatures ſubſiſting only by the produce of the ſpring and ſummer? And when the air is grown rigid, and chilled with froſt, what could ſupport theſe tender ſpecies which are impatient of cold? Therefore, to prevent the total deſtruction and extirpation of ſo many ſpecies of animals, the author of nature has wiſely provided, that creatures, thus bereaved of their food, ſhould be alſo impatient of cold, in order to lead them to ſome receſs, where they may find ſhelter from danger; while the natural texture and vicidity of their blood diſpoſes it, by a farther degree of cold, to become almoſt ſtagnant in their veſſels; ſo that the circulation being hardly carried on, and the animal function in a great meaſure ſuſpended, there is no ſenſible waſte or conſumption of parts, but they remain in a drowſy neutral ſtate, between life and death, till the warm ſun at once recalls them to life, and produces the food neceſſary to their exiſtence, by thawing the congealed juices both of theſe animals and vegetables. Hence it is no wonder that land tortoiſes, dormice, &c. are found as fat and fleſhy after ſome months abſtinence as before. Sir George Ent tells us, (Phil. Tranſ. No. 194,) that he weighed his tortoiſe ſeveral years ſucceſſively, at its going into the earth in October, and at its coming out again in March, and found that of 4lb. 4oz. it never loſt more than an ounce.

It is to be added, that, in moſt inſtances of extraordinary human abſtinence, related by naturaliſts, there were ſaid to have been apparent marks of a texture of blood and humours, much like that of the animals above mentioned; though it is no improbable opinion, that the air itſelf may furniſh ſomething for nutrition. It is certain there are ſubſtances of all kinds, animals, vegetables, &c. floating in the atmoſphere, which muſt be continually taken in by reſpiration; and that an animal body may be nouriſhed thereby, is evident in the inſtance of vipers; which, if taken when firſt brought forth, and kept from every thing but air, will grow very conſiderably in a few days. So the eggs of lizards are obſerved to increaſe in bulk, after they are produced, though there be nothing to furniſh the increment but air alone; in like manner, as the eggs or ſpawn of fiſhes grow and are nouriſhed with the water.

ABSTINENCE, in phyſic, is a term of very extenſive ſignification, for it implies a privation of all ſucculent aliments. Though abſtinence is not ſufficient for the cure of diſeaſes, yet it greatly aſſiſts the operation of medicines, and is a preventative againſt a multitude of dangerous diſorders. Several writers relate extraordinary cures performed by it, and in protracting the term of human life. The noble Venetian, Cornaro, after every method had been tried in vain, and his life was deſpaired of when he was no more than forty years of age, recovered his former health, and lived to near an hundred years old, by the ſole effect of abſtinence, as he himſelf tells us in a book he publiſhed on that ſubject. It is, indeed, ſurprizing to what a great age the primitive Chriſtians of the eaſt, who retired from perſecution into the deſerts of Arabia and Egypt, lived, healthful and chearful, on a very little food. Caſſian aſſures us, that the common allowance for twenty-four hours, was only twelve ounces of bread, and mere water. He adds, that, with this ſparing diet, St. Anthony lived an hundred and five years; James the Hermit, one hundred and four; Arſenius, tutor to the emperor Arcadius, an hundred and twenty; St. Epiphanius, an hundred and fifteen; Simeon, the Stylite, an hundred and twelve; and Romauld, an hundred and twenty. Nor need we have recourſe to the eaſtern Chriſtians for examples, ſince the hiſtory of our own country furniſhes us with ſome even ſuperior to thoſe already recited. Buchan relates, that one Laurence preſerved his life to an hundred and forty years by temperance and labour; and Spotſwood mentions one Kentingem, afterwards called St. Monga, or Mungo, who lived to the age of an hundred and ſeventy-five, by the ſame means.

Dr. Cheyne imputes moſt of the chronical diſeaſes, the infirmities of old age, and the ſhort lives of Engliſhmen, to repletion; and may be either prevented or cured by abſtinence. For other inſtances of the effects of abſtinence, ſee LONGEVITY.

ABSTRACT, *Abſtractum*, in a general ſenſe, any thing ſeparated from ſomething elſe, which is of like parts, powers, or principles.

ABSTRACT *Idea*, in metaphyſics, is a partial idea of a complex object, limited to one or more of the component parts, or properties; laying aſide, or abſtracting from, the reſt. Thus, in viewing an object with the eye, or recollecting it in the mind, we can eaſily abſtract from ſome of its parts or properties, and attach ourſelves to others; e. g. we can attend to beautiful hues of fruits or flowers, without paying any regard to their figure, ſhape, taſte, ſmell, or conſiſtence.

ABSTRACT *Terms*, in logic, are ſuch as denote thoſe objects which exiſt in imagination only. Thus beauty and uglineſs are abſtract terms. There are ſome objects that pleaſe, and appear beautiful; others affect us in a very different manner, which we call ugly; and yet there are no ſuch real ſubſtances in nature as beauty or uglineſs; they ſubſiſt only in our imagination.

ABSTRACT *Numbers* are aſſemblages of units conſidered in themſelves, and not applied to denote any collections of particular ſorts of things.

ABSTRACT *Mathematics*, otherwiſe called *pure mathematics*, are thoſe branches which treat of magnitude or quantity, conſidered abſolutely, without any reſtriction to a particular part. Thus geometry, algebra, and arithmetic, are abſtract mathematics. In this ſenſe, abſtract mathematics ſtand oppoſed to mixed mathematics, wherein ſimple abſtract properties, and the relations of quantities, primitively conſidered in pure mathematics, are applied to ſenſible objects, and by that means become intermixed with phyſical conſiderations; ſuch are, *Navigation, Hydroſtatics, Optics, &c.*

ABSTRACT, in literature, denotes a ſelection of the beauties, or particular and moſt ſtriking paſſages, of an author, without any abridgement of the paſſages ſo ſelected; as is a book entitled *The Flowers of Literature*, which contains abſtracts from Pope, Swift, Watts, Sterne, &c. &c.

ABSTRACTION, in general, the act of abſtracting, or the ſtate of being abſtracted.

ABSTRACTION, in metaphyſics, the operation of the mind when occupied by abſtract ideas. A large oak fixes our attention, and abſtracts us from the ſhrubs that ſurround it. In the ſame manner a beautiful woman, in a crowd, abſtracts our thoughts, and engroſſes our attention ſolely to herſelf. Theſe are examples of real abſtraction: when theſe, or any others of a ſimilar kind, are recalled to the mind, after the objects themſelves are removed from our ſight, they form what they call *abſtract ideas*; or the mind is ſaid to be employed in abſtract ideas. But the power of abſtraction is not confined to objects that are ſeparable in reality as well as mentally; the ſize, the figure, and the colour of a tree are inſeparably connected, and cannot exiſt independent of each other, and yet we can mentally confine our obſervations to any one of theſe properties, neglecting, or abſtracting from, the reſt.

Abſtraction is chiefly employed theſe three ways. Firſt, when the mind conſiders any one part of a thing in ſome reſpect diſtinct from the whole; as a man's arm, without the conſideration of the reſt of the body. Secondly, when we conſider the *mode* of any ſubſtance, omitting the ſubſtance itſelf; or when we ſeparately conſider ſeveral modes which ſubſiſt together in one ſubject. This abſtraction the geometricians make uſe of when they conſider the length of a body ſeparately, which they call a *line*, omitting the conſideration of its breadth and thickneſs. Thirdly, it is by abſtraction that the mind forms general or univerſal ideas, omitting the modes and relations of the particular objects whence they are formed. Thus, when we would underſtand a thinking being, in general, we gather from our ſelf-conſciouſneſs what it is tot hink; and, omitting thoſe things which have a particular relation to our own minds, or to the human mind, we conceive a thinking being in general. Ideas formed in this manner, which are what we properly call *abſtract ideas*, become general repreſentatives of all objects of the ſame kind, and their names applicable to whatever exiſts conformable to ſuch ideas. Thus, the idea of colour that we receive from chalk, ſnow, milk, &c. is a repreſentative of all that kind; and has a name given it, *whiteneſs*, which ſignifies the ſame quality wherever found or imagined.

The late lord Bolingbroke controverted the exiſtence of abſtract deas: and Mr. Hume, in his Eſſays, aſſerts, that it is unintelligible and abſurd to conclude, that the ideas of primary qualities are obtained by abſtraction; and he has purſued Berkeley's reaſoning to an extent, which he himſelf never intended, and repreſented all his arguments as merely ſceptical, "becauſe they admit of no "anſwer, and produce no conviction." He concurs with Dr. Berkeley in denying the exiſtence of matter; and advances a ſtep farther, maintaining that the ſoul is merely a bundle of perceptions, that there is nothing in the univerſe but impreſſions and ideas.

Some late Scotch writers, (Doctors Reid, Beattie, and Oſwald,) with a view of obviating thoſe ſceptical inferences, which had been deduced from the principles of Mr. Locke, have, in oppoſition to theſe, offered a new ſyſtem reſpecting the nature and origin of our ideas.

We ſhall only add, that abſtracting, on the common ſyſtem, is no more than generalizing: it is making one thing ſtand for an hundred, by omitting the conſideration of the differences between them: it is taking ſeveral differents, i. e. different combinations, ſetting aſide the peculiarities in each, and conſidering only what is found alike in all. Thus it is that I ſay, I love my friend, love my miſtreſs, love myſelf, my bottle, my book, my eaſe, &c. Not that it is poſſible I ſhould have the ſame perception with reſpect to ſo many different ſorts of things, things that ſtand in ſuch different relations to me; but only that, there appearing ſomething in them all that bears a reſemblance to the reſt, in ſome circumſtance or other, I chooſe to expreſs all by one name, *love*. For if I conſider the tendency and effects of them all, I ſhall find they lead me very different ways, to very different actions. All the analogy there is between them, is a ſort of pleaſure or ſatisfaction, ariſing upon the application of the particular object to its proper organ, or ſenſe. The abſtract idea of love, then, will terminate in the idea of pleaſure: but it is certain there can be no idea of pleaſure without a thing pleaſant to excite it. Any other abſtract idea of pleaſure will amount to no more than a view or perception of the circumſtances wherewith our pleaſures have been attended; but theſe are mere externals, foreign to the pleaſurable ſenſation itſelf, which nothing but an object applied in ſuch and ſuch a manner can excite. To ſuppoſe an idea of pleaſure produced indirectly, by any other than by the proper cauſe, is as abſurd as to ſuppoſe an idea of ſound, produced without a ſonorous object. The mind has no power of making any ideas, call them what you will, whether *abſtract* or *concrete*, or *general* or *particular*: its activity goes no farther than to the perceiving of ſuch as are preſented to it; ſo that its action is really no other than a degree of paſſion.

Dr. Price, in his Review of the principal Queſtions and Difficulties in Morals, p. 43; Dr. Cudworth, in his external and immutable Morality, book 4; Dr. Campbell, in his Philoſophy of Rhetoric, vol. 2, p. 105; as well as Mr. Locke and Dr. Berkeley, have ſeverally given very accurate deſcriptions of Abſtraction, both generally and particularly.

ABSTRACTITIOUS, or ABSTRACTIVE, is applied by ſome modern chemiſts to a ſpirit drawn from vegetables without fermentation. In which ſenſe abſtractitious ſpirits are ſynonymous with natural ſpirits, and ſtand oppoſed to fermentative or artificial ones. Such ſpirits are chiefly procured from plants, which abound in volatile ſalt. The abſtractitious ſpirit of ſcurvy graſs is preferred to that procured by fermentation. All the native ſpirits of aromatic plants are called abſtractitious.

ABSTRUSE, ſomething deep, hidden, concealed, or far removed from common apprehenſions, and therefore not eaſily underſtood; in oppoſition to what is obvious and palpable. Thus metaphyſics is an abſtruſe ſcience; and the doctrine of fluxions, and the method *de maximis et minimis*, are abſtruſe points of knowledge.

ABSURD, *Abſurdum*, a term applied to any action or ſentiment that contradicts or runs counter to ſome evident truth. Thus a propoſition would be abſurd, that ſhould affirm that two and two make five; or that ſhould deny them to make four. The logicians and mathematicians have a way of proving the truth of a propoſition, by ſhewing that the contrary is abſurd. This they call *reductio ad abſurdum*, or arguing *ex abſurdo*. Euclid, in his Elements of Geometry; Sir Iſaac Newton, in his Theory of the Solar Syſtem; and Dr. Watts, in his Logic, have had recourſe to this method of reaſoning, and with great effect upon particular occaſions.

ABSURDITY, a kind of error or offence againſt ſome evident or generally allowed truth or principle. The ſchoolmen make two ſpecies of *abſurdities*: the one abſolute, απλως, which contradicts the common ſenſe of mankind; the other *relative*, τινι, which gives the lie to ſome one or more philoſophers or perſons of great weight and authority. In this ſenſe the doctrine of a *vacuum* is an abſurdity, as being contrary to Ariſtotle; and that of a *plenum*, as being contrary to Sir Iſaac Newton. In effect, there is ſcarce one truth of any moment that is not an abſurdity in this ſenſe, as being repugnant to the ſyſtem of ſome ſect or party. As reaſon conſiſts in the due uſe of names and words, abſurdity conſiſts in the abuſe of them.

Hobbes aſſigns abſurdity as a privilege peculiar to man, and which no other creature is capable of. He adds, that of all men, thoſe called philoſophers are moſt expoſed to it. Whence the ſaying of Cicero, There is nothing ſo abſurd but has been ſaid by a philoſopher: *Nihil tam abſurde dici poteſt, quod non dicatur a philoſopho.* The reaſon ſeems to be, that of all men they reaſon and diſcourſe moſt. Yet a nearer and more oppoſite cauſe may be aſſigned, viz. their neglect, at ſetting out, to define the terms they make uſe of, i. e. to aſſign the preciſe idea each is made to repreſent: which is much like a man's undertaking to number, without knowing the value of the numeral figures; reaſoning, according to the author firſt cited, being no other than computing.

Divers abſurdities alſo ariſe from the wrong connecting of names into propoſitions: as firſt, when the names of bodies are applied to accidents, or the names of accidents to bodies; as in that propoſition, "faith is infuſed or inſpired:" ſince nothing is either fuſible, or inſpirable, but body: and the ſame abſurdity the Carteſians fall into, when they make extenſion to conſtitute body, &c. Secondly, when the names of accidents, inherent in external bodies, are attributed to accidents of our own bodies; as when it is ſaid, that colour is in the object found in the air, &c. Thirdly, when the names of bodies are attributed to words, or conceptions; as is done by thoſe who aſſert that there are univerſal things, that animal is a genus, &c. Fourthly, when the name of accidents are given to words, and propoſitions; as when it is ſaid, that the definition is the nature of the thing, or a perſon's command is his will. Fifthly, when, in lieu of proper words, metaphors and tropes are made uſe of; as, *the way leads to ſuch a place*; *the proverb ſays this or that*; which, though allowable on ordinary occaſions, yet is of miſchievous conſequence in reaſoning and ſearching after truth. Laſtly, when names are taken at random, and uſed without meaning, as tranſubſtantiation, conſubſtantiation, entelechia, &c. He that can avoid theſe rocks, will not eaſily fall into an abſurdity, except in a very long chain of reaſoning, when he may be apt to forget ſome propoſitions before laid down. Hobb. Lev. p. i. c. 5. p. 22.

ABSYNTHIUM, or ABSINTHIUM, a medicinal plant, of conſiderable efficacy in quality of a bitter and ſtomachic, commonly called Wormwood.

ABUNDANT *Number*, in arithmetic, is a number, the ſum of whoſe aliquot parts is greater than the number itſelf. Thus the aliquot parts of 12, being 1, 2, 3, 4, and 6, they make, when added together, 16. An abundant number is oppoſed to a deficient number, or that which is greater than all its aliquot parts taken together; as 14, whoſe aliquot parts are 1, 2, and 7, which make no more than ten: and to a perfect number, or one to which its aliquot parts are equal; as 6, whoſe aliquot parts are 1, 2, and 3.

ABUSE,

ABUSE, an irregular uſe of a thing, or the introducing of ſomething contrary to the true intention thereof. The word is compounded of *ab*, from, and *uſus*, uſe. In grammar, to apply a word abuſively, or in an abuſive ſenſe, is to miſapply or pervert its meaning. Words being the medium through which perſons communicate their diſcoveries, reaſonings, and knowledge to each other, he who uſes them improperly, though he does not corrupt the fountain of knowledge, commits abuſes in language, and may therefore be conſidered as an enemy to the improvement of learning.

ABUTTAL, Abbutals, Abutals, among law-writers, denote the buttings or boundings of a piece of land; expreſſing on what other lands, highways, or the like, the ſeveral extremes thereof do abut, or terminate. In this ſenſe the word is ſometimes alſo written corruptly abbutals, or abutals. In old ſurveys, we often find them called *headlands*. Abuttals amount to the ſame with what Latin writers call *capita*; Marculſus, *frontes*; the French, *bouts*. In Coke, the plaintiff is ſaid to fail in his abuttals; that is, in ſetting forth how the land is bounded.

ABYSS, in a general ſenſe, denotes ſomething profound, and, as it were, bottomleſs. The word is originally Greek, ἄβυσσος; compounded of the privative *a*, and βυσσος, *bottom*; q. d. *without a bottom*. We ſay, the abyſs of a mountain, an abyſs of waters, the great abyſs, the Moſaic abyſs, an unfathomable abyſs, &c.

Abyss, in a more particular ſenſe, denotes a deep maſs, or fund of waters. In this ſenſe the word is particularly uſed in the Septuagint, for the water which God created at the beginning with the earth, which encompaſſed it round, and which our tranſlators render by the *deep*. Thus it is that darkneſs is ſaid to have been on the face of the *abyſs*.

Abyss is alſo uſed for an immenſe cavern in the earth, where God collected all thoſe waters on the third day, which, in our verſion, is rendered the *deep*, and elſewhere the *great deep*.

Dr. Woodward has made ſeveral obſervations and conjectures with reference to this great abyſs, in his Natural Hiſtory of the Earth. He aſſerts, that there is a vaſt collection of waters enclo-ſed in the bowels of the earth, conſtituting a huge orb in the interior or central parts of it; and over the ſurface of this he ſuppoſes the terreſtrial ſtrata to be expanded. This, according to him, is what Moſes calls the *great deep*, and what moſt authors render the *great abyſs*. That there is ſuch an aſſemblage of waters lodged in the depths of the earth, is confirmed by abundance of obſervations. See Earth and Deluge.

The water of this vaſt abyſs, he aſſerts, does communicate with that of the ocean, by means of certain hiatuſes, or chaſms, paſſing betwixt it and the bottom of the ocean: and this and the abyſs he ſuppoſes to have one common centre, around which the water of both is placed; but ſo that the ordinary ſurface of the abyſs is not level with that of the ocean, nor at ſo great a diſtance from the centre as the other; it being, for the moſt part, reſtrained and depreſſed by the ſtrata of earth lying upon it: but wherever thoſe ſtrata are broken, or are ſo lax and porous that water can pervade them, there the water of the abyſs aſcends, fills up all the cleſts and fiſſures into which it can get admittance, and ſaturates all the interſtices and pores of the earth, ſtone, or other matter, all round the globe, quite up to the level of the ocean.

The exiſtence of an abyſs, or receptacle of ſubterraneous waters, is controverted by Camerarius, and defended by Dr. Woodward, chiefly by two arguments: the firſt, drawn from the vaſt quantity of water which covered the earth in the time of the deluge: the ſecond, from the conſideration of earthquakes, which he endeavours to ſhew are occaſioned by the violence of the waters in this abyſs. A great part of this terreſtrial globe has been frequently ſhaken at the ſame moment: which argues, that the waters, which were the occaſion thereof, were co-extended with that part of the globe. There are even inſtances of univerſal earthquakes; which ſhew that the whole abyſs muſt have been agitated; for ſo general an effect muſt have been produced by as general a cauſe; and that cauſe can be nothing but the ſubterraneous abyſs. For the true cauſe of earthquakes, ſee Earthquake.

The abyſs is no uſeleſs thing; when once eſtabliſhed, it ſerves to ſolve ſeveral difficult phenomena; as the origin of ſprings and rivers; the level maintained in the ſurface of different ſeas, and their not overflowing their banks. To the effluvia emitted from this abyſs, ſome even attribute all the diverſities of weather, and changes in our atmoſphere; and, what is more, the origin of every thing in the earth, or on its ſurface. Dr. Woodward has an epiſtle on the œconomy of the great abyſs hid in the bowels of the earth, and the perpetual communication between it and the atmoſphere. Ray, and other authors, ancient as well as modern, ſuppoſe a communication between the Caſpian Sea and the ocean, by means of a ſubterranean abyſs; and to this they attribute it, that the Caſpian does not overflow, notwithſtanding the great number of large rivers it receives; of which Kempfer reckons above fifty in the compaſs of ſixty miles. But the daily evaporation may be ſufficient for this purpoſe. See Evaporation, Sea, and Spring.

The different arguments concerning this ſubject may be ſeen, collected, and amplified in Cockburn's Enquiry into the Truth and Certainty of the Moſaic Deluge, p. 271, &c. After all, however, this amazing theory of a central abyſs is far from being demonſtrated; it will, perhaps, in ſeveral reſpects, appear inconſiſtent with ſound philoſophy, as well as repugnant to the phenomena of nature. In particular, if we believe any thing like elective attraction to have prevailed in the formation of the earth, we muſt believe that the ſeparation of the chaos proceeded from the union of ſimilar particles. It is certain that reſt is favourable to ſuch operations of nature. As, therefore, the central parts of the earth were more immediately quieſcent than thoſe remote from the centre, it ſeems abſurd to ſuppoſe that the heavier and denſer bodies gave place to the more light and fluid; that the central part ſhould conſiſt of water only, and the more ſuperficial part of a cruſt or ſhell. Vid. Whitehurſt's Enquiry into the original Formation of the Strata, &c. Hiſt. of the Earth. Journal de Scavans, tom. 58. p. 393. Memoirs of Literature, vol. 8. p. 101, &c. Holloway's Introduct. to Woodward's Hiſt. of the Earth. Acta Euruditorum 1727, p. 313, Phyſico Theology, Diſc. II. See Deluge.

Abyss is alſo uſed to denote the cavernous belly of a hollow mountain. In which ſenſe Mr. Tournefort deſcribes the abyſs of mount Ararat as a horrible ſpectacle.

Abyss, in the Septuagint verſion of the Old Teſtament, implies a great deep; as in the old tranſlations, the word has been rendered, "and darkneſs was on the face of the abyſs;" i. e. the *great deep*; which the tranſlators of the Engliſh bible have rendered *deep* only.

Abyss is alſo uſed to denote hell, in which ſenſe the word is ſynonymous with Barathrum, Erebus, and Tartarus: in the Engliſh bible, "the bottomleſs pit." Cruden's Concordance.

Abyss is alſo uſed metaphorically, for a thing not to be known or comprehended, on account of its immenſe extent or profundity. In which ſenſe it coincides with ſecret, inſcrutable, incomprehenſible, &c. The judgments of God are called a great abyſs.

ACACIA, in botany, *Egyptian Thorn*, or *Binding Bean Tree*, the name of a genus of trees, the characters of which are theſe: the flower conſiſts only of one leaf, and is of the funnel-faſhioned kind, and uſually contains a great number of ſtamina; and the flowers are commonly collected in cluſters, or little heads: the piſtil ariſes from the bottom of the flower, and finally becomes a ſiliquoſe fruit, divided into ſeveral hollows, and containing a number of roundiſh ſeeds. The acacias belong to the polyandria claſs of Linnæus. The ſpecies of acacia enumerated by Mr Tournefort are twelve; and by Mr. Miller, twenty-two. The Æthiopian Pepper of Matthiolus ſeems to belong to this genus of plants.

The flowers of the acacia are uſed by the Chineſe in making that yellow which we ſee bears waſhing in their ſilks and ſtuffs, and appears with ſo much elegance in their painting on paper. The method is this: They gather the flowers before they are fully open: theſe they put into a clean earthen veſſel over a gentle heat, and ſtir them continually about, as they do the tea-leaves, till they become dryiſh, and of a yelloviſh colour: then to half a pound of the flowers they add three ſpoonsful of fair water, and after that a little more, till there is juſt enough to hold the flowers incorporated together: they boil this for ſome time, and the juice of the flowers mixing with the water, it becomes thick and yellow: then they take it from the fire, and ſtrain it through a piece of coarſe ſilk. To the liquor they add half an ounce of common allum, and an ounce of calcined oyſter-ſhells, reduced to a fine powder. All is then well mixed together; and this is the fine laſting yellow they have ſo long uſed. The dyers of large pieces uſe the flowers and ſeeds of the acacia for dying three different ſorts of yellow. They roaſt the flowers as before obſerved; and then mix the ſeeds with them, which muſt be gathered for this purpoſe when full ripe. By different admixture of theſe they give the different ſhades of colours; only for the deepeſt of all, they give a ſmall mixture of Braſil wood.

Mr. Geoffroy, with great probability, attributes the origin of bezoar to the ſeeds of this plant; which being broufed by certain animals, and vellicating the ſtomach by their great fourneſs and aſtringency, cauſe a condenſation of the juices, till at length they become coated over with a ſtony matter, which we call bezoar, or bezoard.

Acacia, in the materia medica, the inſpiſſated juice of the unripe fruit of the *Mimoſa Nilotica*. This juice is brought to us from Egypt, in roundiſh maſſes, wrapt up in thin bladders. It is outwardly of a deep brown colour, inclining to black; inwardly of a reddiſh or yelloviſh brown; of a firm conſiſtence, but not very dry. It ſoon ſoftens in the mouth, and diſcovers a rough, not diſagreeable taſte, which is followed by a ſweetiſh reliſh. This inſpiſſated juice entirely diſſolves in watery liquors; but is ſcarce ſenſibly acted on by rectified ſpirit. Acacia is a mild aſtringent medicine. The Egyptians give it in ſpitting of blood, in the quantity of a dram, diſſolved in any convenient liquor; and repeat this doſe occaſionally. They likewiſe employ it in collyria for ſtrengthening the eyes, and in gargariſms for quinſeys. Among us, it is little otherwiſe uſed than as an ingredient in mithridate and theriaca, and is rarely met with in the ſhops. What is uſually ſold for the Egyptian acacia, is the inſpiſſated juice of unripe ſloes: this is harder, heavier, of a darker colour,

and ſomewhat ſharper taſte, than the true ſort. See the next article.

German ACACIA, the juice of unripe ſloes inſpiſſated nearly to drineſs over a gentle fire, care being taken to prevent its burning. It is moderately aſtringent, ſimilar to the Egyptian acacia, for which it has been commonly ſubſtituted in the ſhops. It is given in fluxes, and other diſorders where ſtyptic medicines are indicated, from a ſcruple to a dram.

ACADEMICS, or ACADEMISTS, a denomination given to the cultivators of a ſpecies of philoſophy originally derived from Socrates, and afterwards illuſtrated and enforced by Plato, who taught in a grove near Athens, conſecrated to the memory of Academus, an Athenian hero; from which circumſtance this philoſophy received the name of *academical*. Before the days of Plato, philoſophy had in a great meaſure fallen into contempt. The contradictory ſyſtems and hypotheſes which had ſucceſſively been urged upon the world were become ſo numerous, that, from a view of this inconſtancy and uncertainty of human opinions, many were led to conclude, that truth lay beyond the reach of our comprehenſion. Abſolute and univerſal ſcepticiſm was the natural conſequence of this concluſion. In order to remedy this abuſe of philoſophy, and of the human faculties, Plato laid hold of the principles of the academical philoſophy; and, in his Phædo, reaſons in the following manner. "If we are unable to diſcover truth, (ſays he,) it muſt be owing to theſe two circumſtances; either there is no truth in the nature of things; or the mind, from a defect in its powers, is not able to apprehend it. Upon the latter ſuppoſition, all the uncertainty and fluctuations in the opinions and judgments of mankind admit of an eaſy ſolution. Let us therefore be modeſt, and aſcribe our errors to the real weakneſs of our own minds, and not to the nature of things themſelves. Truth is often difficult of acceſs: in order to come at it, we muſt proceed with caution and diffidence, carefully examining every ſtep; and, after all our labour, we ſhall frequently find our greateſt efforts diſappointed, and be obliged to confeſs our ignorance and weakneſs."

Labour and caution in their reſearches, in oppoſition to raſh and haſty deciſions, were the diſtinguiſhing characteriſtics of the diſciples of the ancient academy. A philoſopher, poſſeſſed of theſe principles, will be ſlow in his progreſs; but will ſeldom fall into errors, or have occaſion to alter his opinion after it is once formed. Vanity and precipitance are the great ſources of ſcepticiſm: hurried on by theſe, inſtead of attending to the cool and deliberate principles recommended by the academy, ſeveral of our modern philoſophers have plunged themſelves into an abſurd and ridiculous kind of ſcepticiſm. They pretend to diſcredit ſubjects that are plain, ſimple, and eaſily comprehended; but give peremptory and deciſive judgments upon things that evidently exceed the limits of our capacity. Of theſe Berkeley and Hume are the moſt conſiderable. Berkeley denied the exiſtence of every thing, excepting his own ideas. Mr. Hume has gone a ſtep farther, and queſtioned even the exiſtence of ideas; but at the ſame time has not heſitated to give determined opinions with regard to eternity, providence, and a future ſtate, miraculous interpoſitions of the Deity, &c. ſubjects far above the reach of our faculties. In his Eſſay on the academical or ſceptical Philoſophy, he has confounded two very oppoſite ſpecies of philoſophy. After the days of Plato, indeed, the principles of the firſt academy were groſsly corrupted by Arceſilas, Carneades, &c. This might lead Mr. Hume into the notion that the *academical* and *ſceptical* philoſophy were ſynonymous terms. But no principles can be of a more oppoſite nature than thoſe which were inculcated by the old academy of Socrates and Plato, and the ſceptical notions which were propagated by Arceſilas, Carneades, and the other diſciples of the ſucceeding academies.

ACADEMICS, or rather ACADEMISTS, is alſo uſed among us for the members of the modern academies, or inſtituted ſocieties of learned perſons.

ACADEMY, ACADEMIA, in antiquity, a fine villa, or pleaſure-houſe, ſituate in one of the ſuburbs of Athens, about a mile from the city; where Plato, and the wiſe men who followed him, held aſſemblies for diſpute and philoſophical conference; and which gave the denomination to the ſect of *Academics*. It took its name academy, from one Academus, or Ecademus, a citizen of Athens, to whom it originally belonged, and who uſed to have gymnaſtic ſports or exerciſes therein. He lived in the time of Theſeus. Some miſtakenly derive his name and origin from Cadmus, the Phœnician, as being the firſt who introduced learning, and the uſe of letters, among the Greeks. The academy was farther improved and adorned by Cimon, with fountains, trees, ſhady walks, &c. for the convenience of the philoſophers, and men of learning, who here met to confer, diſpute, &c. Hipparchus, the ſon of Piſiſtratus, built a wall round it: and in order to defray the charges, laid ſo heavy a tax on the people, that ever after Ἵππαρχος τεῖχος was uſed proverbially for any expenſive buſineſs. It was alſo the burying place of illuſtrious perſons, who had deſerved well of the republic. Here it was that Plato taught his Philoſophy; and from him all public places, deſtined for the aſſemblies of the learned and ingenious, have been ſince called *academies*. Sylla ſacrificed the delicious groves and walks of the academy, planted by Cimon, to the laws of war; and employed thoſe very trees to make machines where-with to batter the city. Cicero alſo had a villa, or country retirement, near Puzzuoli, which he called by the ſame name, *academia*; where he uſed to entertain his philoſophical friends. It was here he compoſed his Academical Queſtions, and his books De Natura Deorum.

ACADEMY is more frequently uſed among the moderns for a regular ſociety, or company of learned perſons, inſtituted under the protection of a prince, for the cultivation and improvement of arts and ſciences. Some authors confound academy with univerſity; but though much the ſame in Latin, they are very different things in Engliſh. An univerſity is properly a body compoſed of graduates in the ſeveral faculties; of profeſſors, who teach in the public ſchools; of regents, of tutors, and ſtudents, who learn under them, and aſpire likewiſe to degrees. Whereas an academy is not intended to teach or profeſs any art, ſuch as it is, but to improve it: it is not for novices to be inſtructed in, but for thoſe that are better informed; for perſons of diſtinguiſhed abilities to confer in, and communicate their lights and diſcoveries to each other, for their mutual benefit and improvement. The firſt academy we read of, was eſtabliſhed by Charlemagne, at the motion of Alcuin: it was compoſed of the chief wits of the court, the emperor himſelf being a member. In their academical conferences every perſon was to give an account of what ancient authors he had read; and each of them aſſumed the name of ſome ancient author, who pleaſed him moſt, or ſome celebrated perſon of antiquity. Alcuin, from whoſe letters we learn theſe particulars, took that of Flaccus, the ſurname of Horace; a young lord, named Augilbert, took that of Homer; Adelard, biſhop of Corbie, was called Auguſtin; Riculfe, biſhop of Mentz, was Dametas; and the king himſelf, David. This ſhows the miſtake of ſome modern writers, who relate, that it was in conformity with the genius of the learned men of thoſe times, who were great admirers of Roman names, that Alcuin took the name of Flaccus Albinus.

ROYAL ACADEMY *of Arts*, was inſtituted in London, for the encouragement of deſigning, painting, ſculpture, &c. &c. in the year 1768. The academy is under the immediate patronage of the king, and under the direction of forty artiſts of the firſt rank in their ſeveral profeſſions. It furniſhes, in winter, living models of different characters to draw after; and in ſummer, models of the ſame kind to paint after. Nine of the ableſt academicians are annually elected out of the forty, whoſe buſineſs is to attend by rotation, to ſet the figures, to examine the performances of the ſtudents, and to give them neceſſary inſtructions. There are likewiſe four profeſſors of painting, of architecture, of anatomy, and of perſpective, who annually read public lectures on the ſubjects of their ſeveral departments; beſide a preſident, a council, and other officers. The admiſſion to this academy is free to all ſtudents properly qualified to reap advantage from the ſtudies cultivated in it; and there is an annual exhibition of paintings, ſculptures, and deſigns, open to all artiſts of diſtinguiſhed merit: by which means, it is preſumed, the expences are ſupported, as there is no known fund for the purpoſe; together with variety of valuable publications for the promotion of the ſtudy of the polite arts: among which are a number of architectural works, as thoſe of Palladio, Inigo Jones; the Ruins of Palmyra and Balbec, by Wood; the Ruins of Athens, by Stewart; Spalatro, the Dioclefian Palace, by Robert Adams; the Ionian Antiquities, collected by Parrs of the Diletanti Society; the Ruins of Pæſtum: and many foreign publications imported; all which artiſts of the preſent day ſeize with avidity for their improvement; which certainly is a means of eſtabliſhing in them true principles, and correct taſte; together with the ſuperior advantages of the experimental knowledge of the art by public buildings, new ſquares, ſtreets, bridges, &c. carrying on in and about the metropolis, with ſo much judgment and alacrity; all which cannot fail to render England the firſt ſchool of architectural ſtudy in the known world. Honorary premiums for deſign in architecture are alſo given; and candidates ſent to Rome to compleat their ſtudies, free of expence.

American ACADEMY *of Arts and Sciences* was eſtabliſhed in 1780, by the council and houſe of repreſentatives of the province of Maſſachuſett's Bay, for promoting and encouraging the knowledge of the antiquities of America, and of the natural hiſtory of the country; to determine the uſes to which its various natural productions may be applied; to promote and encourage medicinal diſcoveries, mathematical diſquiſitions, philoſophical enquiries and experiments; aſtronomical, meteorological, and geographical obſervations; and improvements in agriculture, manufactures, and commerce; and, in ſhort, to cultivate every art and ſcience which might tend to advance the intereſt, honour, dignity, and happineſs of an independent people. The members of this academy are never to be more than two hundred, nor leſs than forty.

ACADEMY is alſo uſed as a kind of collegiate ſchool or ſeminary, where youth are inſtructed in the liberal arts and ſciences in a private way. Now, indeed, it is uſed for all kinds of ſchools.

In England we have two royal *Naval and Military Academies*. One at Portſmouth, for teaching navigation, drawing, &c. and another

another at Woolwich, where youth are taught fortification, gunnery, and ſuch branches of the mathematics as are neceſſary to qualify them for engineers.

The nonconformiſt miniſters, &c. are bred up in private academies, as not approving the common univerſity education. The principal of their academies are thoſe in London, Daventry, and Warrington, and the College at Hackney, in Middleſex, erected in the year 1791.

In the Encyclopædia Britannica, publiſhed in Scotland, and in Rees's Edition of Chambers's Cyclopædia, are given tedious deſcriptions of various academies, in which they have introduced copious accounts of their origin, rules, regulations, &c. but have omitted thoſe of modern date, and introduced accounts of others which have long ago been aboliſhed. As theſe particulars are neither intereſting or entertaining, we have purpoſely omitted them, as inconſiſtent with the œconomy of this work: our plan, in ſelecting from other works, being to lop off their ſuperfluous branches, prune them of their excreſcences, and adopt what is eſſential and intereſting. We ſhall therefore reject all dull and unintereſting details which preceding Dictionaries of Arts and Sciences have introduced to multiply the number of their pages: and the extraneous matter which has had admiſſion into thoſe voluminous works, will ever be omitted in this, to give place to ſubjects of novelty and utility.

ACANTHA, in botany, the prickle of any plant. In ichthyology, a term for the ſpine or prickly fins of fiſhes.

ACANTHOPTERYGIOUS FISHES, a term uſed by Linnæus for thoſe fiſhes whoſe back-fins are hard, oſſeus, and prickly.

ACANTHUS, in architecture, an ornament in the Corinthian and Compoſite orders; being the repreſentation of the leaves of an acanthaceous plant in the capital thereof.

ACARUS, the TICK or MITE, a genus of inſects belonging to the order of aptera, or ſuch as have no wings. The acarus has eight legs; two eyes, (one on each ſide of the head;) and two jointed tentacula. The female is oviparous. Linnæus enumerates 35 ſpecies; of which ſome are inhabitants of the earth, ſome of water; ſome live on trees, others among ſtones, and others on the bodies of other animals, and even under the ſkin. The deſcription of a few of the moſt remarkable will here ſuffice.

1. The *ſiro*, or cheeſe-mite, is a very minute ſpecies. To the naked eye, theſe mites appear like moving particles of duſt; but the microſcope diſcovers them to be perfect animals, having as regular a figure, and performing all the functions of life as perfectly, as creatures that exceed them many times in bulk. The principal parts of them are the head, the neck, and the body. The head is ſmall in proportion to the body; and has a ſharp ſnout, and a mouth that opens and ſhuts like a mole's. They have two ſmall eyes, and are extremely quick-ſighted; and when they have been once touched with a pin, you will eaſily perceive how cunningly they avoid a ſecond touch. Their legs are each furniſhed at the extremity with two little claws, with which the animal very nicely takes hold of any thing. The hinder part of the body is plump and bulky; and ends in an oval form, from which there iſſues out a few exceeding long hairs. Other parts of the body are alſo beſet with thick and long hairs. The males and females are eaſily diſtinguiſhed in theſe little animals. The females are oviparous, as the louſe and ſpider; and from their eggs the young ones are hatched in their proper form, without having any change to undergo afterwards. They are, however, when firſt hatched, extremely minute; and, in their growing to their full ſize, they caſt their ſkins ſeveral times. Theſe little creatures may be kept alive many months between two concave glaſſes, and applied to the microſcope at pleaſure. They are often ſeen *in coitu*, conjoined tail to tail; and this is performed by an incredibly ſwift motion. Their eggs, in warm weather, hatch in 12 or 15 days; but in winter they are much longer. Theſe eggs are ſo ſmall, that a regular computation ſhews, 90 millions of them are not ſo large as a common pigeon's egg. They are very voracious animals, and have often been ſeen to eat one another. Their manner of eating is by thruſting alternately one jaw forward, and the other backward, and in this manner grinding their food; and after they have done feeding, they ſeem to chew the cud. There are ſeveral varieties of this ſpecies found in different ſubſtances, beſides cheeſe; as in malt-duſt, flour, oatmeal, &c. Thoſe in malt-duſt and oatmeal are much nimbler than the cheeſe-mites, and have more and longer hairs. There are alſo a ſort of wandering mites, which range wherever there is any thing they can feed on: they are often ſeen in the form of a white duſt, and are not ſuſpected to be living creatures. The mite is called by authors ſimply *Acarus*. It is an animal very tenacious of life, and will live months without food. Mr. Leewenhoeck had one lived 11 weeks on the point of a pin, on which he had fixed it for examining by his microſcope. For a repreſentation of this inſect magnified, ſee Plate II. of Microſcopical Objects, *Fig.* 9.

2. The *ſanguiſugus*. The hinder part of the abdomen is crenated, the ſcutellum is oval and yelloviſh, and the beak is trifid. It is a native of America, and ſticks ſo faſt on the legs of travellers, ſucking their blood, that they can hardly be extracted.

3. The *exulcerans*, or itch-acarus, is a very ſmall ſpecies; its body is of a figure approaching to oval, and lobated; the head is ſmall and pointed; its colour is whitiſh; but it has two duſky ſemicircular lines on the back. It has long ſetaceous legs, but the two firſt are ſhort. It is found in the puſtules of the itch. Authors in general have ſuppoſed that it cauſes that diſeaſe: but others obſerve, that if this were ſo, it would be found more univerſally in thoſe puſtules. It is more probable that theſe only make a proper nidus for it. See, however, the article ITCH. For a repreſentation of this inſect magnified, ſee Plate II. of Microſcopical Objects, *Fig.* 10.

4. The *ovinus*, or ſheep-tick, has a flat body, of a roundiſh figure, but ſomewhat approaching to oval, and of a yelloviſh white colour, and has a ſingle large round ſpot on the back. The anus is viſible in the lower part of the body: the thorax is ſcarce conſpicuous: the head is very ſmall and black; the mouth is bifid: the antennæ are of a clavated figure, and of the length of the ſnout: the legs are ſhort and black. It is common on ſheep, and its excrement ſtains the wool green. It will live in the wool many months after it is ſhorn from the animal.

5. The *coleoptratorum*, or acarus of inſects, is extremely minute. Its body is round, reddiſh, and covered with a firm and hard ſkin: the head is very ſmall; the neck ſcarce viſible: the legs are moderately long; the anterior pair longer than the others: it has a whiteneſs about the anus. It is frequent on the bodies of many inſects, which it infeſts, as the louſe does others. It runs very ſwiftly. The humble-bee, and many other of the larger inſects, are continually infeſted with it; but none ſo much as the common black-beetle, which has thence been called the louſy beetle.

ACCELERATION, in mechanics, the increaſe of velocity in a moving body. Accelerated motion is that which continually receives freſh acceſſions of velocity, and is either equally or unequally accelerated. Acceleration ſtands directly oppoſed to retardation, which denotes a diminution of velocity.

ACCELERATION is chiefly uſed, in phyſics, in reſpect of falling bodies, i. e. of heavy bodies tending towards the centre of the earth by the force of gravity. That natural bodies are accelerated in their deſcent is evident from various conſiderations, *a priori* and *poſteriori*. Thus we actually find, that the greater height a body falls from, the greater impreſſion it makes, and the more vehemently does it ſtrike the ſubject plane, or other obſtacle. Various are the ſyſtems and opinions which philoſophers have produced to account for this acceleration. Some attribute it to the preſſure of the air. The farther, ſay they, a body falls, the greater load of atmoſphere is of conſequence incumbent on it; and the preſſure of a fluid is in proportion to the perpendicular altitude of the column thereof. Add, that the whole body of the fluid preſſing in innumerable right lines, which all meet in a point, viz. the centre, that point, by the meeting of thoſe lines, ſuſtains, as it were, the preſſure of the whole maſs; conſequently the nearer a body approaches to it, the effect or preſſure of more united lines muſt it ſuſtain. But what overturns this account, is, that, as the preſſure of the air downwards increaſes, ſo, by the known laws of ſtatics, does the reſiſtance, or the force, wherewith the ſame fluid tends to repel, drive the body upwards again. Others inſiſt, that the incumbent air is the groſſer and more vaporous the nearer the earth; and filled with more heterogeneous particles, which are not true elaſtic air: and hence, ſay they, a deſcending body, meeting continually with leſs reſiſtance, from the elaſticity of the air, and having the ſame force of gravity ſtill acting on it, muſt neceſſarily be accelerated. Hobbes (Philoſ. Prob. cap. 1. p. 3.) attributes acceleration to a new impreſſion of the cauſe which makes bodies fall; which, on this principle, is alſo the air. As part of this mounts, part alſo muſt deſcend; from reaſons drawn from the motion of the earth, which is compounded of two motions, one circular, the other progreſſive; conſequently the air aſcends, and circulates at once. As the body, in its fall, receives a new preſſure in every point of its deſcent, its motion, he ſays, muſt needs be accelerated. But what overturns all accounts where the air or atmoſphere is concerned, is, that the acceleration holds *in vacuo*, and even more regularly than in air. See VACUUM. The Peripatetic account is worſe than this. The motion of heavy bodies downwards, ſay they, ariſes from an intrinſic principle which makes them tend to the centre, as their proper ſeat, or element, where they would be at reſt; hence, add they, the nearer bodies approach thereto, the more is their motion accelerated. The Gaſſendiſts, on the other hand, hold that the earth emits a ſort of attractive effluvia, innumerable threads whereof continually aſcend and deſcend, which threads, proceeding like radii from a common centre, divaricate the more the farther they go: ſo that the nearer a heavy body is to the centre, the more of theſe magnetic threads it receives, and hence the more is its motion accelerated. But this is refuted by an eaſy experiment: for if a ball be let fall out of the loweſt window of a high tower, and alſo out of the higheſt, the acceleration will be the ſame in both caſes, notwithſtanding the greater vicinity to the centre in the one than in the other caſe. The Carteſians account for acceleration from the repeated pulſes of a ſubtil etherial matter, which is continually acting on the falling body, and impelling it downwards. After all, the immediate cauſe of acceleration is nothing myſterious; the principle of *gravitation*, which determines the body to deſcend, determining it to be accelerated

accelerated by a neceſſary conſequence. Suppoſe a body let fall from on high: the primary cauſe of its beginning to deſcend is doubtleſs the power of gravity; but when once the deſcent is commenced, that ſtate becomes in ſome meaſure natural to the body; ſo that if left to itſelf, it would perſevere in it for ever, even though the firſt cauſe ſhould ceaſe; as we ſee in a ſtone caſt with the hand, which continues to move after it is left by the cauſe that gave it motion. But, beſides the propenſity to deſcend, impreſſed by the firſt cauſe, and which of itſelf were ſufficient to continue the ſame degree of motion, once begun, *in infinitum*, there is a conſtant acceſſion of ſubſequent efforts of the ſame principle, gravity, which continues to act on the body already in motion, in the ſame manner as if it were at reſt. Here, then, being a double cauſe of motion, and both acting in the ſame direction, viz. directly towards the centre of the earth, the motion they jointly produce muſt neceſſarily be greater than that of any one of them. And the velocity thus increaſed, having the ſame cauſe of increaſe ſtill perſiſting, the deſcent muſt neceſſarily be continually accelerated. For, ſuppoſing gravity, whatever it be, to act uniformly on all bodies, at equal diſtances from the earth's centre, and that the time in which a heavy body falls on the earth, be divided into equal parts, infinitely ſmall; let this gravity incline the body towards the earth's centre, while it moves in the firſt infinitely ſmall part of the time of its deſcent; if, after this, the action of gravity be ſuppoſed to ceaſe, the body would proceed uniformly on towards the earth's centre, with a velocity equal to the force of the firſt impreſſion. But now, ſince the action of gravity is here ſuppoſed ſtill to continue, in the ſecond moment of time the body will receive a new impulſe downwards, equal to what it received at firſt; and thus its velocity will be double to what it was in the firſt moment: in the third moment it will be triple; in the fourth quadruple; and ſo on continually; for the impreſſion made in one moment is not at all altered by what is made in another; but the two are, as it were, aggregated, or brought into one ſum. Wherefore, ſince the particles of time are ſuppoſed infinitely ſmall, and all equal to one another, the impetus acquired by the falling body will be every where, as the times from the beginning of the deſcent: and hence, ſince the quantity of matter in the body given continues the ſame, the velocity will be as the time in which it is acquired. If a falling body deſcribe any given length in given time, in double that time it will deſcribe four times that length; in thrice the time, nine times, &c. and univerſally if the times be in arithmetical proportion, 1, 2, 3, 4, &c. the ſpaces deſcribed will be 1, 4, 9, 16, &c. The ſpaces deſcribed by a falling body, in a ſeries of equal moments, or intervals of time, will be as the unequal numbers 1, 3, 5, 7, 9, &c. And ſince the velocities acquired in falling are as the times, the ſpaces will alſo be as the ſquares of the velocities, and both times and velocities in a ſubduplicate ratio of the ſpaces. The motion of a body aſcending, or impelled upwards, is diminiſhed or retarded from the ſame principle of gravity acting in a contrary direction, in the ſame manner as a falling body is accelerated. See RETARDATION. A body, thus projected upwards, riſes till it has loſt all its motion; which it does in the ſame time that a body falling would have acquired a velocity equal to that wherewith the body was thrown up. Hence, the ſame body thrown up, will riſe to the ſame height from which, falling, it would have acquired the velocity wherewith it was thrown up. And hence the heights, which bodies, thrown up with different velocities, do aſcend to, are to one another as the ſquares of thoſe velocities. Gravity, at a ſmall diſtance from the earth's ſurface, being uniform, or nearly ſo, the effects produced may therefore be conſidered as motion generated from uniform forces; for a further illuſtration of which ſee the article MOTION.

ACCELERATION *of Bodies on inclined Planes*. The ſame general law obtains here as in bodies falling perpendicularly: the effect of the plane is to make the motion ſlower; but the inclination being every where equal, the retardation ariſing therefrom will proceed equally in all parts, at the beginning and the ending of the motion. See the Syſtem of MECHANICS, Sect. III. See likewiſe the Deſcription of a curious Machine, invented by Mr. Atwood, F. R. S. for demonſtrating and aſcertaining the Quantity and Effects of accelerated Motion, with the Plate repreſenting the Apparatus, and its ſeveral Parts, &c. MECHANICS, Sect. IV. and Plate I.

ACCELERATION is alſo applied in the ancient aſtronomy in reſpect of the fixed ſtars. Thus, acceleration was the difference between the revolution of the *primum mobile* and the ſolar revolution, which was computed at 3 minutes and 56 ſeconds.

ACCELERATION *of the Moon*, is a term uſed to expreſs the increaſe of the moon's mean motion from the ſun, compared with the diurnal motion of the earth; ſo that it is now a little ſwifter than it was formerly. Dr. Halley was the firſt who made this diſcovery; and he was led to it by comparing the ancient eclipſes, obſerved at Babylon, with thoſe obſerved by Albatennius in the ninth century, and ſome of his own time. He was not able to aſcertain the quantity of this acceleration, becauſe the longitudes of Bagdat, Alexandria, and Aleppo, where the obſervations were made, had not been accurately determined. But ſince his time the longitude of Alexandria has been aſcertained by Chazelles; and Babylon, according to Ptolemy's account, lies 5° eaſt from Alexandria. From theſe data Mr. Dunthorne compared ſeveral ancient and modern eclipſes with the calculations of them by his own tables, and hereby verified Dr. Halley's opinion; for he found that the ſame tables repreſent the moon's place more backward than her true place in ancient eclipſes, and more forward than her true place in later eclipſes; and thence juſtly inferred, that her motion in ancient times was ſlower, in later times quicker, than the tables give it. But he did not content himſelf with merely aſcertaining the fact; he proceeded to determine the quantity of the acceleration; and by means of the moſt ancient eclipſe, of which any authentic account remains, obſerved at Babylon, in the year before Chriſt 721; he concluded, that the obſerved beginning of this eclipſe was not above an hour and three quarters before the beginning by the tables; and therefore the moon's true place could precede her place by computation but little more than 5° of a degree at that time. Admitting the acceleration to be uniform, and the aggregate of it as the ſquare of the time, it will be at the rate of about 10″ in 100 years. Phil. Tranſ. N° 218. N° 492. or vol. xlvi. p. 162.

Dr Long attributes the acceleration above deſcribed to one or more of theſe cauſes; either, 1. the annual and diurnal motion of the earth continuing the ſame, the moon is really carried round the earth with a greater velocity than heretofore: or, 2. the diurnal motion of the earth, and the periodical revolution of the moon, continuing the ſame, the annual motion of the earth round the ſun is a little retarded; which makes the ſun's apparent motion in the ecliptic a little ſlower than formerly; and conſequently the moon, in paſſing from any conjunction with the ſun, ſpends leſs time before ſhe again overtakes the ſun, and forms a ſubſequent conjunction. In both theſe caſes the motion of the moon from the ſun is really accelerated, and the ſynodical month actually ſhortened: or, 3. the motion of the earth, and the periodical revolution of the moon, continuing the ſame, the rotation of the earth round its axis is a little retarded; in this caſe, days, hours, minutes, ſeconds, &c. by which all periods of time muſt be meaſured, are of a longer duration; and conſequently the ſynodical month will appear to be ſhortened, though it really contains the ſame quantity of abſolute time as it always did. If the quantity of matter in the body of the ſun be leſſened by the particles of light continually ſtreaming from it, the motion of the earth round the ſun may become ſlower: if the earth increaſes in bulk, the motion of the moon round the earth may be quickened thereby.

ACCELERATOR, in anatomy, a muſcle in the penis, whoſe office is to expedite the diſcharge of the urine and the ſemen. This is more peculiarly called *acclerator urinæ*. Some make two muſcles of it, and give them the denomination *acceleratores*, or accleratory muſcles. It ariſes tendinous from the upper and fore-part of the urethra, but ſoon grows fleſhy, paſſes under the *os pubis*, and encompaſſes the bulb of the cavernous body of the urethra. Both ſides of this muſcle meet in a middle line, correſponding to the ſeam in the ſkin over it, and continue ſo united the ſpace of two inches; after which it detaches two fleſhy elongations, which become thin tendons at their terminations on the cavernous bodies of the penis. Its upper parts covering the bulb, when the action ſtraitens the veins which paſs through it from the *corpus cavernoſum* of the urethra, and hinders the reflux of blood in an erection. By the repeated contractions of this upper part, the blood in the bulb is alſo driven towards the glans, and thereby aſſiſts the erection. The two elongations compreſs the channel of the urethra, and ſo force out the contained ſeed or urine; whence the muſcle takes its name. See the Syſtem of ANATOMY, Part III. Sect. IV. and Plate X. *Fig.* 1. Letters G. G.

ACCENT, in reading and ſpeaking, an affection of the voice, which gives each ſyllable in a word its due pitch, in reſpect of height or lowneſs. The word is originally Latin, *accentus*; a compound of *ad*, to; and *cano*, to ſing. In this ſenſe, accent is ſynonymous with the Greek τονος, the Latin, *tenor*, or *tonor*; and the Hebrew טעם *guſtus*, taſte. The accent, properly, only reſpects high and low, or acute and grave. Though the modern grammarians uſe it alſo in reſpect of loud and ſoft, long and ſhort; but this confounds *accent* with *quantity*. The difference between the two may be conceived from that which we obſerve between the beat of a drum and the ſound of a trumpet: the former expreſſes every thing belonging to loud and ſoft, and long and ſhort; but ſo long as there is a μονοτονια in the ſound, there is nothing like *accent*.

ACCENT, in grammar, a character placed over a ſyllable, to mark the accent, i. e. to ſhew it is to be pronounced in a higher or lower tone; and to regulate the inflections of the voice in reading. It is diſtinguiſhed from *emphaſis*, as the former regards the tone of the voice, the latter the ſtrength of it. We reckon three grammatical accents in ordinary uſe, all borrowed from the Greeks, viz. the *acute accent*, which ſhews when the tone of the voice is to be raiſed. In modern writings it is a little line or virgula, placed over the vowel, a little ſloping or inclined in its deſcent from right to left, as (´). It is not ordinarily uſed either in Engliſh or Latin: the French indeed, retain it; but it is only to mark the cloſe or maſculine é. The *grave accent*, when the note

or

or tone of the voice is to be depreſſed; and is figured thus (`). The *circumflex accent*, which is compoſed of both the acute and the grave, points out a kind of undulation of the voice, and is expreſſed thus (ˆ or ^). But if it be true, that the whole ſyſtem of pronunciation turns on three accents, it is no leſs true, that each of theſe three admits of ſeveral degrees. The acute accent, for inſtance, may be either higher or lower; may be ſimply acute, or very acute; and the like holds of the grave and circumflex. So that each of the three common accents is, as it were, a genus, including divers particular ſpecies; though the ancient grammarians have not thought fit to give particular names and figures to all theſe differences. Vonder Hardt. Arcan. Accent. Græc. 1715, 12mo. For the proper management of the voice, with reſpect to accent, ſee the Treatiſe on ORATORY, Part IV. Sect. II. and the article READING.

Words which have no accents are called *atonics*.

The Hebrews have a grammatical, a rhetorical, and a muſical accent; though the firſt and laſt ſeem, in effect, to be the ſame; both being compriſed under the general name of *tonic accents*, becauſe they give the proper tone to ſyllables: as the rhetorical accents are ſaid to be *uphonic*, inaſmuch as they tend to make the pronunciation more ſweet and agreeable. There are four euphonic accents, and twenty-five tonic: however, authors are not agreed as to the number; of which ſome are placed above, and others below, the ſyllables; the Hebrew accents ſerving not only to regulate the riſings and fallings of the voice, but alſo to diſtinguiſh the ſections, periods, and members of periods, in a diſcourſe; and to anſwer the ſame purpoſes with the points in other languages. Their accents are divided into emperors, kings, dukes, &c. each bearing a title anſwerable to the importance of the diſtinction it makes. Their emperor rules over a whole phraſe, and terminates the ſenſe completely; anſwering to our point. Their king anſwers to our colon; and their duke to our comma. The king, however, occaſionally becomes a duke, and the duke a king, as the phraſes are more or leſs ſhort. It muſt be noted, by the way, that the management and combination of theſe accents differ in Hebrew poetry from what it is in proſe.

The uſe of the tonic, or grammatical accents, has been much controverted; ſome holding that they diſtinguiſh the ſenſe, while others maintain that they are only intended to regulate the muſic or ſinging; alledging, that the Jews ſing, rather than read, the ſcriptures in their ſynagogues. The truth ſeems here to lie between the two opinions: for though we are inclined to think, that the primary intention of theſe accents was to direct the ſinging, yet the ſinging ſeems alſo to have been regulated according to the ſenſe; ſo that the accents might ſerve not only to guide the ſinging, but alſo to point out the diſtinctions. Though it muſt be confeſſed, that many of theſe diſtinctions are too ſubtle and inconſiderable; nor can the modern writers, or the editors of old ones, agree in opinion on this ſubject; ſome of them making twice as many of theſe diſtinctions as others.

The Hebrew accents, in effect, have ſomething common with thoſe of the Greeks and Latins, and ſomething peculiar to themſelves. What they have in common is, that they mark the tone; ſhewing how the voice is to be raiſed and ſunk on certain ſyllables. What they have peculiar is, that they do the office of the points in other languages. It is certain the ancient Hebrews were not acquainted with theſe accents; ſo that, at beſt, they are not *jure divino*. The opinion which prevails among the learned, is, that they were invented about the ſixth century, by the Jewiſh doctors of the ſchool of Tiberias, called the Maſſoretes. The learned Hennin affirms them to be of Arabic invention, and to have been adopted and transferred thence into the Hebrew by the Maſſoretes; eſpecially by the celebrated Rabbi Ben Aſcher, who flouriſhed in the middle of the ſixth century, on occaſion of the emperor Juſtinian's prohibiting the reading of their traditions in their ſynagogues. He adds, that they were firſt brought to their degree of perfection by Rabbi Juda Ben David Ching, a native of Fez, in the eleventh century. It is, indeed, poſſible, the Jews might borrow their points from the Arabs: but how they ſhould have their accents from them is hard to conceive, the Arabic language having no ſuch thing as accents, either in proſe or verſe.

As to the Greek accents, now ſeen both in manuſcript and printed books, there has been no leſs diſpute about their antiquity and uſe, than about thoſe of the Hebrews. Iſaac Voſſius, in an expreſs Treatiſe De Accentibus Græcanis, endeavours to prove them of modern invention; aſſerting, that they anciently had nothing of this kind, but only a few notes in their poetry, which were invented by Ariſtophanes, the Grammarian, about the time of Ptolemy Philopater; and that theſe were of muſical rather than of grammatical uſe, ſerving as aids in the ſinging of their poems, and very different from thoſe introduced afterwards. This appears from inſcriptions, as well as manuſcripts, none of which, till 170 years before Chriſt, have either accent, ſpirit, apoſtrophus, or ἰῶτα, ſubſcribed. He adds, that Ariſtarchus, a diſciple of Ariſtophanes, improved on his maſter's art; but that all they both did, was only deſigned to facilitate youth in the making of verſes. The ſame Voſſius ſhews, from ſeveral ancient grammarians, that the manner of writing the Greek accents in thoſe days, was quite different from thoſe now uſed in our books.

The author of La Methode Greque, p. 546, obſerves, that the right pronunciation of the Greek language being natural to the Greeks, it was needleſs for them to mark it by accents in their writings: ſo that, according to all appearance, they only began to make uſe of them ſo low as the time in which the Romans, being curious to learn the Greek tongue, ſent their children to ſtudy at Athens, thinking thereby to fix the pronunciation, and to facilitate it to ſtrangers; which happened, as the ſame author obſerves, a little before the celebrated Cicero's time.

Hen. Chriſt. Hennin thinks that accents were the invention of the Arabians, about nine hundred years ago, and that they were only uſed in poetry; that they were intended to aſcertain the pronunciation of the Greek, and to keep out that barbariſm which was then breaking in upon them; that the ancient accents of Ariſtophanes were perfectly agreeable to the genuine Greek pronunciation, but that the modern ones of the Arabs deſtroy it. Wetſtein, Greek profeſſor at Baſil, in a learned diſſertation, endeavours to prove the Greek accents of an older ſtanding. He owns that they were not always formed in the ſame manner by the ancients, but thinks that difference owing to the different pronunciation which obtained in the ſeveral parts of Greece. He brings ſeveral reaſons *à priori* for the uſe of accents, even in the earlieſt days; as that then they wrote all in capital letters, equally diſtant from each other, without any diſtinction either of words or phraſes; ſo that without accents they could ſcarce be intelligible; and that accents were neceſſary to diſtinguiſh ambiguous words, and to point out their proper meaning; and this ſentiment he confirms from a diſpute on a paſſage in Homer, mentioned by Ariſtotle in his Poetics, chap. v. Accordingly, he obſerves that the Syrians, who have tonic, but no diſtinctive, accents, have yet invented certain points, placed either below or above the words, to ſhew their mood, tenſe, perſon, or ſenſe. See farther in his Diſſertatio Epiſtolica de Accentum Græcorum Antiquitate & Uſu. Printed at Baſil, in 1686.

The uſe of accents, to prevent ambiguities, is moſt remarkably perceived in ſome eaſtern languages, particularly the Siameſe and Chineſe. Among the people of China, every word, or (which is the ſame thing) ſyllable, admits of five accents, as ſpoken more acutely or remiſsly; and thus ſtands for many different things. The ſame ſound *ya*, according to the accent affixed to it, ſignifies *God*, *a wall*, *excellent*, *ſtupidity*, and *a gooſe*. The Chineſe have but 330 ſpoken words in their language; but theſe being multiplied by the different accents or tones, which affect the vowels, furniſh a language tolerably copious. By means hereof, their 330 ſimple ſounds come to denote 1650 things; but this being hardly ſufficient, they are increaſed further by aſpirates added to each word, to double the number. The Chineſe only reckon four accents: for which the miſſionaries uſe the following mark, *aá*, *á*, *à*, *ä*; to which they have added a fifth, thus, *â*. They make a kind of modulation; wherein, prolonging the duration of the ſound of the vowel, they vary the tone, raiſing and ſinking it by a certain pitch of voice; ſo that their talking is a kind of muſic or ſinging. Attempts have been made to determine the quantity of the riſe or fall in each accent by means of muſical notes; but this is hard to effect, as being different in different perſons. Hence the great difficulty of the language to foreigners. They are forced to ſing moſt ſcrupulouſly; if they deviate ever ſo little from the accent, they ſay quite a different thing from what was intended. Thus, meaning to compliment the perſon you are talking to with the title *Sir*, you call him a beaſt with the ſame word, only a little varied in the tone. Spizel. de Re Liter. Sinenſ. p. 106. Bulffing. Diſſert. de Lit. Sinenſ. p. 308. Le Compte, Nouv. Mem. ſur la Chine, tom. i. p. 270.

Magalhon makes the language the eaſier to learn on this account. The Siameſe are alſo obſerved to ſing rather than talk. Their alphabet begins with ſix characters, all only equivalent to a K, but differently accented. For though, in the pronunciation, the accents are naturally on the vowels, yet they have ſome to diverſify ſuch of their conſonants as are in many other reſpects the ſame. De la Loubere du Royaume de Siam, tom. ii. § 8.

As minutely as the accent of words have been ſtudied, the accents of ſentences ſeem to have been utterly overlooked: yet it may be obſerved, that all mankind lower the voice at the end of a period, elevate it in interrogations, and the like. See Bacon, de Augment. Scient. lib. vi. cap. 1. Elem. Crit. vol. ii.

ACCENT is alſo applied, not very properly, to the characters which mark the quantities of ſyllables, or the time the voice is to dwell on them. The ſpurious accents anſwer to the characters of time in muſic; as crotchets, quavers, &c. The genuine accents rather anſwer to the muſical notes, ſol, fa, &c. Such are the *long accent*, which ſhews that the voice is to ſtop on the vowel, and is expreſſed thus (—). The *ſhort accent*, which ſhews that the time of pronunciation ought to be ſhort, is marked thus (˘). See the Syſtem of MUSIC, under Definition of TECHNICAL TERMS.

ACCENT also denotes a certain inflection of voice; or a peculiar tone and manner of pronunciation, contracted from the country, or province, where a person was bred. In this sense, we say, the Welsh tone or accent, the northern accent, the Gascoign accent, Norman accent, &c.

ACCENT is also a tone or modulation of the voice, frequently used as a mark of the intention of the speaker, and giving a good or evil signification to his words. One may give offence with the softest and most soothing words imaginable, by a proper management of the accent, and manner of pronouncing them. The accent frequently gives a contrary sense to what the words themselves naturally imported.

ACCEPTANCE, in commerce, is particularly used in respect of bills of exchange. To accept a bill of exchange, is to sign or subscribe it, and thereby become principal debtor of the sum contained therein, with an obligation to pay or discharge it at the time prefixed. The acceptance is usually performed by him on whom the bill is drawn, upon its being presented to him by the person on whose behalf it was drawn, or by some others by his order. A small matter amounts to an acceptance, so that there be a right understanding between both parties; as, "Leave your bill with me, and I will accept it; or, "Call for it to-morrow, and it shall be accepted." This obliges as effectually, by the custom of merchants, and according to law, as if the party had actually subscribed, or signed it, which is usually done. But should a man say, "Leave your bill with me; I will look over my accounts and books between the drawer and me, and call to-morrow, and accordingly the bill shall be accepted." This shall not amount to a complete acceptance; for this mention of his books and accounts was really intended to give him an opportunity of examining if there were effects in his hands to answer; without which, perhaps, he would not accept the same; and so it was ruled by the lord chief Justice Hale, at Guildhall, London. A bill may be accepted for part; because the party, upon whom the same was drawn, had no more effects in his hands; which being usually done, there must be a protest, if not for the whole sum, yet at least for the residue: however, after payment of such part, there must be a protest for the remainder.

Bills payable at sight are not to be accepted, as being to be acquitted at their presenting; or, in defect of payment, to be protested. In bills drawn for a certain number of days after sight, the acceptance must be dated; because the time is to be accounted therefrom. The form of this acceptance is, *accepted such a day*; and then the signature. Bills drawn payable on a day named, or at usance, or double usance, need not be dated; usance being reckoned from the date of the bill itself. On these it is sufficient to write, *accepted*, and the signature. If the bearer of a bill be contented with an acceptance to be paid in twenty days after sight, where, in the bill itself, only eight days are expressed, he runs the risk of the twelve additional days; so that if the acceptor fail, he has no remedy against the drawer. And if the bearer contents himself to receive a less sum than is expressed, in part, he is to stand the chance of the rest.

ACCEPTATION, in grammar, the signification of a word; or the sense wherein it is taken and received. Thus we say, such a word has several acceptations. In its first and most natural acceptation, it denotes, &c.

ACCESS, in a general sense, signifies the approach of a thing towards another. In which sense, access stands opposed to recess. We sometimes say, the access of bodies, the access of the moon, the sun, planets, &c. but more frequently the approach of bodies, the appulse of the moon, the rising of the sun, &c. Geometricians speak of a line called the curve of equal access or approach.

ACCESS, in medicine, denotes a fit, or return of some periodical disease. We say an access of the gout, but especially of an ague, an intermitting fever, an epilepsy, &c. an access of madness; sometimes also a prophetical access, a cold access, &c. Access is frequently confounded with paroxysm: but they are different things; an access being frequently the beginning or first onset of a disease, a paroxysm the height of it.

ACCESSION, in a general sense, is the act of approaching or going to a place, person, or thing. It is more particularly used for the act whereby a thing is joined or united to something existing before. Accession is also used for the act of engaging and becoming a party, in a treaty before concluded between other powers, on the same footing and conditions as if originally comprehended in the treaty itself: such as the accession of the States General to the treaty of Hanover; of the Czarina to the treaty of Vienna, &c.

ACCESSORY, or ACCESSARY, something that accedes, or is added to another more considerable thing. In which sense the word stands opposed to *principal*.

ACCESSORY or ACCESSARY, in common law, is chiefly used for a person guilty of a felonious offence, not principally, but by participation; as by advice, command, or concealment. There are two kinds of accessories; before the fact, and after it. The first is he who commands or procures another to commit felony, and is not present himself; for if he be present, he is a principal. The second is he who receives, assists, or comforts any man that has done murder or felony, whereof he has knowledge. A man may be also accessory to an accessory, by aiding, receiving, &c. an accessory in felony. An accessory in felony shall have judgment of life and member, as well as the principal, who did the felony; but not till the principal be first attainted, and convicted, or outlawed thereon. Where the principal is pardoned without attainder, the accessory cannot be arraigned; it being a maxim in law, *Ubi non est principalis, non potest esse accessorius*. But if the principal be pardoned, or have his clergy after attainder, the accessory shall be arraigned; 4 & 5 W. & M. cap. 4. And by stat. 1 Anne, cap. 9. it is enacted, that where the principal is convicted of felony, or stands mute, or challenges above twenty of the jury, it shall be lawful to proceed against the accessory in the same manner as if the principal had been attainted; and notwithstanding such principal shall be admitted to his clergy, pardoned, or delivered before attainder. In some cases also, if the principal cannot be taken, then the accessory may be prosecuted for a misdemeanor, and punished by fine, imprisonment, &c. Stat. ibid. See Stat. 5 Anne, cap. 31. In the lowest and highest offences there are no accessories, but all are principals: as in riots, routs, forcible entries, and other trespasses, which are the lowest offences. So also in the highest offence, which is, according to our law, high treason, there are no accessories. Cok. Littlet. 71. Accessories, in petty treason, murder, and in felonies of several kinds, are not to have their clergy. There can be no accessory before the fact in manslaughter, because that is sudden and unpropensed.

ACCESSORY by statute, is such a one as abets, advises, aids, or receives one that commits an offence, which is made felony by statute.

ACCESSORY *nerves*, in anatomy, a pair of nerves, which, arising from the medulla in the vertebræ of the neck, ascend, and enter the skull, and pass out of it again, with the *par vagum*, wrapped up in the same common integument, and after quitting them, are distributed into the muscles of the neck and shoulders. See the SYSTEM, Part. VI. Sect. II. and Plate XI. *Fig.* 5.

ACCIDENT, in a general sense, denotes any casual event. Among logicians it is used in a threefold sense. 1. Whatever does not essentially belong to a thing: as the cloathes a man wears, or the money in his pocket. 2. Such properties in any subject as are not essential to it; thus, whiteness in paper is an accidental quality. 3. In opposition to substance, all qualities whatever are called accidents, as sweetness, softness, &c.

ACCIDENT has an immediate and essential dependence on its substance, both as to its production, its continuation, and its effect: it arises, or is deduced, from its subject; is preserved or subsisted by it; and can only be affected by what alters or affects the subject. The old schoolmen, however, will not have accidents to be mere modes of matter, but entities really distinct from it; and in some cases separable from all matter. But the notion of real accidents and qualites is now exploded.

ACCIDENTAL, something that partakes of the nature of an accident; or what is not essential to its subject, but indifferent. Thus, whiteness is accidental to marble; and heat to iron.

ACCIDENTAL *Colours*, so called by M. Buffon, are those which depend upon the affections of the eye, in contradistinction to such as belong to the light itself. The impressions made upon the eye, by looking stedfastly on objects of a particular colour, are various, according to the single colour, or assemblage of colours, in the object; and they continue for some time after the eye is withdrawn, and give a false colouring to other objects which are viewed during their continuance. M. Buffon has endeavoured to trace the connection which these accidental colours have with those that are natural, in a variety of instances. The subject has likewise been considered by M. de la Hire, and M. Epinus; and M. d'Arcy has contrived a machine for measuring the duration of the above mentioned impression on the eye; and he inferred, in the result of several trials, that the effect of the action of light on the eye continued about eight thirds of a minute. See Ac. Par. 1743. Ditto, 1765. Nov. Comp. Petrop. v. 10. And for an abstract, Dr. Priestley's Hist. &c. of Discoveries relating to Vision, &c. p. 631.

ACCIDENTAL *Point*, in perspective, is a point in the horizontal line, where lines parallel to one another, though not perpendicular to the picture, or representation, meet.

ACCIPENSER, in ichthyology, a genus of fishes belonging to the Amphibia Nantes of Linnæus. The accipenser has a single linear nostril: the mouth is in the under part of the head, and contains no teeth: the cirri are below the snout, and before the mouth. There are three species of this genus, viz.

1. The *ruthenus* has 4 cirri, and 15 squamous protuberances. It is a native of Russia.

2. The *huso* has 4 cirri: the body is naked, *i. e.* has no prickles or protuberances. The skin of the huso is so tough and strong that it is employed for ropes in carts and other wheel-carriages: and the ichthyocolla, or *isinglass* of the shops, famous as an agglutinant, and used for the fining of wines, is made from its sound or scales. The ancients were acquainted with the fish that afforded this drug. The huso is the largest of the genus, and grows to 24 feet in length. It inhabits the Danube and the rivers of Russia. See ICHTHYOCOLLA.

3. The

3. The *sturio*, or sturgeon, with 4 cirri, and 11 squamous protuberances on the back. This fish annually ascends our rivers, but in no great numbers, and is taken by accident in the salmon-nets. It seems a spiritless fish, making no manner of resistance when entangled, but is drawn out of the water like a lifeless lump. It is seldom taken far out at sea, but frequents such parts as are not remote from the æstuaries of great rivers. It is admired for the delicacy and firmness of its flesh, which is white as veal, and extremely good when roasted. It is generally pickled. The most we receive comes either from the Baltic rivers or North America. Great numbers are taken during the summer in the lakes Frisch-haff and Curisch-haff, near Pillau, in large nets made of small cord. The adjacent shores are formed into districts, and farmed out to companies of fishermen, some of which are rented for six thousand guilders, or near three hundred pounds *per annum*. They are found in vast abundance in the American rivers, in May, June, and July; at which time they leap some yards out of the water, and, falling on their sides, make a noise to be heard in still weather at some miles distance. Caviare is made of the rows of this, and also of all the other sorts of sturgeon, dried, salted, and packed up close. Ichthyocolla, or isinglass, is likewise made of the sound of this fish, as well as that of the others; but in very small quantity. The sturgeon grows to a great size, to the length of 18 feet, and to the weight of 500 pounds; but it is seldom taken in our rivers of that bulk. In the manner of breeding, this fish is an exception among the cartilaginous kind; being, like the bony fish, oviparous, spawning in the water. For the classification, see the SYSTEM, Order I.

ACCIPITER, in ornithology, the name of an order of birds. For a characteristic description of this order, see the SYSTEM, Sect. IV. For the generic description, and classes of the genera appertaining to this order, see the head article CLASSIFICATION, &c. For a representation of the genera of this order, see Plate I. Genus I. II. III.

ACCLAMATION, a confused noise, or shout of joy, by which the public express their applause, esteem, or approbation.

ACCLAMATION, in a more proper sense, denotes a certain form of words, uttered with extraordinary vehemence, and in a peculiar tone, somewhat resembling a song, frequent in the ancient assemblies. Acclamations were usually accompanied with applauses, with which they are sometimes confounded: though they ought to be distinguished; as acclamation was given by the voice, applause by the hands: add, that acclamation was also bestowed on persons absent, applause only on those present. Acclamation was also given by women, whereas applause seems to have been confined to men. Acclamations were not unknown on the theatres in the earliest ages of the Roman common wealth; but they were artless then, and little other than confused shouts. Afterwards they became a sort of regular concerts. That mentioned by Phædrus, *Lætare incolumis Roma salvo principe*, which was made for Augustus, and proved the occasion of a pleasant mistake of a flute player, called *Princeps*, shews that musical acclamations were in use in that emperor's reign. *Revertentem ex Provincia modulatis carminibus prosequebantur*, says Suetonius, who gives another instance in the time of Tiberius: a false report of Germanicus's recovery being spread through Rome, the people ran in crowds to the capitol with torches and victims, singing *Salva Roma, Salva Patra, Salvus est Germanicus*. Nero, passionately fond of music, took special care to improve and perfect the music of acclamations. Charmed with the harmony wherewith the Alexandrians, who came to the games celebrated at Naples, sung his praises, he brought several over to instruct a number of youth, chosen from among the knights and people, in the different kinds of acclamations practised at Alexandria. These continued in use as low as the reign of Theodoric. But the people did not always make a single chorus; sometimes there were two, who answered each other alternately; thus, when Nero played on the theatre, Burrhus and Seneca, who were on either hand, giving the signal by clapping, 5000 soldiers, called augustals, began to chant his praise, which the spectators were obliged to repeat. The whole was conducted by a music-master, *Mesochorus*, or *Pansarius*. The honour of acclamations was chiefly rendered to emperors, their children, and their favourites; and to the magistrates who presided at the games. Persons of distinguished merit also sometimes received them, of which Quintilian gives us instances in Cato and Virgil. The most usual forms were, *Feliciter, Longiorem vitam, Annos felices*. The actors themselves, and they who gained the prizes in the games of the circus, were not excluded the honour of acclamations.

To theatrical acclamations may be added those of the soldiery and the people in time of triumph. The victorious army accompanied their general to the capitol; and among the verses they sung in his praise, frequently repeated, *Io Triumphe*, which the people answered in the same strain. It was also in the way of acclamation, that the soldiers gave their general the title of *Imperator*, after some notable victory; a title which he only kept till the time of his triumph.

The acclamations of the senate were somewhat more serious than the popular ones; but arose from the same principle, viz. a desire of pleasing the prince or his favourites; and aimed likewise at the same end, either to express the general approbation and zeal of the company, or to congratulate him on his victories, or to make new protestations of fidelity. These acclamations were usually given after a report made by some senator, to which the rest all expressed their consent, by crying OMNES, OMNES; or else, ÆQUUM EST, JUSTUM EST. Sometimes they began with acclamations, and sometimes ended with them without other debates. It was after this manner that all the elections and proclamations of emperors, made by the senate, were conducted; something of which practice is still retained at modern elections of kings and emperors, where *Vivat Rex, Vive le Roy*, and *Long live the King*, are customary forms.

The Greeks borrowed the custom of receiving their emperors in the public places from the Romans. Luitprand relates, that at a procession where he was present, they sung to the emperor Nicephorus πολλα ετη; that is, *Many years*; which Codin expresses thus, by το ψαλλειν το πογυχρονιον; or by το πολυχρονιζειν and the wish, or salutation, by πολιχρονισμα. And at dinner, the Greeks, then present, wished, with a loud voice, to the emperor and Bardas, *Ut Deus annos multiplicet*; as he translates the Greek. Plutarch mentions an acclamation so loud, upon occasion of Flaminius's restoring liberty to Greece, that nothing equal to it was ever known or heard of. The Turks practise something like this on the sight of their emperors and grand vizirs to this day.

For the acclamations wherewith authors, poets, &c. were received, who recited their works in public, it is to be observed, the assemblies for this purpose were held with great parade in the most solemn places, as the capitol, temples, the Athenæum, and the houses of great men. Invitations were sent every where, in order to get the greater appearance. The chief care was, that the acclamations might be given with all the order and pomp possible. Men of fortune, who pretended to wit, kept able applauders in their service, and lent them to their friends. Others endeavoured to gain them by presents and treats. Philostratus mentions a young man, named Vavus, who lent money to the men of letters, and forgave the interest to such as applauded his exercises. These acclamations were conducted much after the same manner as those on the theatre, both as to the musick and the accompaniments: they were to be suited both to the subject and to the person. There were particular ones for the philosophers, for orators, for historians, and for poets. It would be difficult to rehearse all the forms of them. One of the most usual was *Sophos*, which was to be repeated three times. Martial comprehends several other usual forms in this verse, *Graviter, Cito, Nequiter, Euge, Beate*. Neither the Greeks or Romans were barren on this head. The names of gods and heroes were given those whom they would extol. It was not enough to do it after each head of discourse, chiefly after the exordium; but the acclamations were renewed at every fine passage.

The acclamations wherewith the spectators honoured the victories of the athletæ, were a natural consequence of the impetuous motions which attended the gymnastic games. The cries and acclamations of the people, sometimes expressing their compassion and joy, sometimes their horror and disgust, are strongly painted by different poets and orators. Acclamations made also a part of the ceremony of marriage. They were used for the omen's sake; being the *Læta Omina*, sometimes spoken of before marriage in Roman writers.

Schlemm. de Acclam. Veter. Gen. 401. 1663. Pitisc. Lex. Ant. tom. i. p. 12. Ferrar. de Acclam. & Plauf. lib. i. cap. 8. Aquinas Lex. Milt. tom. i. p. 6. Bingham Orig. Eccles. lib. 14. cap. 4.

ACCOLADE, a ceremony anciently used in the conferring of knighthood. The word literally denotes an embrace, or hugging; being formed of *ad*, to; and *col* or *collum*, neck. Antiquaries are not agreed wherein the *accolade* properly consisted. The generality suppose it to be the embrace, or kiss, which princes anciently gave the new knight, as a token of their affection. Whence the word accolade, q. d. a clasping, or taking round the neck. A very ingenious author will rather have it to be a blow on the chine of the neck, given on the same occasion. Fauchet seems to reconcile the two opinions: he supposes it to be a kiss; but withal, imagines the kiss to be intended as a stroke on the cheek; *En leur baillant sur la joue*. The ceremony being only an imitation of that practised among the Romans in the *manumission* of their slaves, where it is known a blow was given. Skinner Caseneuve. Orig. Franc. Colomb Theat. d'Honneur.

ACCOMMODATION, in philosophy, the application of one thing, by analogy, to another. To know a thing by accommodation, is to know it by the idea of a similar thing referred thereto.

ACCOMMODATION is also used in theology. Thus, a prophecy of scripture is said to be fulfilled properly, as when a thing foretold comes to pass; and improperly, or by way of accommodation, when an event happens to any place or people, like to what fell out some time before to another. This method of explaining scripture by accommodation, serves as a key for solving some of the greatest difficulties relating to the prophecies. Thus, the words of Isaiah are spoken to those of his own time

are said to be fulfilled in thoſe who lived in our Saviour's; and are *accommodated* to them: "Ye hypocrites, well did Iſaias propheſy of you," &c. which ſame words St. Paul afterwards *accommodates* to the Jews of his time.

The primitive church *accommodated* multitudes of Jewiſh, and even heathen ceremonies and practices, to Chriſtian purpoſes; but the Jews had before done the ſame with the Gentiles. Some will even have circumciſion, the tabernacle, brazen ſerpent, &c. to have been originally of Egyptian uſe, and only *accommodated* by Moſes to the purpoſes of Judaiſm. Spencer maintains, that moſt of the rites of the old law were an imitation of thoſe of the Gentiles, and particularly of the Egyptians; that God, in order to divert the children of Iſrael from the worſhip they paid to the falſe deities, conſecrated the greateſt part of the ceremonies performed by thoſe idolaters, and had formed out of them a body of the ceremonial law; that he had, indeed, made ſome alterations therein, as barriers againſt idolatry; and that he thus *accommodated* his worſhip to the genius and occaſion of his ancient people. To this condeſcenſion of God, according to Spencer, is owing the origin of the tabernacle, and particularly that of the ark. Theſe opinions, however, have been controverted by later writers. Saurin's Diſſert. Old Teſt. tom. i. p. 500. Spencer de Leg. Hebr. Diſc. I. lib. iii. p. 32. Middleton's Letters from Rome.

ACCOMPANIMENT, ſomething attending or added as a circumſtance to another, either by way of ornament, or for the ſake of ſymmetry.

ACCOMPANIMENT, in muſic, denotes the inſtruments which accompany a voice to ſuſtain it, as well as to make the muſic more full. The accompaniment is uſed to recitative, as well as in ſong; on the ſtage, as well as in the choir, &c. The ancients had likewiſe their accompaniments on the theatre; they had even different kinds of inſtruments to accompany the chorus, from thoſe which accompanied the actors in the recitation. The accompaniment, among the moderns, is frequently a different part or melody from the ſong it accompanies. It is diſputed whether it was ſo among the ancients. It is generally alledged, that their accompaniments went no farther than the playing in octave, or in antiphony to the voice. The Abbé Fraguier, from a paſſage in Plato, pretends to prove, that they had actual ſymphony, or muſic in parts: but his arguments ſeem far from being concluſive.

ACCOMPANIMENTS, in heraldry, are all ſuch things as are applied about the ſhield by way of ornament; as the belt, mantlings, ſupporters, &c. A thing is alſo ſaid to be accompanied, when there are ſeveral bearings, or figures, about ſome principal one; as a ſaltier, bend, feſs, chevron, or the like.

ACCOMPLICE, one that has a hand in a buſineſs; or is privy in the ſame deſign or crime with another. By the law of Scotland, the accomplice can only be proſecuted after the conviction of the principal offender: unleſs the acceſſion of the accomplice is immediate, in *ipſo actu*, ſo as in effect to render them co-principal. By the general rule, the accomplice ſuffers the ſame puniſhment with the principal offender. Yet if he be remarkably leſs guilty, juſtice will not permit equal puniſhment. The Council of Sens, and ſeveral other ſynodical ſtatutes, expreſsly prohibit the revealing accomplices. See ACCESSORY.

ACCOMPLISHMENT, the entire execution, atchievement, or fulfilling of ſomething propoſed or undertaken.

ACCOMPLISHMENT is alſo uſed for any mental or perſonal endowment.

ACCOMPLISHMENT, in theology, is principally uſed in ſpeaking of events foretold by the Jewiſh prophets, in the Old Teſtament, and fulfilled under the New. We ſay a literal accompliſhment, a myſtical or ſpiritual accompliſhment, a ſingle accompliſhment, a double accompliſhment, a Jewiſh accompliſhment, a Chriſtian, a heathen accompliſhment. The ſame propheſy is ſometimes accompliſhed in all or ſeveral of thoſe different ways. Thus, of ſome of the propheſies of the Old Teſtament, the Jews find a literal accompliſhment in their own hiſtory, about the time when the propheſy was given: the Chriſtians find another in Chriſt, or the earlieſt days of the church; the heathens another, in ſome of their emperors; the Mahometans another, in their legiſlator, &c. There are two principal ways of accompliſhing a propheſy; *directly* and by *accommodation*. See ACCOMMODATION and PROPHECY.

Dr. Sykes has a particular enquiry into the meaning of thoſe words uſed by the evangeliſt, "that it might be fulfilled, or accompliſhed, which was ſpoke by the prophets;" where he ſhews, that the ἵνα πληρωθῇ, *fulfilled*, does not neceſſarily refer to a prediction of a future event *accompliſhed*; but is frequently a mere accommodation of words borrowed from ſome other author, and accommodated to the preſent occaſion. Grotius ſuggeſted the opinion firſt.

ACCOUNT, or ACCOMPT, in a general ſenſe, a computation or reckoning of any thing by numbers. Collectively, it is uſed to expreſs the books which merchants, traders, bankers, &c. uſe for recording their tranſactions in buſineſs. See BOOK-KEEPING.

There are various ways of accounting; as by enumeration, or telling one by one; and by the rules of arithmetic, addition, ſubtraction, &c. See thoſe rules in the Syſtem of ARITHMETIC.

We account time by years, months, &c. The Greeks accounted it by olympiads; the Romans by indictions, luſtres, &c. We account diſtances by miles, leagues, &c.

ACCOUNT is taken ſometimes in a particular ſenſe for the computation of time. Thus we ſay, The Julian Account, the Gregorian Account, &c. in which ſenſe it is equivalent to ſtyle.

Books of ACCOUNTS, of merchants and tradeſmen, are conſidered as a ſort of private inſtruments; and, in the civil law, and law of merchants, are allowed to make a half proof. The reaſon is, that merchants are often under a neceſſity of dealing on truſt, without note or writing. Hence the ſuppletory oath of the merchant, with his book of accounts, is admitted abroad as a full proof againſt his chapman. But in England this is under ſome limitation. See ſtat. 7. Jac. I. cap. 12. which confines this ſpecies of proof to ſuch tranſactions as have happened within one year before the action brought; unleſs between merchant and merchant, in the uſual intercourſe of trade.

ACCRETION, in phyſics, the growth or increaſe of an organical body, by the acceſſion of new parts. Alſo a growing together, as of the fingers to one another. The word is compounded of *ad*, to, and *creſcere*, to grow. Accretion is of two kinds; the one conſiſting in an external oppoſition of new matter. This is what we otherwiſe call *juxta poſition*; and it is thus ſtones, ſhells, &c. are ſuppoſed to grow. The other is by ſome fluid matter received into proper veſſels, and gradually brought to adhere or grow to the ſides thereof. This is what we call *introſuſception*; and it is thus that plants and animals are nouriſhed.

ACCROCHE', in heraldry, denotes a thing being hooked into another. See the laſt line of Plate V. in the SYSTEM, where, by miſtake, it is called *accioche*.

ACCUBATION, a poſture of the body, between ſitting and lying. The word is compounded of *ad*, to, and *cubo*, I lie down. Accubation, or *accubitus*, was the table poſture of the Greeks and Romans; whence we find the words particularly uſed for the lying, or rather, as we call it, ſitting down to meat. The Greeks introduced this poſture. The Romans, during the frugal ages of the republic, were ſtrangers to it. But as luxury got footing, this poſture became adopted, at leaſt by the men; for as to women, it was reputed an indecency in them to lie down among the men; though afterwards this too was got over. But children did not lie down, nor ſervants, nor ſoldiers, nor perſons of meaner condition, but took their meals ſitting, as a poſture leſs indulgent. The Roman manner of diſpoſing themſelves at table was this; a low round table was placed in the cœnaculum, or dining room, and about this uſually three, ſometimes only two, beds, or couches; according to the number of which, it was *biclinium*, or *triclinium*. Theſe were covered with a ſort of bed cloaths, richer or plainer, according to the quality of the perſon, and furniſhed with quilts and pillows, that the gueſts might lie the more commodiouſly. There were ordinarily three perſons on each bed; to crowd more was eſteemed ſordid. In eating they lay down on their left ſides, with their heads reſting on their pillows, or rather on their elbows. The firſt lay at the head of the bed, with his feet extended behind the back of the ſecond: the ſecond lay with the back of his head towards the navel of the firſt, only ſeparated by a pillow, his feet behind the back of the third; and ſo of the third, or fourth. The middle place was eſteemed the moſt honourable. Before they came to table, they changed their cloaths, putting on what they called *cænatoria veſtis*, the dining garment, and pulled off their ſhoes, to prevent dirtying their couch. Pitiſc. Lex. Ant.

ACCUSATION, the charging any perſon with a criminal action, either in one's own name, or in that of the public. The word is compounded of *ad*, to, and *cauſari*, to plead. It has formerly been the cuſtom, in ſome parts of Europe, where the accuſation was very heavy, either to decide by combat, or at leaſt to make the accuſed purge himſelf by oath; which, however, was not admitted, excepting a certain number of his neighbours and acquaintance ſwore together with him.

Writers on politics treat of the benefit and the inconveniencies of public accuſations. Various arguments are alledged, both for the encouragement, and diſcouragement of accuſations againſt great men. Nothing, according to Machiavel, tends more to the preſervation of a ſtate, than frequent accuſations of perſons truſted with the adminiſtration of public affairs. This, accordingly, was ſtrictly obſerved by the Romans, in the inſtances of Camillus, accuſed of corruption by Manlius Capitolinus, &c. Accuſations, however, in the judgment of the ſame author, are not more beneficial than calumnies are pernicious; which is alſo confirmed by the practice of the Romans. Manlius not being able to make good his charges againſt Camillus, was caſt into priſon.

By the Roman law, there was no public accuſer for public crimes; every private perſon, whether intereſted in the crime or not, might accuſe and proſecute the accuſed to puniſhment, or abſolution. Cato, the moſt innocent perſon of his age, had been accuſed 42 times, and as often abſolved. But the accuſation of private crimes was never received but from the mouths of thoſe who

who were immediately intereſted in them; but the huſband could accuſe his wife of adultery.

In the French law, previous to the revolution, none but the procureur-general, or his deputies, could form an accuſation, except for high-treaſon and coining, where accuſation was open to every body. In other crimes, private perſons could only act the part of denouncers, and demand reparation for the offence, with damages.

In Britain, by Magna Charta, no man ſhall be impriſoned or condemned on any accuſation, without trial by his peers, or the law: none ſhall be vexed with any accuſation, but according to the law of the land; and no man ſhall be moleſted by petition to the king, &c. unleſs it be by indictment or preſentment of lawful men, or by proceſs at common law. Promoters of ſuggeſtion are to find ſurety to purſue them; and if they do not make them good, ſhall pay damages to the party accuſed, and alſo a fine to the king. No perſon is obliged to anſwer upon oath to a queſtion whereby he may accuſe himſelf of any crime.

ACCUSATIVE, in grammar, the fourth caſe of nouns that are declined. Its uſe may be conceived from this, that all verbs which expreſs actions that paſs from the agent, as *to beat*, &c. muſt have ſubjects to receive thoſe actions: for, if I beat, I muſt beat ſomething; ſo that ſuch verb evidently requires after it a noun, or name, to be the object of the action expreſſed. Hence, in all languages which have caſes, the nouns have a termination, which they call accuſative; as *amo Deum*; I love God. In Engliſh, we have nothing to diſtinguiſh this caſe from the nominative; but as we ordinarily place words in their natural order, it is eaſily diſcovered; the nominative conſtantly preceding, and the accuſative following, the verb. Thus, when we ſay the prince loves the princeſs, and the princeſs loves the prince; the prince is the nominative in the firſt, and the accuſative in the laſt; and the princeſs the accuſative in the firſt, and the nominative in the ſecond. See the Syſtem, Part I. Sect. I.

ACEPHALUS, or ACEPHALOUS, ſomething that wants a head. The word is compoſed of the privative *a*, and κεφαλη, *caput*, head.

Acephalous worms, or what are ſuppoſed ſuch, are frequent. The *lumbricus latus*, or joint-worm, was long taken to be acephalous. The firſt who gave it a head was Tulpius, and after him Fehr: the former even makes it *biceps*, or two-headed.

The levellers, in the reign of Henry I. were called *acephali*. This word, in our ancient law-books, is alſo uſed for thoſe poor people who had no proper lord; as holding nothing in fee, either of king, biſhop, baron, or other feudal lord.

ACESCENT, a word uſed to denote any thing which is turning ſour, i. e. acid, or which is ſlightly acid. It is only applied properly to denote the firſt of theſe two meanings. The ſecond may be better expreſſed by either of the words *acidulous* or *ſubacid*.

ACETABULUM, in anatomy, is uſed for a deep cavity in certain bones appointed for the reception of the large heads of other bones, in order to their articulation. Thus the cavity of the iſchium or huckle-bone, which receives the head of the thigh bone, is called *acetabulum*, and ſometimes *cotyle*, or *cotyloides*. The acetabulum is lined, and capped round with a cartilage, whoſe circular margin is called *ſupercilium*. In its bottom lies a large mucilaginous gland. See the Syſtem, Part. I. Sect. I.

Acetabulum is alſo uſed by anatomiſts in the ſame ſenſe with Cotyledon. It ſignifies alſo a glandular ſubſtance, found in the placenta of ſome animals.

ACETARY. Nehemiah Grew, in his anatomy of plants, applies this term to a pulpy ſubſtance in certain fruits, *e. g.* the pear, which is incloſed in a congeries of ſmall calculous bodies towards the baſe of the fruit, and is always of an acid taſte.—The acetary of a pear is a globular part, lying within the calculary of the choak, and ſurrounding the core. It is of the ſame ſubſtance with the *parenchyma*, or pulp, only that the bladders of which it conſiſts are ſmaller and rounder than thoſe of the parenchyma: from whence, however, it ſeems to be derived: whence it is ſometimes alſo called, the *inner parenchyma*. The quince alſo has an acetary, reſembling, though leſs than, that of a pear.

ACETIFICATION is uſed by ſome chymiſts to denote the action or operation whereby vinegar is made. Acetification is a branch or ſpecies of fermentation, ariſing by expoſing vinous liquors in open veſſels and a warm place, which turns them acid. Acetification chiefly differs from the fermentation whereby wine is made, in this, that the latter is effected by a gentler heat, ſufficient only to raiſe and rarefy the ſulphureous parts; whereas, in acetification, there is what is ſufficient to raiſe and rarefy the ſaline parts; which is the preciſe point wherein acetification conſiſts.

ACETOUS, an epithet applied to ſuch ſubſtances as are ſour, or partake of the nature of vinegar.

ACETUM *diſtillatum*, diſtilled vinegar, chiefly uſed in preparations for diſſolution and precipitation.

SPIRITUS ACETI, ſpirit of vinegar, is made by drenching copper-filings with diſtilled vinegar; then evaporating it till the fumes of the vinegar cannot be ſmelt; the ſaturation and evaporation to be again repeated, till the menſtruum be ſatiated; which being then diſtilled, the ſpirit comes over. Its qualities and uſes are much the ſame with thoſe of the diſtilled vinegar, only it is more powerful.

ACETUM *roſatum*, vinegar of roſes. This is made of roſe-buds infuſed in vinegar, forty or fifty days: the roſes are then preſſed out, and the vinegar preſerved. It is chiefly uſed by way of embrocation on the head and temples, in the head-ach. After the like manner are made *acetum ſambucinum*, vinegar of elder; *acetum anthoſatum*, vinegar of roſemary flowers; *acetum ſcilliticum*, vinegar of ſquills, &c. The German diſpenſatories abound with medicated vinegars; chiefly aimed againſt peſtilential diſeaſes; but they are not much uſed among us. Our diſpenſatories, indeed, retain ſome of them, as the *acetum theriacale Norimbergenſe*; but is never preſcribed.

ACETUM *alcalizatum* is made of diſtilled vinegar, with the addition of ſome alkaline or volatile ſalt.

ACETUM *Eſuriens*, in chymiſtry, a diſtilled vinegar, rectified with the help of verdigreaſe It is made by diſſolving the common verdigreaſe in fine diſtilled vinegar, then evaporating the ſolution, and recovering the verdigreaſe again in form of cryſtals; and from this, by a proper degree of fire, diſtilling with a retort an acid ſpirit, which is the richeſt acid that can by any art be prepared from vinegar. Boerhaaves's Chym. p. 138.

ACHIAR is a Malayan word, which ſignifies all ſorts of fruits and roots pickled with vinegar and ſpice. The Dutch import from Batavia all ſorts of achiar, but particularly that of bamboo, a kind of cane extremely thick, which grows in the Eaſt Indies. It is preſerved there whilſt it is ſtill green, with very ſtrong vinegar and ſpice; and is called *bamboo achiar*. The name changes according to the fruit with which the achiar is made.

ACHOR, in medicine, the third ſpecies or degree of a *tinea*, or ſcald head. Achor is a ſort of ſmall running ulcer on the face and head, chiefly of children while they ſuck; by which the ſkin is broke into a number of little holes, out of which iſſues a viſcid humour, like ichor, whence its name. Achor, differs from the *favus* and *tinea* only in the degree of virulence. It is called favus when the perforations are large; and tinea when they are like thoſe which are made by moths in cloth. Writers of medical obſervations afford divers anomalous inſtances of *achores*, viz. ſome are found even in aged people; others on the feet; others reſembling the venereal diſeaſe; others which diſappeared upon cutting the hair, and returned on its growing again; others followed by a thickneſs of hearing; others by panics; and others by a *gutta ſerena*. Their drying up has ſometimes been followed by a fever, their repulſion inwards by an epilepſy.

ACHRAS, or SAPOTA PLUM: a genus of the Monogynia order, belonging to the Hexandria claſs of plants; and ranking in the 43d natural order, *Dumoſa*. There are four ſpecies, all natives of the Weſt Indies. The principal are, 1. The *ſapota* with oblong oval leaves, and ſmooth turbinated fruit. 2. The *mammoſa*, with ſpear-ſhaped leaves, and large oval fruit. The firſt is common about Panama, and ſome places in the Spaniſh Weſt Indies; but is not to be found in any of the Britiſh Settlements in America. The ſecond ſort is very common in Jamaica, Barbadoes, and moſt of the Weſt India Iſlands, where the trees are planted in the gardens for their fruit, which is by many perſons greatly eſteemed. They grow to the height of thirty-five or forty feet, having a ſtraight trunk, covered with an aſh-coloured bark. The branches are produced on every ſide, forming a regular head; and are beſet with leaves near a foot long, and almoſt three inches broad in the middle. The flowers are covered by a browniſh ſkin, incloſing a thick pulp of a ruſſet colour, very luſcious, and called *natural marmalade*, from its reſemblance to that of quinces. The ſtones taken in emulſion are reckoned good againſt the gravel. Theſe trees being natives of very hot climates, cannot be preſerved in this country, except in the warmeſt ſtoves.

ACHROMATIC, an epithet expreſſing want of colour. The word is Greek, being compounded of *a* privative, and χρωμα *colour*.

ACHROMATIC *Teleſcopes*, are teleſcopes contrived to remedy the aberrations in colours.

ACICULÆ, in natural hiſtory, ſmall ſpikes, or prickles, in form of needles, with which nature has armed ſeveral creatures, as the echinus marinus, alſo the hedge-hog, &c. For a repreſentation of the latter, ſee the Plates in the Syſtem of MAMMALIA, Genus XX. which ſhews their aciculæ.

ACIDITY, ACIDITAS, the quality which conſtitutes or denominates a body acid, or that ſenſation of ſharpneſs and ſourneſs which acids excite upon the taſte.

ACIDS derive their name from the word *acere*, *to be ſharp*; which expreſſes one quality by which they are diſtinguiſhed, viz. their ſour taſte. They form one of the general claſſes, into which ſimple ſalts are divided, and are the moſt ſimple of all ſaline ſubſtances. For the ſeveral diviſions of acids and their peculiar qualities and properties, ſee the Syſtem of CHYMISTRY, Part I. Chap. IV. throughout.

ACIDULÆ, in natural hiſtory, ſpecies of mineral waters, diſtinguiſhed

diſtinguiſhed by a ſatent acidity in their nature. When they are accompanied with heat, they are called *acidulæ*; but if heat be added to their briſk ſpirit, they are denominated *thermæ*. Acidulæ are native waters, impregnated with particles of ſome acid mineral, as vitriol, alum, nitre, or ſalt; and, as Dr. Seip, of Pyrmont, firſt diſcovered, in 1736, and Dr. Brownrigg, of Whitehaven, farther evinced, with a conſiderable quantity of fixed air, formerly known by the name of their ſpirit, or mephites, to which they owe their briſk ſparkling quality. Phil. Tranſ. Abr. vol. viii. p. 659; and Phil. Tranſ. vol. lv. p. 230, &c.

The phyſicians alſo frequently include chalybeate and aluminous, or ferruginous, waters, under the claſs of acidulæ. Their virtues depend, in general, on the principles and ingredients in their compoſition. A general analyſis of mineral waters may be made, either by evaporation, which will diſcover both the quantity of ſolid matter contained in the water, and, by ſubſequent trials, the peculiar nature of it; or by diſtillation, whence it may be known, whether the water contains any volatile matter, ſaline or bituminous; or again, by the mixture of certain liquors. See further on this ſubject, the Syſtem of CHYMISTRY, and the Article WATERS in the Alphabet. See alſo Hoffman de Acidulis, &c. Shaw's Improvements on Mineral Waters, in his Chymical Works; and Neuman's Works, with Dr. Lewis's Additions, p. 252.

ACIDULATED, any thing wherein acid juices have been put, in order to give it a coolneſs and briſkneſs.

ACIDULOUS denotes a thing that is ſlightly acid. It is ſynonymous with the word *ſub-acid*.

ACLOWA, in botany, a barbarous name of a ſpecies of Colutea. It is uſed by the natives of Guinea to cure the itch: they rub it on the body as we do unguents.

ACME, the height or top of any thing. The word is Greek, ſignifies point, and is more eſpecially uſed to denote the height, or utmoſt vehemence, of a diſtemper. Accordingly, ſome medical writers divide diſeaſes into four ſtates, or periods: 1. *Arche*, the beginning, or firſt attack. 2. *Anabaſis*, the growth. 3. *Acme*, the height: and 4. *Paracme*, which is the declenſion of the diſtemper.

ACONCROBA, in botany, a name given by the natives of Guinea to a plant growing wild with them, and in great eſteem for its virtues in the ſmall-pox. They give an infuſion of it in wine. The leaves of this plant are opake, and as ſtiff as thoſe of the phillerey: they grow in pairs, and ſtand on ſhort foot-ſtalks: they are ſmall at each end, and broad in the middle; and the largeſt of them are about three inches in length, and an inch and a quarter in breadth in the middle. They ſomewhat reſemble thoſe of our bay. They are of a duſky colour on the upper ſide, and of a pale green underneath.

ACONITUM, ACONITE, WOLFSBANE, or MONKSHOOD; a genus of the Trigynia order, belonging to the Polyandria claſs of plants. In the natural order, it aſſociates with the *Multiſiliquæ*, 26. The characters are: There is no calyx. The corolla conſiſts of five unequal petals oppoſite, in pairs; the higheſt helmet-tubed, inverted, and obtuſe: the two lateral ones broad, roundiſh, oppoſite, and converging; the two loweſt oblong, and looking downwards. The nectaria are two, piped, nodding, and ſitting on long ſubulated peduncles, and concealed under the higheſt petal: the ſcales are ſix, very ſhort, coloured, and in an orb with the nectaria. The ſtamina conſiſts of numerous ſmall ſubulated filaments; the antheræ are erect, and ſmall. The piſtillum has three [five] oblong germens, ending in ſtyli the length of the ſtamina: the ſtigmata are ſimple, and reflected. The pericarpium has three or five univalve capſules, gaping inward. The ſeeds are numerous, angular, and wrinkled.

There are ten different ſpecies of wolfsbane; all of which, except one, (the oriental,) are natives of the Alps, the mountains of Germany, Auſtria, and Tartary; ſo require a cool ſhady ſituation; except the wholeſome wolfsbane, which muſt have an open expoſure. They thrive beſt in a moiſt than dry ſoil; but the ground muſt not be ſo wet as to have the water ſtanding near their roots in the winter-time. They may all be propagated by ſowing their ſeeds in autumn, upon a north border, where they are ſcreened from the ſun. The plants will come up in the ſpring, when they muſt be kept clean from weeds during the ſummer-months; and in very dry ſeaſons, if they are frequently refreſhed with water, their growth will be greatly promoted. The following autumn they ſhould be tranſplanted into ſhady borders, in rows a foot aſunder, and the plants ſix inches diſtant from one another. In this ſituation they may remain two years, when they will carry flowers, and ſo may be tranſplanted to thoſe places where they are to remain. The eaſtern monkſhood is a native of the Levant, from whence the ſeeds of it were firſt ſent, by Dr. Tournefort, to the royal garden at Paris, from whence ſome other gardens have been furniſhed with ſeeds. It is very rare in Europe at preſent. Since the time of Theophraſtus, moſt of the ſpecies of monkſhood have been reckoned a deadly poiſon both to men and brutes. Dioſcorides, however, recommends the external application of common monkſhood for pains of the eyes. The flowers of a great many ſpecies communicate their noxious quality by being ſmelled to; and thoſe of the ſpecies called *napellus* being placed on the head, occaſion a violent megrim. Of the bad qualities of theſe plants we ſometimes avail ourſelves to get rid of vermin. A decoction of the roots will deſtroy bugs. The ſame part being powdered, and adminiſtered in bread, or ſome other palatable vehicle, to rats and mice, corrodes and inflames their inteſtines, and ſoon proves mortal. The juice of the plant is uſed to poiſon fleſh with, for the deſtruction of wolves, foxes, and other ravenous beaſts. The beſt antidote to the poiſon of the different monkſhoods is ſaid to be the root of the *anthora*, a ſpecies of the ſame genus, hence termed *healthful* or *wholeſome monkſhood*. The ſame plant is regarded as efficacious againſt bites of ſerpents, and other venomous creatures. The roots have a bitter acrid taſte: the leaves are only bitter. The former are chiefly uſed in medicine: and, beſides the excellent quality juſt mentioned, are ſtomachic, and promote perſpiration. The peaſants, who gather the plants on the Alps and Pyrenees, are ſaid to uſe it with ſucceſs againſt the biting of mad dogs, and to cure the colic. It is remarkable, that the monkſhood with blue flowers are much more virulent than the yellow or white-flowered kinds. Miller aſſerts that the huntſmen of the wolves, and other wild beaſts, on the Alps, dip their arrows into the juice of thoſe plants, which renders the wounds made by them deadly. That the anthora is an antidote to the poiſon of the reſt of the ſpecies, is not conſidered as a fact ſufficiently eſtabliſhed. Of the effects of the above, indeed, and other vegetable poiſons, medical writers give but a confuſed account. In general, thoſe which are not of the narcotic kind, nor excite violent vomitings and purgings, produce their pernicious effects, by irritating the nervous coats of the ſtomach and inteſtines, ſo as to occaſion violent convulſions, not only in them, but through the whole body. The proper cure is evacuation by vomit: but this is not to be obtained without ſome difficulty; becauſe there is uſually ſuch a contraction about the upper orifice of the ſtomach, that nothing can either be ſwallowed or thrown up. In this caſe, an infuſion of tobacco has been recommended, and may probably be of ſervice: for being of itſelf of a very ſtimulating nature, it may for a moment take off the violent ſpaſms occaſioned by the poiſon: in which caſe, a violent vomiting will immediately enſue. The ſtomach being thoroughly emptied, and deglutition rendered eaſy, the cure may be completed by oily and mucilaginous medicines. On account of the poiſonous qualities of monkſhood, no ſpecies of it ſhould be planted where children have acceſs, leſt they ſhould ſuffer by putting the leaves or flowers in their mouths, or rubbing them about their eyes; for the juice of the leaves will occaſion great diſorder by being only rubbed upon very tender fleſh; and the farina of the flowers, when blown into the eyes, cauſes them to ſwell greatly.

ACORN, in botany and agriculture, denotes the fruit of trees of the oak kind. See QUERCUS.

The acorn, according to Dr. Grew, is the nut of an oak, with this difference only, that beſides the cup it ſtands in, it has only a leathern or parchment cover, inſtead of a ſhell. And hence it is, that whereas the kernel of a nut is ſweet, that of an acorn is of a very rough taſte; the auſtere parts of the ſap, which in a nut are drained off into the ſhell, being here imbibed by the kernel itſelf. Writers on huſbandry give rules concerning ſeminaries or nurſeries of acorns, the propagating, ſowing, or planting of acorns. For timber, thoſe acorns are to be choſen as ſeed, which are moſt ſolid and heavy, not thoſe which are biggeſt.

In the Phil. Tranſ. vol. lviii. No. 11, an. 1768, p. 75, there is a curious and important memoir by John Ellis, Eſq. containing a method of preſerving acorns in bee's-wax, for a whole year, in a ſtate fit for vegetation, whereby other ſeeds may be preſerved in like manner; and ſuch as are valuable may be brought over from the Eaſt Indies, to plant for the benefit of the American colonies.

Acorns were the food of the firſt ages; but when corn was found out, acorns were neglected. They are of little uſe in our days, but to fatten hogs, and other cattle, and poultry. Yet among the Spaniards, the acorn, *Glans Iberica*, is ſaid to have long remained a delicacy, and to have been ſerved up in the nature of a deſert. In dearths, acorns have been ſometimes dried, ground into meal, and baked into bread. The inhabitants of Chile held out a long ſiege, without other food. But they are ſaid to breed head-achs and ventoſities, and to be hard of digeſtion. A decoction of acorns is reputed good againſt dyſenteries and colics. A peſſary of them is ſaid to be good in immoderate fluxes of the menſes.

ACOUSTICS, ACOUSTICA, the doctrine or theory of hearing, or of ſounds. The word is formed of the Greek ακουω *audio*, to hear. Acouſtics is the ſame with what we otherwiſe call *phonics*.

ACOUSTICS is uſually divided into two parts; namely, *diacouſtics*, which explains thoſe ſounds that come directly from a ſonorous body to the ear; and *catacouſtics* which treats of reflected ſounds; but ſuch diſtinction does not appear neceſſary, as the whole Syſtem may well be comprehended under one head, as will be clearly ſhewn from what follows.

TREATISE

TREATISE on ACOUSTICS, or PHONICS.

CHAP. I. *Different Theories of Sound.*

MOST ſounds are conveyed to us on the boſom of the air. In whatever manner they either float upon it, or are propelled forward in it, certain it is, that, without the vehicle of this or ſome other fluid, we ſhould have no ſounds at all. Let the air be exhauſted from a receiver, and a bell ſhall emit no ſound when rung in the void; for, as the air continues to grow leſs denſe, the ſound dies away in proportion, ſo that at laſt its ſtrongeſt vibrations are almoſt totally ſilent. Thus air is a vehicle for ſound. However, we muſt not, with ſome philoſophers, aſſert that it is the only vehicle; that, if there were no air, we ſhould have no ſounds whatſoever: for it is found, by trial, that ſounds are conveyed through water almoſt with the ſame facility with which they move through air. A bell rung in water returns a tone as diſtinct as if rung in air. This was obſerved by Derham, who alſo remarked, that the tone came a quarter deeper. Some naturaliſts aſſure us alſo, that fiſhes have a ſtronger perception of ſounds, even at the bottom of deep rivers. But this is much doubted.

One thing, however, is certain, that whether the fluid, which conveys the note, be elaſtic or non-elaſtic, whatever ſound we hear is produced by a ſtroke, which the ſounding body makes againſt the fluid, whether air or water. The fluid being ſtruck upon, carries the impreſſion forward to the ear, and there produces its ſenſation. Philoſophers are ſo far agreed, that they all allow that ſound is nothing more than the impreſſion made by an elaſtic body upon the air or water, and this impreſſion carried along by either fluid to the organ of hearing. Though air and water are both vehicles of ſound, yet neither of them ſeems to be ſo by itſelf, but only as it contains an exceedingly ſubtle fluid, capable of penetrating the moſt ſolid bodies. Hence, by the medium of that fluid, ſounds can be propagated through wood, or metals, even more readily than through the open air. By the ſame means, deaf people may be made ſenſible of ſounds, if they hold a piece of metal in their mouth, one end of which is applied to the ſounding body. As it is certain, therefore, that air cannot penetrate metals, we muſt acknowledge the medium of ſound to be of a more ſubtle nature; and thus the electrical fluid will naturally occur as the proper one. But why then is ſound no longer heard in an exhauſted receiver, if the air is not the fluid by which it is conveyed, ſeeing the electrical matter cannot be excluded? The reply to this is obvious: The electrical fluid is ſo exceedingly ſubtle, and pervades ſolid bodies with ſo much eaſe, that any motion of a ſolid body, in a quantity of electric matter by itſelf, can never excite a degree of agitation in it ſufficient for producing a ſound; but if the electric fluid is entangled among the particles of air, water, wood, metal, &c. whatever affects their particles will alſo affect this fluid, and produce an audible noiſe. In the experiment of the air pump, however, there may be an ambiguity, as the gradual exhauſting of the air creates an increaſing difference of preſſure on the outſide, and may occaſion in the glaſs a difficulty of vibrating, ſo as to render it leſs fit to communicate to the air without the vibrations that ſtrike it from within. From this cauſe the diminution of ſound in an exhauſted receiver may be ſuppoſed to proceed, as well as from the diminution of the air. But if any internal agitation of its parts ſhould happen to the electrical fluid, exceeding loud noiſes might be propagated through it, as has been the caſe when large meteors have kindled at a great diſtance from the earth. It is alſo difficult to account for the exceeding great ſwiftneſs of ſound, upon the ſuppoſition that it is propagated by means of air alone; for nothing is more certain, than that the ſtrongeſt and moſt violent gale is, in its courſe, inert and ſluggiſh, compared with the motion of ſound. But the manner in which this conveyance is made is ſtill diſputed: whether the ſound is diffuſed into the air, in circle beyond circle, like the waves of water, when we diſturb the ſmoothneſs of its ſurface by dropping in a ſtone; or whether it travels along, like rays diffuſed from a centre, ſomewhat in the ſwift manner that electricity runs along a rod of iron; theſe are the queſtions which have divided the learned. Sir Iſaac Newton was of the firſt opinion. He has explained the progreſſion of ſound by an undulatory, or rather a vermicular, motion in the parts of the air. If we have an exact idea of the crawling of ſome inſects, we ſhall have a tolerable notion of the progreſſion of ſound upon this hypotheſis. The inſect, for inſtance, in its motion, firſt carries its contractions from the hinder part, in order to throw its fore part to the proper diſtance; then it carries its contractions from the fore part to the hinder to bring that forward. Something ſimilar to this is the motion of the air when ſtruck upon by a ſounding body.

To be a little more preciſe, ſuppoſe ABC the ſtring of an harpſichord, ſcrewed to a proper pitch, and drawn out of the right line by the finger at B. We ſhall have occaſion elſewhere to obſerve, that ſuch a ſtring would, if let go, vibrate to E; and from E to D, and back again; that it would continue thus to vibrate like a pendulum for ever, if not externally reſiſted, and, like a pendulum, all its little vibrations would be performed in equal times, the laſt and the firſt being equally long in performing; alſo, that, like a pendulum, its greateſt ſwiftneſs would always be when it arrived at E, the middle part of its motion. Now then, if this ſtring be ſuppoſed to fly from the finger at B, it is obvious, that whatever be its own motion, ſuch alſo will be the motion of the parts of air that fly before it. Its motion, as is obvious, is firſt uniformly accelerated forward from B to E, then retarded as it goes from E to D, accelerated back again as it returns from D to E, and retarded from E to B. This motion being therefore ſent in ſucceſſion through a range of elaſtic air, it muſt happen that the parts of one range of air muſt be ſent forward with accelerated motion, and then with a retarded motion. This accelerated motion reaching the remoteſt end of the firſt range, will be communicated to a ſecond range, while the neareſt parts of the firſt range being retarded in their motion, and falling back with the receſſion of the ſtring, retire firſt with an accelerated, then with a retarded motion, and the remoteſt parts will ſoon follow. In the mean time, while the parts of the firſt range are thus falling back, the parts of the ſecond range are going forward with an accelerated motion. Thus there will be an alternate condenſation and relaxation of the air during the time of one vibration; and as the air going forward ſtrikes any oppoſing body with greater force than upon retiring, ſo each of theſe accelerated progreſſions have been called by Newton a *pulſe* of ſound. Thus will the air be driven forward in the direction of the ſtring. But now we muſt obſerve, that theſe pulſes will move every way; for all motion, impreſſed upon fluids, in any direction whatſoever, operates all around in a ſphere: ſo that ſounds will be driven in all directions; backwards, forwards, upwards, downwards, and on every ſide. They will go on ſucceeding each other, one on the outſide of the other, like circles in diſturbed water; or rather they will lie one without the other in concentric ſhells, ſhell above ſhell, as we ſee in the coats of an onion.

All who have remarked the tone of a bell, while its ſounds are decaying away, muſt have an idea of the pulſes of ſound, which, according to Newton, are formed by the air's alternate progreſſion and receſſion. And it muſt be obſerved, that, as each of theſe pulſes is formed by a ſingle vibration of the ſtring, they muſt be equal to each other; for the vibrations of the ſtring are known to be ſo. For accelerated motion, ſee the Syſtem of MECHANICS, Sect. IV. and Plate I. Fig. 1.

As to the velocity with which ſounds travel, Newton determines it, by the moſt difficult calculation that can be imagined, to be in proportion to the thickneſs of the parts of the air, and the diſtance of theſe parts from each other. From hence he goes on to prove, that each little part moves backward and forward like a pendulum; and from thence he proceeds to demonſtrate, that if the atmoſphere were of the ſame denſity every where as at the ſurface of the earth, in ſuch a caſe, a pendulum, that reached from its higheſt ſurface down to the ſurface of the earth, would by its vibrations diſcover to us the proportion of the velocity with which ſounds travel. The velocity with which each pulſe would move, he ſhows, would be as much greater than the velocity of ſuch a pendulum ſwinging with one complete vibration, as the circumference of a circle is greater than the diameter. From hence he calculates, that the motion of ſound will be 979 feet in one ſecond. But this not being conſonant to experience, he takes in another conſideration, which deſtroys entirely the rigour of his former demonſtration, namely, vapours in the air; and then finds the motions of ſound to be 1142 feet in one ſecond, or near 13 miles in a minute: a proportion which experience had eſtabliſhed nearly before. Thus much will ſerve to give an idea of a theory which has met with numbers of oppoſers.

Various have been the objections that have been made to the Newtonian ſyſtem of ſounds. It is urged, that this theory can only agree with the motion of ſound in an elaſtic fluid, whereas ſounds are known to move forward through water that is not elaſtic. To explain their progreſs, therefore, through water, a ſecond theory muſt be formed: ſo that two theories muſt be made to explain a ſimilar effect; which is contrary to the ſimplicity of true philoſophy; for it is contrary to the ſimplicity of nature. It is further urged, that the ſlow vermicular motion but ill repreſents the velocity with which ſounds travel, as we know by experience, that it is almoſt 13 miles in a minute. In ſhort, it is urged, that ſuch undulations as have been deſcribed, when coming from ſeveral ſonorous bodies at once, would croſs, obſtruct, and confound each other; ſo that, if they were conveyed to the ear by this means, we ſhould hear nothing but a medley of diſcord and broken articulations. But this is equally with the reſt contradictory to experience, ſince we hear the fulleſt concert, not only without confuſion, but with the higheſt pleaſure. Theſe objections, whether well founded or not, have given riſe to another theory; which we ſhall likewiſe lay before the reader; though it too appears liable to objections, which ſhall be afterwards mentioned.

Every ſound may be conſidered as driven off from the ſounding body in ſtraight lines, and impreſſed upon the air in one direction only; but whatever impreſſion is made upon a fluid in one direction, is diffuſed upon its ſurface into all directions; ſo that the

the ſound firſt driven directly forward ſoon fills up a wide ſphere, and is heard on every ſide. Thus, as it is impreſſed, it inſtantaneouſly travels forward with a very ſwift motion, reſembling the velocity with which we know electricity flies from one end of a line to another. Now, as to the pulſes, or cloſe ſhakes, as the muſicians expreſs it, which a ſounding body is known to make, each pulſe (ſay the ſupporters of this theory) is itſelf a diſtinct and perfect ſound, and the interval between every two pulſes is profoundly ſilent. Continuity of ſound from the ſame body is only a deception of the hearing; for as each diſtinct ſound ſucceeds at very ſmall intervals, the organ has no time to tranſmit its images with equal ſwiftneſs to the mind, and the interval is thus loſt to ſenſe; juſt as in ſeeing a flaming torch, if ſtared round in a circle, it appears as a ring of fire. In this manner a beaten drum, at ſome ſmall diſtance, preſents us with the idea of continuing ſound. When children run with their ſticks along a rail, a continuing ſound is thus repreſented, though it need ſcarce be obſerved that the ſtroke againſt each rail is perfectly diſtinct and inſulated. According to this theory, therefore, the pulſes are nothing more than diſtinct ſounds repeated by the ſame body, the firſt ſtroke or vibration being ever the loudeſt, and travelling farther than thoſe that follow; while each ſucceeding vibration gives a new ſound, but with diminiſhed force, till at laſt the pulſes decay away totally, as the force decays that gives them exiſtence. All bodies whatſoever that are ſtruck return more or leſs a ſound: but ſome, wanting elaſticity, give back no repetition of the ſound; the noiſe is at once begotten and dies: while other bodies, however, there are, which, being more elaſtic, and capable of vibration, give back a ſound, and repeat the ſame ſeveral times ſucceſſively. Theſe laſt are ſaid to have a tone; the others are not allowed to have any.

We now come to a critical queſtion: What is it that produces the difference of tone in two elaſtic ſounding-bells or ſtrings? Or what makes one deep and the other ſhrill? This queſtion has always been hitherto anſwered by ſaying, that the depth or height of the note proceeded from the ſlowneſs or ſwiftneſs of the times of the vibrations. The ſloweſt vibrations, it has been ſaid, are qualified for producing the deepeſt tones; while the ſwifteſt vibrations produce the higheſt tones. In this caſe, an effect has been given for a cauſe. It is, in fact, the force with which the ſounding ſtring ſtrikes the air when ſtruck upon, that makes the true diſtinction in the tones of ſounds. It is this force, with greater or leſs impreſſions, reſembling the greater or leſs force of the blows upon a non-elaſtic body, which produces correſpondent affections of ſound. The greateſt forces produce the deepeſt ſounds: the high notes are the effect of ſmall efforts. In the ſame manner a bell, wide at the mouth, gives a grave ſound; but if it be very maſſy withal, that will render it ſtill graver; but if maſſy, wide, and long, or high, that will make the tone deepeſt of all. Thus, then, will elaſtic bodies give the deepeſt ſound, in proportion to the force with which they ſtrike the air: but if we ſhould attempt to increaſe the force by giving them a ſtronger blow, this will be in vain; they will ſtill return the ſame tone; for ſuch is their formation, that they are ſonorous only becauſe they are elaſtic, and the force of this elaſticity is not increaſed by our ſtrength, as the greatneſs of a pendulum's vibration will not be increaſed by falling from a greater height. Thus far of the length of chords. As to the frequency with which they vibrate the deepeſt tones, it has been found, from the nature of elaſtic ſtrings, that the longeſt ſtrings have the wideſt vibrations, and conſequently go backward and forward ſloweſt; while, on the contrary, the ſhorteſt ſtrings vibrate the quickeſt, or come and go in the ſhorteſt intervals. From hence thoſe who have treated of ſounds, have aſſerted, as was ſaid before, that the tone of the ſtring depended upon the length or ſhortneſs of the vibrations. This, however, is not the caſe. One and the ſame ſtring, when ſtruck, muſt always, like the ſame pendulum, return preciſely ſimilar vibrations; but it is well known, that one and the ſame ſtring, when ſtruck upon, does not always return preciſely the ſame tone: ſo that in this caſe the vibrations follow one rule, and the tone another. The vibrations muſt be invariably the ſame in the ſame ſtring, which does not return the ſame tone invariably, as is well known to muſicians in general. In the violin, for inſtance, they can eaſily alter the tone of the ſtring an octave, or eight notes higher, by a ſofter method of drawing the bow; and ſome are known thus to bring out the moſt charming airs imaginable. Theſe peculiar tones are by the Engliſh muſicians called *flute-notes*. The only reaſon, it has been alledged, that can be aſſigned for the ſame ſtring thus returning different tones, muſt certainly be the different force of its ſtrokes upon the air. In one caſe, it has double the tone of the other; becauſe upon the ſoft touches of the bow, only half its elaſticity is put into vibration. This being underſtood, (continue the authors of this theory,) we ſhall be able clearly to account for many things relating to ſounds that have hitherto been inexplicable. Thus, for inſtance, if it be aſked, When two ſtrings are ſtretched together of equal lengths, tenſions, and thickneſs, how does it happen, that one of them being ſtruck, and made to vibrate throughout, the other ſhall vibrate throughout alſo? the anſwer is obvious: the force that the ſtring ſtruck receives is communicated to the air, and the air communicates the ſame to the ſimilar ſtring; which therefore receives all the force of the former; and the force being equal, the vibrations muſt be ſo too. Again, put the queſtion, If one ſtring be but half the length of the other, and be ſtruck, how will the vibrations be? The anſwer is, the longeſt ſtring will receive all the force of the ſtring half as long as itſelf, and therefore it will vibrate in proportion; that is, through half its length. In the ſame manner, if the longeſt ſtring were three times as long as the other, it would only vibrate in a third of its length; or if four times, in a fourth of its length. In ſhort, whatever force the ſmaller ſtring impreſſes upon the air, the air will impreſs a ſimilar force upon the longer ſtring, and partially excite its vibrations. From hence alſo we may account for the cauſe of thoſe charming, melancholy gradations of ſound in the Eolian lyre; an inſtrument (ſays Sir John Hawkins) lately obtruded upon the public as a new invention, though deſcribed above a century ago by Kircher. This inſtrument is eaſily made, being nothing more than a long narrow box of thin deal, about thirty inches long, five inches broad, and 1¼ inches deep, with a circle in the middle of the upper ſide, or belly, about 1¼ inch diameter, pierced with ſmall holes. On this ſide are ſeven, ten, or (according to Kircher) fifteen or more ſtrings of very fine gut, ſtretched over bridges at each end, like the bridge of a fiddle, and ſcrewed up or relaxed with ſcrew-pins. The ſtrings are all tuned to one and the ſame note; and the inſtrument is placed in ſome current of air, where the wind can bruſh over its ſtrings with freedom. A window, with the ſaſh juſt raiſed to give the air admiſſion, will anſwer this purpoſe exactly. Now, when the entering air blows upon theſe ſtrings with different degrees of force, there will be excited different tones of ſound: ſometimes the blaſt brings out all the tones in full concert; ſometimes it ſinks them to the ſofteſt murmurs: it feels for every tone; and, by its gradations of ſtrength, ſolicits thoſe gradations of ſound which art has taken different methods to produce.

It remains, in the laſt place, to conſider (by this theory) the loudneſs and lowneſs, or, as the muſicians ſpeak, the ſtrength and ſoftneſs, of ſound. In vibrating elaſtic ſtrings, the loudneſs of the tone is in proportion to the deepneſs of the note; that is, in two ſtrings, all things in other circumſtances alike, the deepeſt tone will be loudeſt. In muſical inſtruments upon a different principle, as in the violin, it is otherwiſe; the tones are made in ſuch inſtruments by a number of ſmall vibrations crowded into one ſtroke. The roſined bow, for inſtance, being drawn along a ſtring, its roughneſſes catch the ſtring at very ſmall intervals, and excite its vibrations. In this inſtrument, therefore, to excite loud tones, the bow muſt be drawn quick, and this will produce the greateſt number of vibrations. But it muſt be obſerved, that, the more quick the bow paſſes over the ſtring, the leſs apt will the roughneſs of its ſurface be to touch the ſtring at every inſtant. To remedy this, therefore, the bow muſt be preſſed the harder as it is drawn quicker, and thus its fulleſt ſound will be brought from the inſtrument. If the ſwiftneſs of the vibrations, in an inſtrument thus rubbed upon, exceed the force of the deeper ſound in another, then the ſwift vibrations will be heard at a greater diſtance, and as much farther off as the ſwiftneſs in them exceeds the force in the other.

By the ſame theory (it is alledged) may all the phenomena of muſical ſounds be eaſily explained. The fables of the ancients pretend, that muſic was firſt found out by the beating of different hammers upon the ſmith's anvil. Without purſuing the fable, let us endeavour to explain the nature of muſical ſounds by a ſimilar method. Let us ſuppoſe an anvil, or ſeveral ſimilar anvils, to be ſtruck upon by ſeveral hammers of different weights or forces. The hammer, which is double that of another, upon ſtriking the anvil, will produce a ſound double that of the other. This double ſound muſicians have agreed to call an octave. The ear can judge of the difference or reſemblance of theſe ſounds with great eaſe, the numbers being as one and two, and therefore very readily compared. Suppoſe that an hammer, three times leſs than the firſt, ſtrikes the anvil, the ſound produced by this will be three times leſs than the firſt: ſo that the ear, in judging the ſimilitude of theſe ſounds, will find ſomewhat more difficulty, becauſe it is not ſo eaſy to tell how often one is contained in three, as to tell how often it is contained in two.—Again, ſuppoſe that an hammer four times leſs than the firſt ſtrikes the anvil, the ear will find greater difficulty ſtill in judging preciſely the difference of the ſounds; for the difference of the numbers four and one cannot ſo ſoon be determined with preciſion as three and one. If the hammer be five times leſs, the difficulty of judging will be ſtill greater. If the hammer be ſix times leſs, the difficulty ſtill increaſes; and ſo alſo of the ſeventh; inſomuch, that the ear cannot always readily, and at once, determine the preciſe gradation. Now, of all compariſons, thoſe which the mind makes moſt eaſily, and with leaſt labour, are the moſt pleaſing. There is a certain regularity in the human ſoul, by which it finds happineſs in exact and ſtriking, and eaſily-made compariſons. As the ear is but an inſtrument of the mind, it is therefore moſt pleaſed with the combination of any two ſounds, the differences of which it can moſt readily diſtinguiſh. It is more pleaſed with the concord of two ſounds, which are to each other as one and two, than of two ſounds which are as one and three, or one and four, or one and five, or one and ſix or ſeven.

Upon

Upon this pleasure, which the mind takes in comparison, all harmony depends. The variety of sounds is infinite; but, because the ear cannot compare two sounds so as readily to distinguish their discriminations when they exceed the proportion of one and seven, musicians have been content to confine all harmony within that compass, and allowed but seven notes in musical composition.

Let us now then suppose a stringed instrument fitted up in the order mentioned above. For instance; let the first string be twice as long as the second; let the third string be three times shorter than the first; let the fourth be four times, the fifth string five times, and the sixth six times as short as the first. Such an instrument would probably give us a representation of the lyre as it came first from the hands of the inventor. This instrument will give us all the seven notes following each other in the order in which any two of them will accord together most pleasingly: but yet it will be very inconvenient, and a very disagreeable instrument: inconvenient, because, in a compass of seven strings only, the first must be seven times as long as the last; and disagreeable, because this first string will be seven times as loud also; so that when the tones are to be played in a different order, loud and soft sounds will be intermixed with most disgusting alternations. In order to improve the first instrument, therefore, succeeding musicians very judiciously threw in all the other strings between the two first, or in other words, between the two octaves, giving to each, however, the same proportion to what it would have had in the first natural instrument. This made the instrument more portable, and the sounds more even and pleasing. They therefore disposed the sounds between the octave in their natural order, and gave each its own proportional dimensions. Of these sounds, where the proportion between any two of them is most obvious, the concord between them will be most pleasing. Thus octaves, which are as two to one, have a most harmonious effect; the fourth and fifth also sound sweetly together; and they will be found, upon calculation, to bear the same proportion to each other that octaves do.

But there is another property in the vibration of a musical string not yet taken notice of, and which confirms the forgoing theory. If we strike the string of an harpsicord, or any other elastic sounding chord whatever, it returns a continuing sound. This till of late was considered as one simple uniform tone; but all musicians now confess, that, instead of one tone, it actually returns four tones, and that constantly. The notes are, beside the fundamental tone, an octave above, a twelfth above, and a seventeenth. One of the bass notes of an harpsicord has been dissected in this manner by Rameau, and the actual existence of these tones proved beyond a possibility of being controverted. In fact, the experiment is easily tried: for if we smartly strike one of the lower keys of an harpsichord, and then take the finger briskly away, a tolerable ear will be able to distinguish, that, after the fundamental tone has ceased, three other shriller tones will be distinctly heard: first the octave above, then the twelfth, and lastly the seventeenth. The octave above is, in general, almost mixed with the fundamental tone, so as not to be easily perceived, except to an ear long habituated to the minute discriminations of sounds. So that we may observe, that the smallest tone is heard last, and the deepest and largest one first: the two others in order.

In the whole theory of sounds, nothing has given greater room for speculation, conjecture, and disappointment, than this amasing property in elastic strings. The whole string is universally acknowledged to be in vibration in all its parts, yet this single vibration returns no less than four different sounds. Those who account for the tones of strings by the number of their vibrations, are here at the greatest loss. Daniel Bernouilli supposes, that a vibrating string divides itself into a number of curves, each of which has a peculiar vibration; and though they all swing together in the common vibration, yet each vibrates within itself. This opinion, which was supported, as most geometrical speculations are, with the parade of demonstration, was only born soon after to die. Others have ascribed this to an elastic difference in the parts of the air, each of which, at different intervals, thus received different impressions from the string, in proportion to their elasticity. This is absurd. If we allow the difference of tone to proceed from the force, and not the frequency, of the vibrations, this difficulty will admit of an easy solution. These sounds, though they seem to exist together in the string, actually follow each other in succession: while the vibration has greatest force, the fundamental tone is brought forward: the force of the vibration decaying, the octave is produced, but almost only instantaneously; to this succeeds, with diminished force, the twelfth; and, lastly, the seventeenth is heard to vibrate with great distinctness, while the three other tones are always silent. These sounds, thus excited, are all of them the harmonic tones, whose differences from the fundamental tone are, as was said, strong and distinct. On the other hand, the discordant tones cannot be heard. Their differences being but very small, they are overpowered, and in a manner drowned in the tones of superior difference: yet not always neither; for Daniel Bernouilli has been able, from the same stroke, to make the same string bring out its harmonic and its discordant tones also. Vid. Memoirs d l'Academie de Berlin, 1753, p. 153. So that from hence we may justly infer, that every note whatsoever is only a succession of tones; and that those are most distinctly heard, whose differences are most easily perceivable. To this theory, however, though it has a plausible appearance, there are strong and indeed insuperable objections. The very fundamental principle of it is false. No body whatever, whether elastic or non-elastic, yields a graver sound by being struck with a larger instrument, unless either the sounding body, or that part of it which emits the sound, is enlarged. In this case, the largest bodies always return the gravest sounds. In speaking of elastic and non-elastic bodies in a musical sense, we are not to push the distinction so far as when we speak of them philosophically. A body is *musically* elastic, all of whose parts are thrown into vibrations so as to emit a sound when only part of their surface is struck. Of this kind are bells, musical strings, and all bodies whatever that are considerably hollow. Musical non-elastics are such bodies as emit a sound only from that particular place which is struck: thus, a table, a plate of iron nailed on wood, a bell sunk in the earth, are all of them non-elastics in a musical sense, though not philosophically so. When a solid body, such as a log of wood, is struck with a switch, only that part of it emits a sound which comes in contact with the switch; the note is acute and loud, but would be no less so though the adjacent parts of the log were removed. If, instead of the switch, a heavier or larger instrument is made use of, a larger portion of its surface then returns a sound, and the note is consequently more grave: but it would not be so, if the large instrument was struck with a sharp edge, or a surface only equal to that of the small one. In sounds of this kind, where there is only a single stroke, without any repetition, the immediate cause of the gravity or acuteness seems to be the quality of air displaced by the sounding body: a large quantity of air displaced produces a grave sound, and a smaller quantity a more acute one, the force wherewith the air is displaced signifying very little.

The argument grounded on the production of what are called *flute-notes* on the violin, is built on a false foundation; for the bow being lightly drawn on an open string, produces no *flute notes*, but only the harmonies of the note to which the string is tuned. The *flute-notes* are produced by a particular motion of the bow, quick and near the bridge, and by fingering very gently. By this management, the same sounds are produced, tho' at certain intervals only, as if the vibrations were transferred to the space between the end of the finger-board and the finger, instead of that between the finger and the bridge. Why this small part of the string should vibrate in such a case, and not that which is under the immediate action of the bow, we must own ourselves ignorant: nor dare we affirm that the vibrations really are transferred in this manner, only the same sounds are produced as if they were.

Though these objections seem sufficient to overturn the foregoing theory, with regard to acute sounds being the effects of weak strokes, and grave ones of stronger impulses, we cannot admit that longer or shorter vibrations are the occasion of gravity or acuteness in sound. A musical sound, however lengthened, either by string or bell, is only a repetition of a single one, whose duration by itself is but for a moment, and is therefore termed *inappretiable*, like the smack of a whip, or the explosion of an electrical battery. The continuation of the sound is nothing more than a repetition of this instantaneous inappretiable noise after the manner of an echo, and it is only this echo that makes the sound agreeable. For this reason, music is much more agreeable when played in a large hall, where the sound is reverberated, than in a small room, where there is no such reverberation. For the same reason, the sound of a string is more agreeable when put on a hollow violin, than when fastened to a plain board, &c. In the sound of a bell we cannot avoid observing this echo very distinctly. The sound appears to be made up of distinct pulses, or repetitions of the same note produced by the stroke of the hammer. It can by no means be allowed, that the note would be more acute though these pulses were to succeed one another more rapidly; the sound would indeed become more simple, but would still preserve the same tone. In musical strings the reverberations are vastly more quick than in bells; and therefore their sound is more uniform or simple, and consequently more agreeable than that of bells. In musical glasses, the vibrations must be inconcivably quicker than in any bell, or stringed instrument: and hence they are of all others the most simple and the most agreeable, though neither the most acute nor the loudest. As far as we can judge, quickness of vibration contributes to the uniformity or simplicity, but not the acuteness, nor the loudness of a musical note.

It may here be objected, that each of the different pulses, of which we observe the sound of a bell to be composed, is of very perceptible length, and far from being instantaneous; so that it is not fair to infer that the sound of a bell is only a repetition of a single instantaneous stroke, seeing it is evidently the repetition of a lengthened note. To this it may be replied, that the inappretiable sound, which is produced by striking a bell in a non elastic state, is the very same which, being first propagated round the bell, forms one of these short pulses that is afterwards re-echoed as long as the vibrations of the metal continue, and it is impossible that the quickness of repetition of any sound can either increase or diminish its gravity.

CHAP. II. *Of the Velocity, &c. of Sounds. Axioms.*

EXPERIENCE has taught us, that ſound travels at about the rate of 1142 feet in a ſecond, or near 13 miles in a minute; nor do any obſtacles hinder its progreſs, a contrary wind only a ſmall matter diminiſhing its velocity. The method of calculating its progreſs is eaſily made known. When a gun is diſcharged at a diſtance, we ſee the fire long before we hear the ſound. If then we know the diſtance of the place, and know the time of the interval between our firſt ſeeing the fire and then hearing the report, this will ſhow us exactly the time the ſound has been travelling to us. For inſtance, if the gun is diſcharged a mile off, the moment the flaſh is ſeen, if you take a watch, and count the ſeconds till you hear the ſound, the number of ſeconds is the time the ſound has been travelling a mile. Again, by the above axiom, we are enabled to find the diſtance between objects that would otherwiſe be immeaſurable. For example, ſuppoſe you ſee the flaſh of a gun in the night at ſea, and tell ſeven ſeconds before you hear the report, it follows, therefore, that the diſtance is ſeven times 1142 feet, that is, 24 yards more than a mile and a half. In like manner, if you obſerve the number of ſeconds between the lightning and the report of the thunder, you know the diſtance of the cloud from whence it proceeds.

Derham has proved, by experience, that all ſounds whatever travel at the ſame rate. The ſound of a gun, and the ſtriking of a hammer, are equally ſwift in their motions; the ſofteſt whiſper flies as ſwiftly, as far as it goes, as the loudeſt thunder.

To theſe axioms we may add the following. Smooth and clear ſounds proceed from bodies that are homogeneous, and of an uniform figure; and harſh or obtuſe ſounds, from ſuch as are of a mixed matter and irregular figure. The velocity of ſound is to that of a briſk wind as fifty to one. The ſtrength of ſounds is greateſt in cold and denſe air, and leaſt in that which is warm and rarefied. Every point againſt which the pulſes of ſound ſtrike, becomes a centre from which a new ſeries of pulſes are propagated in every direction. Sound deſcribes equal ſpaces in equal times.

CHAP. III. *Of Reverberated Sounds.*

SOUND, like light, after it has been reflected from ſeveral places, may be collected in one point, as into a focus; and it will be there more audible than in any other part, even than at the place form whence it proceeded. On this principle it is that a whiſpering gallery is conſtructed. The form of this gallery muſt be that of a concave hemiſphere; and if a low ſound or whiſper be uttered, the vibrations expanding themſelves, when brought to a point, the ſound will be diſtinctly heard.

The augmentation of ſound by means of ſpeaking trumpets is very conſiderable. When a perſon ſpeaks through the trumpet, the whole force of his voice is ſpent upon the air contained in the tube, which will be agitated through the whole length of it; and, by various reflections from the ſide of the tube to the axis, the air along the middle part of the tube will be greatly condenſed, and its *momentum* proportionably increaſed, ſo that when it comes to agitate the air at the orifice of the tube, its force will be as much greater than what it would have been without the tube, as the ſurface of the ſphere, whoſe radius is equal to the length of the tube, is greater than the ſurface of the ſegment of ſuch a ſphere, whoſe baſe is the orifice of the tube. For a perſon, ſpeaking without the tube, will have the force of his voice ſpent in exciting concentric ſuperfices of air all round the mouth of the trumpet; and when thoſe ſuperfices or pulſes of air are diffuſed, it is plain the force of the voice will there alſo be diffuſed through the whole ſuperfices of a ſphere; but in the trumpet it will be ſo confined, that at its exit it will be diffuſed through ſo much of that ſpherical ſurface of air as correſponds to the orifice of the tube. But ſince the force is given, its intenſity will be always inverſely as the number of particles it has to move; and therefore in the tube it will be to that without, as the ſuperfices of ſuch a ſphere to the æra of the large end of the tube nearly. But it is obvious (Mr. Young, of Dublin, obſerves) that the confinement of the voice can have little effect in increaſing the ſtrength of the ſound, as this ſtrength depends on the velocity with which the particles move. Were this reaſoning concluſive, the voice ſhould iſſue through the ſmalleſt poſſible orifice; cylindrical tubes would be preferable to any that increaſed in diameter; and the leſs the diameter, the greater would be the effect of the inſtrument; becauſe the plate, or maſs of air to be moved, would, in that caſe, be leſs, and conſequently the effect of the voice the greater; all which is contradicted by experience. The cauſe of the increaſe of ſound in theſe tubes muſt therefore be derived from ſome other principles: and amongſt theſe we ſhall probably find, that what the ingenious Kircher has ſuggeſted in his Phonurgia is the moſt deſerving of our attention. He tells us, that "the augmentation of the ſound depends on its reflection from the tremulous ſides of the tube; which reflections, conſpiring in propagating the pulſes in the ſame direction, muſt increaſe its intenſity." Newton alſo ſeems to have conſidered this as the principal cauſe, in the ſcholium of prop. 50. B. 2. Princip. where he ſays, "we hence ſee why ſounds are ſo much increaſed in ſtentorophonic tubes, for every reciprocal motion is, in each return, increaſed by the generating cauſe."

Farther, when we ſpeak in the open air, the effect on the tympanum of a diſtant auditor is produced merely by a ſingle pulſe. But when we uſe a tube, all the pulſes propagated from the mouth, except thoſe in the direction of the axis, ſtrike againſt the ſides of the tube, and every point of impulſe becoming a new centre, from whence the pulſes are propagated in all directions, a pulſe will arrive at the ear from each of thoſe points; thus, by the uſe of a tube, a greater number of pulſes are propagated to the ear, and conſequently the ſound increaſed. The confinement too of the voice may have ſome effect, though not ſo much as is aſcribed to it by ſome; for the condenſed pulſes produced by the naked voice freely expand every way; but in tubes, the lateral expanſion being diminiſhed, the direct expanſion will be increaſed, and conſequently the velocity of the particles, and the intenſity of the ſound. The ſubſtance alſo of the tube has its effect; for it is found by experiment, that the more elaſtic the ſubſtance of the tube, and conſequently the more ſuſceptible it is of theſe tremulous motions, the ſtronger is the ſound. If the tube be laid on any non-elaſtic ſubſtance, it deadens the ſound, becauſe it prevents the vibratory motion of the parts. The ſound is increaſed in ſpeaking-trumpets, if the tube be ſuſpended in the air; becauſe the agitations are then carried on without interruption. Theſe tubes ſhould increaſe in diameter from the mouth-piece; becauſe the parts, vibrating in directions perpendicular to the ſurface, will conſpire in impelling forward the particles of air, and conſequently, by increaſing their velocity, will increaſe the intenſity of the ſound: and the ſurface alſo increaſing, the number of points of impulſe and of new propagations will increaſe proportionally. The ſeveral cauſes, therefore, of the increaſe of ſound in theſe tubes, Mr. Young concludes to be, 1. The diminution of the lateral, and conſequently the increaſe of the direct, expanſion and velocity of the included air. 2. The increaſe of the number of pulſes, by increaſing the points of new propagation. 3. The reflections of the pulſes from the tremulous ſides of the tube, which impel the particles of air forward, and thus increaſe their velocity.

An echo is a reflection of ſound ſtriking againſt ſome object, as an image is reflected in a glaſs: but it has been diſputed what are the proper qualities in a body for thus reflecting ſounds. It is in general known, that caverns, grottos, mountains, and ruined buildings, returned this image of ſound. We have heard of a very extraordinary echo, at a ruined fortreſs near Louvain, in Flanders. If a perſon ſung, he only heard his own voice, without any repetition: on the contrary, thoſe who ſtood at ſome diſtance heard the echo, but not the voice; but then they heard it with ſurpriſing variations, ſometimes louder, ſometimes ſofter, now more near, then more diſtant. There is an account in the Memoirs of the French Academy of a ſimilar echo near Rouen.

As there may be ſeveral ſphæriods of different magnitudes, ſo there may be ſeveral different echoes of the ſame original ſound. And as there may happen to be a greater number of reflecting points in the ſurface of an exterior ſphæriod than in that of an interior, a ſecond or a third echo may be much more powerful than the firſt, provided that the ſuperior number of reflecting points, that is, the ſuperior number of reflected pulſes propagated to the ear, be more than ſufficient to compenſate for the decay of ſound which ariſes from its being propagated through a greater ſpace. This is finely illuſtrated in the celebrated echoes at the lake of Killarney, in Ireland, where the firſt return of the ſound is much inferior in ſtrength to thoſe which immediately ſucceed it.

In churches we never hear a diſtinct echo of the voice, but a confuſed ſound when the ſpeaker utters his words too rapidly; becauſe the greateſt difference of diſtance between the direct and reflected courſes of ſuch a number of pulſes, as would produce a diſtinct ſound, is never in any chuch equal to 127 feet, the limit of echoes. But though the firſt reflected pulſes may produce no echo, both on account of their being too few in number, and too rapid in their return to the ear; yet it is evident, that the reflecting ſurface may be ſo formed, as that the pulſes which come to the ear after two reflections, or more, may, after having deſcribed 127 feet or more, arrive at the ear in ſufficient numbers, and alſo ſo nearly at the ſame inſtant, as to produce an echo, though the diſtance of the reflecting ſurface from the ear be leſs than the limit of echoes. This is confirmed by a ſingular echo in a grotto on the banks of the little brook called the Dinan, about two miles from Caſtlecomber, in the county of Kilkenny. As you enter the cave, and continue ſpeaking loud, no return of the voice is perceived; but on your arriving at a certain point, which is not above 14 or 15 feet from the reflecting ſurface, a very diſtinct echo is heard. Now this echo cannot ariſe from the firſt courſe of pulſes that are reflected to the ear, becauſe the breadth of the cave is ſo ſmall, that they would return too quickly to produce a diſtinct ſenſation from that of the original ſound: it therefore is produced by thoſe pulſes, which, after having been reflected ſeveral times from one ſide of the grotto to the other, and having run over a greater ſpace than 127 feet, arrive at the ear in conſiderable numbers, and not more diſtant from each other, in point of time, than the ninth part of a ſecond.

ACRAI, an Arable word, ſignifying either *ſuppreſſio uteri* or *fluxus uterinus*. For a phyſical deſcription of this term, and the cauſes from which the malady ſo called ariſes, ſee the article SATYRIASIS.

ACRE, the univerſal meaſure of land in Britain. The word (formed from the Saxon *acker*, or the German *aker*, a field) did not originally ſignify a determined quantity of land, but any open ground, eſpecially a wide champaign; and in this antique ſenſe it ſeems to be preſerved in the names of places, as Caſtle-acre, Weſt Acre, &c. An acre in England contains four ſquare roods; a rood forty perches or poles, of 16½ feet each, by ſtatute. Yet this meaſure does not prevail in all parts of England, as the length of the pole varies in different counties, and is called *cuſtomary meaſure*, the difference running from the 16½ feet to 24. The acre is alſo divided into 10 ſquare chains, of 22 yards each; that is, 4840 ſquare yards. An acre in Scotland contains four ſquare roods. One ſquare rood is 40 ſquare falls; one ſquare fall, 36 ſquare ells; one ſquare ell, 9 ſquare feet and 73 ſquare inches; one ſquare foot, 144 ſquare inches. The Scots acre is alſo divided into 10 ſquare chains. The meaſuring chain ſhould be 24 ells in length, divided into 100 links, each link 8 $\frac{64}{100}$ inches; and ſo one ſquare chain will contain 10,000 ſquare links. The Engliſh ſtatute-acre is about three roods and ſix falls ſtandard-meaſure of Scotland. The French acre (*arpent*) contains 1¼ Engliſh acre, or 54,450 ſquare Engliſh feet, whereof the Engliſh acre contains only 43,560. The Welſh acre contains commonly two Engliſh ones. The Iriſh acre is equal to one acre, two roods, and 19 perches $\frac{1}{11}$ Engliſh.

Dr. Grew attempts to aſcertain the number of acres in England, which, according to him, amounts to 46 millions and 80,000. The United Provinces are ſaid to contain 4,382,000 acres. The province of Holland but one million of acres. The territory of the United States of America, according to calculations lately made by order of Congreſs, contains 589 millions of acres, excluſive of water, which is computed at 51 millions more.

ACRID, in natural hiſtory, denotes any thing ſharp and pungent to the taſte. Acrid, according to Grew, properly belongs to the claſs of compound taſtes. It is not ſimply ſour or pungent; there being bodies not acrid, which are yet pungent, e. g. arum: nor is it ſimply hot: for there are many hot bodies which are not acrid, as the roots of zedoary, yarrow, and contrayerva. The characteriſtic, therefore, of acritude, conſiſts in pungency joined with heat. Acrid bodies, by the pungency and tenuity of their parts, incide, digeſt, heat, open, irritate, purge, cauſe appetite, &c They inflame the ſkin: when chewed, produce ſaliva; and when ſnuffed, ſneezing. The eating of acrid food, with thoſe intentions, is particularly called, by the Greeks, *drimyphagia*. Acrid things are hurtful to the head and eyes, and contrary to bilious temperaments; but advantageous to pituitous ones. Acrids may be divided into claſſes, according as they yield their acrimony. 1. By diſtillation. 2. By infuſion. 3. Neither by infuſion nor diſtillation. In leucophlegmatic habits they are powerful expectorants, deobſtruents, diureticks, and emmenagogues. Their virtue frequently depends on the effects which they have on the ſtomach.

ACRIMONY, that quality in things which renders them acrid to the taſte. Acrimony imports much the ſame with *aſperity*, or ſharpneſs; and expreſſes a quality in bodies, by which they corrode, deſtroy, or diſſolve others. Salts are only cauſtic in virtue of their acrimony. The acrimony of the bile is ſuppoſed the cauſe of divers diſorders; and a catarrh is believed to be a defluction of acrimonious humour. The Briſtol water is recommended by Dr. Randolph for tempering the bad effects of acrimonious blood. This he mentions as its firſt and principal virtue. See his Enquiry into the Medicinal Virtues of Briſtol Water, 8vo. 1750.

ACROMATIC, in a more general ſenſe, denotes a thing ſublime, profound, or abſtruſe. In which ſenſe it ſtands oppoſed to *exoteric*. We ſay acromatic philoſophy, acromatic theology, an acromatic method, acromatic interpretation, &c. There are few ſects, or profeſſions, that have not two ways of teaching, if not two ſorts of doctrine; an *acromatic* for adepts and proficients, and an *exoteric* for novices. We find traces of this among the heathen as well as Chriſtian divines, philoſophers, and chymiſts. Hence the ceremonies of initiations and ablutions, the diſcipline of ſecreſy; and hence alſo the origin of fables, ænigmas, parables, ſymbols, &c. Acromatic is ſometimes alſo uſed in a more general ſenſe for any thing kept ſecret, or remote from popular uſe. In which ſenſe Reimman gives the title Bibliotheca Acromatica to a deſcription of the MSS. of the library of Vienna, abridged from the vaſt commentaries of Lambecius and Neſſelius.

ACROPOSTHIA, ἀκροποσθία, or ἀκροποσθία, from ἄκρος, *extreme*, and ὀσθη, the prepuſe, or ſkin, which covers the glans of the penis, denotes the extremity of the prepuce, which is cut off in circumciſion

ACROSPIRED, or ACROSPIRED, is uſed in reſpect of barley; which, in the operation of making malt, is apt, after coming, or ſprouting, at the lower or root end, to become acroſpired, i. e. to ſprout alſo at the upper or blade end.

ACROSTIC, a kind of poetical compoſition, the verſes whereof are diſpoſed in ſuch a manner, as that the initial letters make up ſome perſon's name, title, motto, or the like. The word is derived from the Greek ἄκρος, *ſummus*, that which is at one of the extremes, and στίχος, *verſus*. There are alſo acroſtics, where the name or title is made up by the initial letters of the middle words, or the laſt of the final ones. And others which go backwards; beginning with the firſt letter of the laſt verſe, and proceeding upwards. Some refiners, in this trifling way, have even gone to *pentacroſtics*, where the name is to be repeated five times. The acroſtic is conſidered by the critics as a ſpecies of falſe wit, and is therefore very little regarded by the moderns.

ACT, in general, denotes the exertion of power, and differs from power as the effect from the cauſe; or it is an affective exerciſe or application of ſome power or faculty. In this ſenſe act ſtands oppoſed to power, *potentia*, which is only the capacity of acting, not the exertion of that capacity.

Metaphyſicians make various diviſions of act; viz. into *infinite*, as the act of creating; and *finite*, as the act of moving. *Tranſient*, or thoſe exerciſed in other beings, as heating; and *immanent*, which remain in their own ſubject, as thinking.

Act is particularly underſtood of an operation of the human mind. Thus, to diſcern, examine, and judge, are acts of the underſtanding: to affirm and chuſe, are acts of the will. There are voluntary acts, and ſpontaneous ones, which ſeem produced without the privity or participation of the ſoul.

ACT, in a legal ſenſe, is an inſtrument, or other matter in writing; of uſe to declare or juſtify the truth of a thing. In which ſenſe, records, decrees, ſentences, reports, certificates, &c. are called acts, authentic acts, ſolemn acts, &c. Acts alſo denote the deliberations and reſolutions of an aſſembly, ſenate, council, or convocation; taken down by clerks, notaries, or the like, and entered in a regiſter.

Public ACTS. The knowledge of public acts has been erected into a peculiar ſcience, called the diplomatic, of great importance to an hiſtorian, ſtateſman, chronologer, and even critic. The preſervation of them was the firſt occaſion of erecting libraries.

ACTS *of Parliament* are particularly denominated *Statutes*. The acts of the Royal Society are called *Tranſactions*; thoſe of the Royal Academy of Sciences at Paris, *Memoirs*; thoſe of the ſocieties of Leipſic, &c. ſimply *Acta*, *Acta eruditorem*, &c.

Acts are alſo matters of fact tranſmitted to poſterity in certain authentic books and memoirs. In which ſenſe we ſay, the Acts of the Apoſtles, Acts of the Martyrs, &c.

ACTS *of the Apoſtles*, one of the ſacred books of the New Teſtament, containing the hiſtory of the infant-church, during the ſpace of 29 or 30 years, from the aſcenſion of our Lord to the year of Chriſt 63. It was written by St Luke; and addreſſed to Theophilus, the perſon to whom the evangeliſt had before dedicated his goſpel. We here find the accompliſhment of ſeveral of the promiſes made by our Saviour; his aſcenſion; the deſcent of the Holy Ghoſt; the firſt preaching of the apoſtles, and the miracles whereby their doctrines were confirmed; an admirable picture of the manners of the primitive Chriſtians; and, in ſhort, every thing that paſſed in the church till the diſperſion of the apoſtles, who ſeparated themſelves, in order to propagate the goſpel throughout the world. From the period of that ſeparation, St. Luke quits the hiſtory of the other apoſtles, who were then at too great a diſtance from him, and confines himſelf more particularly to that of St. Paul, who had choſen him for the companion of his labours. He follows that apoſtle in all his miſſions, and even to Rome itſelf; for it appears that the acts were publiſhed in the ſecond year of St. Paul's reſidence in that city, or the 36th year of the Chriſtian æra, in the 9th or 10th year of Nero's reign. The ſtyle of this work, which was originally compoſed in Greek, is much purer than that of the other canonical writers; and it is obſervable, that St. Luke, who was much better acquainted with the Greek than with the Hebrew language, always, in his quotations from the Old Teſtament, makes uſe of the Septuagint verſion. The council of Laodicea places the Acts of the apoſtles among the canonical books, and all the churches have acknowledged it as ſuch without any controverſy.

There are ſeveral *ſpurious* Acts of the Apoſtles; particularly, I. *Acts*, ſuppoſed to be written by Abdias, the pretended biſhop of Babylon, who gave out that he was ordained biſhop by the apoſtles themſelves when they were upon their journey into Perſia. II. *The Acts of St. Peter*. This book came originally from the ſchool of the Ebonites. III. *The Acts of St. Paul*, which is entirely loſt. IV. *The Acts of St. John the Evangeliſt*; a book made uſe of by the Encratites, Manichæans, and Priſcillianiſts. V. *The Acts of St. Andrew*; received by the Manichæans, Encratites, and Apotactics. VI. *The Acts of St. Thomas the Apoſtle*; received particularly by the Manichæans. VII. *The Acts of St. Philip*. This book the Gnoſtics made uſe of. VIII. *The Acts of St. Matthias*. Some have imagined that the Jews for a long time had concealed the original acts of the life and death of St. Matthias, written in Hebrew; and that a monk of the abbey of St. Matthias, at Treves, having got them out of their hands, procured them to be tranſlated into Latin, and publiſhed them, but the critics will not allow them to be authentic.

ACTS *of Pilate*; a relation ſent by Pilate to the emperor Tiberius, concerning Jeſus Chriſt, his death, reſurrection, aſcenſion, and

and the crimes of which he was convicted before him. It was a cuſtom among the Romans that the proconſuls and governors of provinces ſhould draw up acts, or memoirs, of what happened in the courſe of their government, and ſend them to the emperor and ſenate. The genuine Acts of Pilate were ſent by him to Tiberius, who reported them to the ſenate; but they were rejected by that aſſembly, becauſe not immediately addreſſed to them; as is teſtified by Tertullian, in his Apol. cap. 5. and 26, 21. The heretics forged acts in imitation of them. In the reign of the emperor Maximin, the Gentiles, to throw an odium on the Chriſtian name, ſpread about ſpurious Acts of Pilate; which the emperor, by a ſolemn edict, ordered to be ſent into all the provinces of the empire, and enjoined the ſchool-maſters to teach and explain them to their ſcholars, and make them learn them by heart. Theſe acts, both the genuine and the ſpurious, are loſt. There is, indeed, extant, in the Pſeudo-Hegeſippus, a letter from Pilate to the emperor Claudius, concerning JeſusChriſt; but it diſcovers itſelf at firſt ſight not to be authentic. See Euſebius's Eccleſiaſtical Hiſtory, lib. 1. cap. 2. & lib. 9. cap. 5.

ACT *of Parliament* is a poſitive law, conſiſting of two parts, the words of the act, and its true ſenſe and meaning; which being joined, make the law. The words of acts of parliament ſhould be taken in a lawful ſenſe. Caſes of the ſame nature are within the intention, though without the letter, of the acts; and ſome acts extend by equity to things not mentioned therein. See PARLIAMENT.

ACT, in the univerſities, is a theſis maintained in public by a candidate for a degree; or to ſhew the capacity and proficiency of a ſtudent in the univerſity. The candidates for a degree of bachelor and maſter of arts are to hold philoſophical acts; thoſe for bachelor of divinity are to hold theological acts, &c. At Oxford, the time when the maſters or doctors complete their degrees, is alſo called the *act*; which is held with great ſolemnity. At Cambridge they call it the *commencement*.

ACT *of faith*, AUTO *da fe*, in the Romiſh church, is a ſolemn day held by the inquiſition, for the puniſhment of heretics, and the abſolution of the innocent accuſed. They uſually contrive the *auto* to fall on ſome great feſtival, that the execution may paſs with the more awe and regard: at leaſt it is always on a Sunday.

The *auto da fe* may be called the laſt act of the inquiſitorial tragedy: it is a kind of a gaol-delivery, appointed as oft as a competent number of priſoners in the inquiſition are convicted of hereſy, either by their own voluntary or extorted confeſſion; or on the evidence of certain witneſſes. The proceſs is thus: in the morning they are brought into a great hall, where they have certain habits put on, which they are to wear in the proceſſion. The proceſſion is led by Dominican friars; after which come the penitents, ſome with ſan benitoes, and ſome without, according to their crimes; being all with black coats without ſleeves, and bare-footed, with a wax candle in their hands. Theſe are followed by the penitents who have narrowly eſcaped being burnt, who over their black coats have flames painted, with their points downwards, *fuego revolto*. Next come the negative, and relapſed, who are to be burnt, having flames on their habits pointing upwards: after theſe come ſuch as profeſs doctrines contrary to the faith of Rome, who, beſides flames pointing upwards, have their picture painted on their breaſts, with dogs, ſerpents, and devils, all open-mouthed, about it. Each priſoner is attended with a familiar of the inquiſition; and thoſe to be burnt have alſo a Jeſuit on each hand, who are continually preaching to them to abjure. After the priſoners comes a troop of familiars on horſe-back; and after them the inquiſitors, and other officers of the court, on mules: laſt of all, the inquiſitor-general on a white horſe, led by two men, with black hats, and green hat-bands. A ſcaffold is erected in the Terreiro de Paio, big enough for two or three thouſand people; at one end of which are the priſoners, at the other the inquiſitors. After a ſermon made up of encomiums on the inquiſition, and invectives againſt heretics, a prieſt aſcends a deſk near the middle of the ſcaffold, and having taken the abjuration of the penitents, recites the final ſentence of thoſe that are to be put to death; and delivers them to the ſecular arm, earneſtly beſeeching, at the ſame time, the ſecular power not to touch their blood, or put their lives in danger. The priſoners being thus in the hands of the civil magiſtrate, are preſently loaded with chains, and carried firſt to the ſecular gaol, and from thence in an hour or two brought before the civil judge, who, after aſking in what religion they intend to die, pronounces ſentence on ſuch as declare they die in the communion of the church of Rome, that they ſhall be firſt ſtrangled, and then burnt to aſhes; on ſuch as die in any other faith, that they be burnt alive. Both are immediately carried to the Ribera, the place of execution, where there are as many ſtakes ſet up as there are priſoners to be burnt, with a quantity of dry furze about them. The ſtakes of the profeſſed, that is, ſuch as perſiſt in their hereſy, are about four yards high, having a ſmall board towards the top for the priſoner to be ſeated on. The negative and relapſed, being firſt ſtrangled and burnt, the profeſſed mount their ſtakes by a ladder; and the Jeſuits, after ſeveral repeated exhortations to be reconciled to the church, part with them, telling them they leave them to the devil, who is ſtanding at their elbow to receive their ſouls, and carry them with him into the flames of hell. On this a great ſhout is raiſed, and the cry is, *let the dogs beards be made*, which is done by thruſting flaming furze, faſtened to long poles againſt their faces, till their faces are burnt to a coal, which is accompanied with the loudeſt acclamations of joy. At laſt, fire is ſet to the furze at the bottom of the ſtake, over which the profeſſed are chained ſo high, that the top of the flame ſeldom reaches higher than the ſeat they ſit on, ſo that they rather ſeem roaſted than burnt. There cannot be a more lamentable ſpectacle; the ſufferers continually crying out, while they are able, *Miſericordia per amor di Dios*: or, "*Pity for the love of God!*" yet it is beheld, by all ſexes and ages, with tranſports of joy and ſatisfaction. Geddes's Miſc. Tracts, tom. 1. p. 442. Limb. Hiſt. Inq. lib. iv.

ACT, in dramatic poetry, ſignifies a certain diviſion, or part, of a play, deſigned to give ſome reſpite both to the actors and ſpectators. The Romans were the firſt who divided their theatrical pieces into acts; for no ſuch diviſions appear in the works of the firſt dramatic poets. Their pieces, indeed, conſiſted of ſeveral parts or diviſions, which they called *protaſis*, *epitaſis*, and *cataſtrophe*; but theſe diviſions were not marked by any real interruptions on the theatre. Nor does Ariſtotle mention any thing of acts in his Art of Poetry. But, in the time of Horace, all regular and finiſhed pieces were divided into five acts.

Neuve minor, neu ſit quinto productior actu
Fabula, quæ poſci vult & ſpectata reponi.

The firſt act, according to ſome critics, beſides introducing upon the ſtage the principal characters of the play, ought to propoſe the argument or ſubject of the piece; the ſecond, to exhibit this to the audience, by carrying the fable into execution; the third, to raiſe obſtacles and difficulties; the fourth, to remove theſe, or raiſe new ones in the attempt; and the fifth, to conclude the piece, by introducing ſome accident that may unravel the whole affair. This diviſion, however, is not eſſentially neceſſary, but may be varied according to the humour of the author, or the nature of the ſubject.

ACTINIA, in vermeology, a genus belonging to the order of Vermes Molluſca. The body is oblong and ſmooth, attaching itſelf firmly, by its baſis, to rocks, or other ſolid ſubſtances, having a dilatable apex hooked within. The mouth is furniſhed with crooked teeth; the roſtrum cylindrical, and radiated. There are five ſpecies, ſome of which make a beautiful appearance, and are called *Animal Flowers*, *Sea Anemonies*, and *Urtica Marina*.

Progreſſive motion in theſe creatures is ſo ſlow, that it is difficult to perceive any, as they ſcarce advance the length of one inch in an hour. It would ſeem they do not all produce, when handled, the painful ſenſation which had acquired them the name of *ſea-nettles*. They are viviparous; feed on ſhell-fiſh; open their mouths more or leſs, according to the ſize of the prey they have to deal with, and then reject the ſhell through the ſame aperture. When the mouth is open, all the tentacula of the actinia may be ſeen, reſembling in that ſituation a full blown flower, which has given it the denomination of the *flower-fiſh*. See VERMEOLOGY.

ACTION, in a general ſenſe, denotes the operation of a power. The idea of action is ſo familiar to us, that a definition may as eaſily obſcure as explain it. Action implies nearly the ſame thing with act. Grammarians, however, obſerve ſome diſtinction between action and act; the former being generally reſtricted to the common or ordinary tranſactions, whereas the latter are uſed to expreſs thoſe which are remarkable. Thus, we ſay it is a good action to comfort the unhappy; it is a generous act to deprive ourſelves of what is neceſſary for their ſake. The wiſe man propoſes to himſelf an honeſt end in all his actions; a prince ought to mark every day of his life with ſome act of greatneſs. The Abbé Girard makes a further diſtinction between the words action and act. The former, according to him, has more relation to the power that acts than the latter; whereas the latter has more relation to the effect produced than the former; and hence the one is properly the attribute of the other. Thus we may properly ſay, "Be ſure to preſerve a preſence of mind in all your actions; and take care that they be all acts of equity."

Actions are divided, with reſpect to their principle, into *univocal*, where the effect is of the ſame kind with the cauſe; as the production of man by man; and *equivocal*, where it is different, as the ſuppoſed production of frogs by the ſun. And again into *vital*; as nutrition, reſpiration, the action of the heart, &c. and *not-vital*; as heating. With reſpect to their ſubject, actions are divided into *immanent*; which are received within the agent that produced them; as are vital actions, cogitation, &c. and *tranſient*, which paſs into another. In reſpect of duration, actions are again divided into *inſtantaneous*, where the whole effect is produced in the ſame moment: as the creation of light: and *ſucceſſive*, where the effect is produced by degrees; as corruption, fermentation, putrefaction, diſſolution, &c.

ACTION, in mechanics, implies either the effort which a body or power makes againſt another body or power, or the effect itſelf of that effort. As it is neceſſary, in works of this kind, to have a particular regard to the common language of mechanics and

and philoſophers, we have given this double definition: but the proper ſignification of the term is the motion which a body really produces, or tends to produce, in another; that is, ſuch is the motion it would have produced, had nothing hindered its effect. All power is nothing more than a body actually in motion, or which tends to move itſelf; that is, a body which would move itſelf if nothing oppoſed it. The action, therefore, of a body is rendered evident to us by its motion only; and conſequently, we muſt not fix any other idea to the word action, than that of actual motion, or a ſimple tendency to motion. The famous queſtion relating to *vis viva*, and *vis mortua*, owes, in all probability, its exiſtence to an inadequate idea of the word action; for had Leibnitz and his followers obſerved, that the only preciſe and diſtinct idea we can give to the word force or action, reduces it to its effect, that is, to the motion it actually produces, or tends to produce, they would never have made that curious diſtinction. For the principles and practice of Mechanics, ſee the SYSTEM throughout, and the Plates annexed. See alſo the Article MOTION.

Quantity of ACTION, a name given by M. de Maupertuis, in the Memoirs of the Pariſian Academy of Sciences for 1744, and thoſe of Berlin for 1746, to the product of the maſs of a body by the ſpace which it runs through, and by its celerity. He lays it down as a general law, "that, in the changes made in the ſtate of a body, the quantity of action neceſſary to produce ſuch change, is the leaſt poſſible." This principle he applies to the inveſtigation of the laws of refraction, of equilibrium, &c. and even to the ways of acting employed by the Supreme Being. In this manner M. de Maupertuis attempts to connect the metaphyſics of final cauſes with the fundamental truths of mechanics, to ſhow the dependence of the colliſion of both elaſtic and hard bodies upon one and the ſame law, which before had always been referred to ſeparate laws; and to reduce the laws of motion, and thoſe of equilibrium, to one and the ſame principle.

ACTION, in painting and ſculpture, is the attitude or poſition of the ſeveral parts of the face, body, and limbs, of ſuch figures as are repreſented, and whereby they ſeem to be really actuated by paſſions. Thus we ſay, the action of ſuch a figure finely expreſſes the paſſions with which it is agitated. We alſo uſe the ſame expreſſion with regard to animals.

ACTION, in phyſiology, is applied to the functions of the body, whether vital, animal, or natural. The *vital* functions, or actions, are thoſe which are abſolutely neceſſary to life, and without which there is no life, as the action of the heart, lungs, and arteries. On the action and re-action of the ſolids and fluids on each other, depend the vital functions. The pulſe and reſpiration are the external ſigns of life. Vital diſeaſes are all thoſe which hinder the influx of the venous blood into the cavities of the heart, and the expulſion of the arterial blood from the ſame. The *natural* functions are thoſe which are inſtrumental in repairing the ſeveral loſſes which the body ſuſtains; for life is deſtructive of itſelf, its very offices occaſioning a perpetual waſte. The mandication of food, the deglutition and digeſtion thereof, alſo the ſeparation and diſtribution of the chyle and excrementitious parts, &c. are under the head of natural functions, as by theſe our aliment is converted into our nature. The *animal* functions are thoſe which we perform at will, as muſcular motion, and all the voluntary actions of the body: they are thoſe which conſtitute the ſenſes of touch, taſte, ſmell, ſight, hearing, perception, reaſoning, imagination, memory, judgment, affections of the mind. Without any, or all of theſe, a man may live, but not ſo comfortably as with them.

In the year 1752, Dr. White publiſhed an ingenious performance, under the title of an Eſſay on the Vital and other voluntary Motions of Animals, 8vo. and in the ſame year Dr. Simpſon alſo publiſhed a book on Vital and Animal Actions, 8vo.

ACTION, in law, is a demand made before a judge for obtaining what we are legally intitled to demand, and is more commonly known by the name of *law-ſuit* or *proceſs*. See SUIT.

ACTION, in ethics, or *moral action*, is a voluntary motion of a creature capable of diſtinguiſhing good and evil; whoſe effect, therefore, may be juſtly imputed to the agent. See MORALS. A moral action may be more fully defined to be whatever a man, conſidered as endued with the powers of underſtanding, and willing, with reſpect to the end he ought to aim at, and the rule he is to regard in acting, reſolves, thinks, does, or even omits to do; in ſuch a manner as to become accountable for what is thus done or omitted, and the conſequences thereof. The foundation, then, of the morality of actions is, that they are done knowingly and voluntarily. All moral actions may be divided, with reſpect to the rule, into good and evil.

ACTION, in oratory, is an accommodation of the perſon of the orator to his ſubject; or, a management of the voice and geſture, ſuited to the manner ſpoken or delivered. Action makes one of the greateſt branches or diviſions of rhetoric, as generally taught. The ancients uſually called it *pronunciation*. Action is a collateral or ſecondary method of expreſſing our ideas; and is ſuſceptible of a kind of eloquence as well as the primary. It is an addreſs to the external ſenſes, which it endeavours to move, and bring into its party, by well-concerted motion and modulation; at the ſame time that the reaſon and underſtanding are attacked by force of argument. Accordingly, Tully very pertinently calls it *ſermo corporis*, the diſcourſe of the body; and *corporis eloquentia*, the eloquence of the body. The Roman mimes and pantomimes, we read, had ſuch a copia in this kind, ſuch a compaſs even of mute action, that voice and language ſeemed uſeleſs to them: they could make themſelves underſtood to people of all nations: and Roſcius, the comedian, is particularly famed, as being able to expreſs any ſentence by his geſtures, as ſignificantly and various as Cicero with all his oratory. Quintilian gives us a ſyſtem of the rules of action, taken not only from the writings of the ancient orators, but from the beſt examples of the forum. What we uſually attribute to eloquence was really the effect of the action only, as ſome of the greateſt maſters in that way have frankly acknowledged. Demoſthenes expreſsly calls it, "the beginning, the middle, and the end, of the orator's office:" and Cicero profeſſes, "that it is not of ſo much importance what the orator ſays, as how he ſays it." For a copious deſcription of this part of oratory, ſee the TREATISE, Part IV. throughout.

ACTION, in a theatrical ſenſe, is nearly the ſame with that among orators; with this difference, that the actor adapts his action to an aſſumed character, whereas the orator is ſuppoſed, in reality, to feel the paſſion which his action expreſſes, whether joy, grief, &c.

ACTION, in poetry, is an event, either real or imaginary, which makes the ſubject of an epic or dramatic poem. The action of a poem coincides nearly with the fable thereof; it being the uſual practice, not to take any real tranſaction of the hiſtory, but to feign or invent one; or at leaſt to alter the hiſtorical fact, ſo as to render it in a great meaſure fictitious. F. Boſſu has two chapters of *real actions*, the recitals whereof are fables; and of *feigned actions*, the recitals whereof are hiſtorical. The critics lay down four qualifications as neceſſary to the epic and tragic action: the firſt, *unity*; the ſecond, *integrity*; the third, *importance*; and the fourth, *duration*: to which ſome add a fifth, *continuity*. This unity is not only to exiſt in the firſt draught or model of the fable, but in the whole epiſodized action. In order to the integrity of the action, it is neceſſary, according to Ariſtotle, that it have a beginning, middle, and end. If the three parts of a whole ſeem to be generally denoted by the words, *beginning*, *middle*, and *end*, Boſſu interprets them more expreſsly, thus: "the cauſes and deſigns of a man's doing an action are the beginning; the effects of thoſe cauſes, and the difficulties met withal in the execution of thoſe deſigns, are the middle of it; and the unravelling and extricating thoſe difficulties are the end of the action." For the duration of the epic action, Ariſtotle obſerves, it is not ſo limited as that of the tragic action: the latter is confined to a natural day; but the epic, according to that critic, has no fixed time. In effect, tragedy, being full of paſſion, and conſequently of violence, which cannot be ſuppoſed to laſt long, requires a ſhorter time; and the epic poem, being for the habits which proceed more ſlowly, requires a longer time, either for them to take hold, or to be rooted up; and hence the difference between the epic and dramatic action in point of duration. Boſſu lays it down as a rule, that the more vehement the manners of the principal perſonages are, the leſs time ought the action to laſt: accordingly, the action of the Iliad, containing the wrath of Achilles, &c. holds but forty-ſeven days; whereas that of the Odyſſey, where prudence is the reigning quality, laſts eight years and a half; and that of the Æneid, where the prevailing character of the hero is piety and mildneſs, nearly ſeven years. As to the importance of the epic action, there are two ways of providing for it. The firſt, by the dignity and importance of the perſons. This way alone Homer makes uſe of; there being, otherwiſe, nothing great and important in his models, but what might have happened to ordinary perſons. The ſecond, by the importance of the action itſelf; ſuch as the eſtabliſhment or downfall of a religion or ſtate; which is Virgil's action, and in which he has much the advantage of Homer. Boſſu mentions a third way of making the action important; viz. by giving a higher idea of the perſonages than what the readers conceive of all that is great among men. This is done by comparing the characters of the poem with thoſe of the preſent time. See DRAMA and EPIC POEM.

ACTION, in affairs of commerce, or action of a company, is a part or ſhare in the company's ſtock or capital, which conſiſts of a number of ſuch actions. Actions in France and Holland amount to the ſame with ſhares or ſubſcriptions in England. Thus, the capital of a company, which has three hundred actions of a thouſand livres each, conſiſts of three hundred thouſand livres. Hence a perſon is ſaid to have four or ſix actions in ſuch company, if he hath contributed to the capital, and is intereſted in it, for four or ſix thouſand livres. A proprietor cannot have a deliberate vote in the aſſemblies of a company, unleſs he has a certain number of actions, fixed by the letters patent of its eſtabliſhment; nor can he be a director, unleſs he has a ſtill greater number of actions. Action alſo denotes an obligation or inſtrument, which the directors of ſuch companies deliver to thoſe who pay money into their ſtock. See ACTIONARY. Actions are always riſing and falling, according as the company's credit gains or loſes. The ſmalleſt whiſper of an approaching war or peace, true or falſe, will frequently occaſion a conſiderable alteration in it. In the year 1719, the French company of the Weſt, ſince called the

India Company, arrived at ſuch an immenſe degree of credit, that, in ſix months time, its actions roſe to eighteen per cent. a degree of temporary credit which no other company ever attained. In 1672, the actions of the Dutch Eaſt India Company were at ſix hundred and fifty per cent. and they were never known to be higher. But the war with France then coming on, they fell 250 per cent. in a few months. After the peace of Nimeguen, they roſe again; and in 1718 were 600 per cent.

ACTIONARY, or ACTIONIST, a term frequent in foreign news-papers, denoting the proprietor of an action, or ſhare in the company's ſtock.

ACTIVE, ACTIVUS, ſomething that communicates motion or action to another. In this ſenſe, the word ſtands oppoſed to *paſſive*. Thus we ſay, an active cauſe, active principles, &c. The quantity of motion in the world, Sir Iſaac Newton ſhews, muſt be always decreaſing, in virtue of the *vis inertiæ*, &c. So that there is a neceſſity for certain active principles to recruit it: ſuch he takes the cauſe of gravity to be, and the cauſe of fermentation. Adding, that we ſee but little motion in the univerſe, except what is owing to theſe active principles.

ACTIVE *power*, in metaphyſics, the power of executing any work or labour; in contradiſtinction to *ſpeculative* powers, or the powers of ſeeing, hearing, remembering, judging, reaſoning, &c. The exertion of active power, we call action; and as every action produces ſome change, ſo every change muſt be cauſed by ſome effect, or by the ceſſation of ſome exertion of power. That which produces a change by the exertion of its power, we call the cauſe of that change; and the change produced, the effect of that cauſe.

ACTIVE *principles*, in chymiſtry, are thoſe which are ſuppoſed to act of themſelves, and do not need to be put in action by others. Salt, ſulphur, and mercury, are uſually conſidered by the chymiſts as active principles: and phlegm and earth as paſſive ones. Mr. Homberg, and ſome late chymiſts after him, only make one active principle, viz. ſulphur, or fire, which they take to be the ſource or principle of all the motion and action of the univerſe. The term active principles, ſays Dr. Quincy, has been uſed to expreſs certain diviſions of matter, that are, by ſome particular modifications, comparatively active in reſpect of others. ſuch are ſpirit, oil, and ſalt, whoſe parts are better fitted for motion than thoſe of earth and water; but with how much impropriety will eaſily appear. For, in a ſtrict ſenſe, all motion in matter is rather paſſion; and there is no active principle, unleſs we thus call the known powers of gravitation, attraction, and repulſion, on which the Newtonian philoſophy is founded: ſo that, let bodies exiſt under what modification ſoever, there can be no alteration made of theſe univerſal properties. Hence the diviſion of matter into what, for diſtinction ſake, may be called *ſpirit*, does not give it any properties inconſiſtent with this general law.

ACTIVE, in grammar, denotes a word having a ſignification that ſerves to explain or denote an action. Thus we ſay, a verb active, a conjunction active, &c. or an active participle.

ACTIVE *verbs* are ſuch as do not only ſignify doing, or acting, but have alſo nouns following them, to be the ſubject of the action or impreſſion. Thus *to love*, *to teach*, are verbs active; becauſe we can ſay, *to love a thing*, *to teach a man*.

Verbs *neuter* alſo denote an action, but are diſtinguiſhed from verbs active in that they cannot have a noun following them. Such are *to ſleep*, *to go*, &c.

Some grammarians, however, make three kinds of verbs active: the *tranſitive*, where the action paſſes into a ſubject different from the agent; *reflected*, where the action returns upon the agent, and *reciprocal*, where the action turns mutually upon the two agents who produced it. See Treatiſe on GRAMMAR, Part I. Chap. II. and Part II. Chap. I. Art. V.

ACTIVITY, the power of acting, or the active faculty. The activity of fire exceeds all imagination. The activity of an acid, a poiſon, &c. Bodies, according to Sir Iſaac Newton, derive their activity from the principles of attraction.

The ſphere of ACTIVITY *of the body*, is the ſpace which ſurrounds it, ſo far as its efficacy or virtue extends to produce any ſenſible effect.

ACTON *Water*, a purging water in a town ſo called near London, noted for the pungency of its ſalt. Its colour is whitiſh; its taſte ſweetiſh, with a mixture of the ſame bitter which is in the Epſom water. Its ſalt is not quite ſo ſoft, and is more calcareous than that of the Epſom water, being more of the nature of the ſalt of lime: it is, however, more nitrous than the other. A quantity of it being boiled high, and mixed with a ſolution of ſublimate in pure water, throws down a yellow ſediment. It ſtrikes a deep red or purple with the tincture of log wood in brandy, as is uſual with nitrous ſalts. It does not precipitate ſilver out of the ſpirit of nitre, as common ſalt does: a pint and a half of the water yields forty-eight grains of ſalt. See Allen's Hiſtory of Purging Waters.

ACTOR, in general, ſignifies a perſon who acts or performs ſomething. Actor, among civilians, is the proctor or advocate in civil courts or cauſes: as, *actor eccleſiæ* has been ſometimes uſed for the advocate of the church; *actor dominicus* for the lord's attorney; *actor villæ*, the ſteward or head bailiff of a village.

ACTOR, in the drama, is a perſon who repreſents ſome part or character upon the theatre. The drama conſiſted originally of nothing more than a ſimple chorus, who ſung hymns in honour of Bacchus; ſo that the primitive actors were only ſingers and muſicians. Theſpis was the firſt who, in order to eaſe this unformed chorus, introduced a declaimer, who repeated ſome heroic or comic adventure. Æſchylus, finding a ſingle perſon tireſome, attempted to introduce a ſecond, and changed the ancient recitals into dialogues. He alſo dreſſed his actors in a more majeſtic manner, and introduced the *cothurnus*, or buſkin. Sophocles added a third, in order to repreſent the various incidents in a more natural manner: and here the Greeks ſtopped; at leaſt we do not find in any of their tragedies above three perſons in the ſame ſcene. Perhaps they looked upon it as a rule of the dramatic poem, never to admit more than three ſpeakers at a time on the ſtage; a rule which Horace has expreſſed in the following verſe:

Nec quarta loqui perſona laboret.

This, however, did not prevent their increaſing the number of actors in comedy. Before the opening of a play, they named their actors in full theatre, together with the parts they were to perform. The ancient actors were maſked, and obliged to raiſe their voices extremely, in order to make themſelves heard by the innumerable crowd of people who filled the amphitheatres: they were accompanied with a player on the flute, who played a prelude, gave them the tone, and played while they declaimed. Horace ſpeaks of a kind of ſecondary actors, in his time, whoſe buſineſs was to imitate the firſt; and leſſen themſelves, to become better foils to their principals. The moderns have introduced an infinite number of actors upon the ſtage. This heightens the trouble and diſtreſs that ſhould reign there, and makes a diverſity, in which the ſpectator is ſure to be intereſted. Actors were highly honoured at Athens. At Rome they were deſpiſed; and not only denied all rank among the citizens, but even when any citizen appeared upon the ſtage, he was expelled his tribe, and deprived of the right of ſuffrage by cenſors. Cicero, indeed, eſteems the talents of Roſcius; but he values his virtues ſtill more; virtues which diſtinguiſhed him ſo remarkably above all others of his profeſſion, that they ſeemed to have excluded him from the theatre. The French have, in this reſpect, adopted the ideas of the Romans; and the Engliſh thoſe of the Greeks.

ACTRESS, in a general ſenſe, as well as in the drama in particular, is a female who acts or performs ſomething. Women actors were unknown to the ancients, among whom men always performed the female characters; and hence one reaſon for the uſe of maſks among them. Actreſſes are ſaid not to have been introduced on the Engliſh ſtage till after the reſtoration of King Charles II. who has been charged with contributing to the corruption of our manners by importing this uſage from abroad. But this can be but partly true: the queen of James I. acted a part in a paſtoral; and Prynn, in his Hiſtriomaſtix, ſpeaks of women actors in his time as whores; which was one occaſion of the ſevere proſecution brought againſt him for that book. There are ſome very agreeable and beautiful talents, for which the poſſeſſion commands a certain ſort of admiration; but of which the exerciſe, for the ſake of gain, is conſidered, whether from reaſon or prejudice, as a ſort of public proſtitution. The pecuniary recompence, therefore, of thoſe who exerciſe them in this manner, muſt be ſufficient, not only to pay for the time, labour, and expence of acquiring the talents, but for the diſcredit which attends the employment of them as the means of ſubſiſtence. The exorbitant rewards of players, opera-ſingers, opera dancers, &c. are founded upon theſe two principles; the rarity and beauty of the talents, and the diſcredit of employing them in this manner. It ſeems abſurd, at firſt ſight, that we ſhould deſpiſe their perſons, and yet reward their talents with the moſt profuſe liberality. While we do the one, however, we muſt of neceſſity do the other. Should the public opinion or prejudice ever alter with regard to ſuch occupations, their pecuniary recompence would quickly diminiſh. More people would apply to them, and the competition would quickly reduce the price of their labour. Such talents, though far from being common, are by no means ſo rare as is imagined. Many people poſſeſs them in great perfection, who diſdain to make this uſe of them; and many more are capable of acquiring them, if any thing could be made honourably by them.

ACTUAL, ſomething that is real and effective; or that exiſts truly and abſolutely. In philoſophy, we ſay actual heat or cold, in oppoſition to *virtual* or *potential*. Actual heat, conſidered actively, is the act of producing heat: paſſively taken, it is the quality whereby a body is denominated hot. Virtual or potential heat, actively taken, is the power or faculty of producing heat; paſſively taken, it ſhould be the power or faculty of being heated, or receiving actual heat.

In medicinal language, actual is alſo oppoſed to *potential*, and is applied to any thing endued with a quality which operates by an immediate power inherent in it. For example: a red-hot iron, or fire, is called an actual cautery, in contradiſtinction to cauteries, which have a power of producing the ſame effects on animal ſolids as actual fire; and which are called potential cauteries, or cauſtics. Boiling water is actually hot, and brandy is potentially hot.

ACTUATE, to bring into act, or put a thing into action. Thus an agent is ſaid, by the ſchoolmen, to actuate a power, when it produces an act in a ſubject. And thus the mind may be ſaid to actuate the body.

ACULEATE, ACULEATED, ſomething that has aculei, or prickles. Naturaliſts divide fiſhes into thoſe with aculeated and non-aculeated fins. Phil. Tranſ. No. 204.

ACULEI, among botaniſts, &c. denote the prickles or ſpines of plants of the thorny kind. The word is Latin, formed from *acus*, a needle.

Among zoologiſts, aculeus is alſo uſed for the ſting of a bee, ſcorpion, or the like. The word aculeus is alſo uſed for certain parts of the echini marini.

ACUTE, ſharp, ſomething that terminates in a point, or edge; diſpoſed either for piercing or cutting. In this ſenſe the word uſually ſtands oppoſed to obtuſe,

ACUTE *angle*, in geometry, is that whoſe three angles are all angle; or which does not ſubtend 90 degrees.

ACUTE-*angled triangle*, is that which is leſs than a right acute. See the Syſtem of GEOMETRY, Part I. Sect. I.

ACUTE *diſeaſes*, ſuch as come ſuddenly to a criſis. This term is uſed for all diſeaſes which do not fall under the head of chronic diſeaſes.

ACUTE, in muſic, is underſtood of a ſound, or tone, which is ſharp, ſhrill, or high, in reſpect of ſome other. In this ſenſe the word ſtands oppoſed to grave; and both theſe properties of ſound depend on the quickneſs or ſlowneſs of the vibrations by which they are produced. Sounds conſidered as acute and grave, that is, in the relation of gravity and acuteneſs, conſtitute what we call tune, the foundation of all harmony. See the SYSTEM, Part I. Sect. I.

ACUTE *accent*, in grammar. See ACCENT.

AD, a Latin preposition, originally ſignifying *to*, and frequently uſed in compoſition, both with and without the *d*, to expreſs the relation of one thing to another.

AD *Hominem*, in logic, a kind of argument, drawn from the principles or prejudices of thoſe with whom we argue.

AD *Valorem*, a term chiefly uſed in ſpeaking of the duties or cuſtoms paid for certain goods. The duties on ſome articles are paid by the number, weight, meaſure, tale, &c. and others are paid *ad valorum*; that is, according to their value.

ADAGE, a proverb, or ſhort ſentence, containing ſome wiſe obſervation, or popular ſaying, Eraſmus has made a very large and valuable collection of the Greek and Roman adages; and Mr. Ray has done the ſame with regard to the Engliſh. We have alſo Kelly's Collection of Scots Proverbs.

ADAGIO, in muſic, one of the words uſed by the Italians to denote a degree or diſtinction of time. Adagio expreſſes a ſlow time; the ſloweſt of any, except grave. Uſed ſubſtantively, it ſignifies a ſlow movement. Sometimes this word is repeated, as *adagio adagio*, to denote a ſtill greater retardation in the time of the muſic.

ADANSONIA, ETHIOPIAN SOUR GOURD, MONKIES BREAD, or AFRICAN CALABASH TREE, a Genus of the Monodelphia order, belonging to the Polyandria claſs of plants. There is but one known ſpecies belonging to this genus, the *baobab*, which is perhaps the largeſt production of the whole vegetable kingdom. It is a native of Africa. The trunk is not above twelve or fifteen feet high, but from ſixty to ſeventy feet round. The loweſt branches extend almoſt horizontally; and as they are about ſixty feet in length, their own weight bends their extremities to the ground, and thus form an hemiſpherical maſs of verdure of about one hundred and twenty, or one hundred and thirty feet diameter. The roots extend as far as the branches: that in the middle forms a pivot, which penetrates a great way into the earth; the reſt ſpread near the ſurface. The flowers are in proportion to the ſize of the tree; and are followed by an oblong fruit, pointed at both ends, about ten inches long, five or ſix broad, and covered with a kind of greeniſh down, under which is a ligneous rind, hard, and almoſt black, marked with rays which divide it lengthwiſe into ſides. It is very common in Senegal, and the Cape de Verd Iſlands; and is found one hundred leagues up the country at Gulum, and upon the ſea coaſts as far as Sierra Leona.

The age of this tree is no leſs remarkable than its enormous ſize. Mr. Adanſon relates, that, in a botanical excurſion to the Magdalene Iſlands, he diſcovered ſome calabaſh trees, from five to ſix feet diameter, on the bark of which were engraved, or cut to a conſiderable depth, a number of European names. Two of theſe names, which he was at the trouble to repair, were dated one the fourteenth, the other the fifteenth century. The inſcribed trees, mentioned by this ingenious Frenchman, had been ſeen in 1555, almoſt two centuries before, by Thevet, who mentions them in the relation of his voyage to Terra Antarctica, or Auſtralis. Adanſon ſaw them in 1749. The virtues and uſes of this tree and its fruits are various. The negroes of Senegal dry the bark and leaves in the ſhaded air; and then reduce them to powder, which is of a pretty good green colour. This powder they preſerve in bags of linen or cotton, and call it *lalo*. They uſe it every day, putting two or three pinches of it into a meſs, whatever it happens to be, as we do pepper and ſalt: but their view is, not to give a reliſh to their food, but to preſerve a perpetual and plentiful perſpiration, and to attemper the too great heat of the blood; purpoſes which it certainly anſwers, as ſeveral Europeans have proved by repeated experiments; preſerving themſelves from the epidemic fever, which, in that country, deſtroys Europeans like the plague, and generally rages during the months of September and October, when, the rains having ſuddenly ceaſed, the ſun exhales the water left by them upon the ground, and fills the air with a noxious vapour. M. Adanſon, in that critical ſeaſon, made a light ptiſan of the leaves of the baobab, which he had gathered in the Auguſt of the preceding year, and had dried in the ſhade; and drank conſtantly about a pint of it every morning, either before or after breakfaſt, and the ſame quantity of it every evening, after the heat of the ſun began to abate: he alſo ſometimes took the ſame quantity in the middle of the day, but this was only when he felt ſome ſymptoms of an approaching fever. By this precaution he preſerved himſelf, during the five years he reſided at Senegal, from the diarrhœa and fever, which are ſo fatal there, and which are, however, the only dangerous diſeaſes of the place; while other officers ſuffered very ſeverely, only one excepted, upon whom M. Adanſon prevailed to uſe this remedy, which for its ſimplicity was deſpiſed by the reſt. This ptiſan alone prevents that heat of urine which is common in theſe parts, from the month of July to November, provided the perſon abſtains from wine. The fruit is not leſs uſeful than the leaves and the bark. The pulp that envelopes the ſeeds has an agreeable acid taſte, and is eaten for pleaſure: it is alſo dried and powdered, and thus uſed medicinally in peſtilential fevers, the dyſentery, and bloody flux; the doſe is a drachm, paſſed through a fine ſieve, taken either in common water, or in an infuſion of the plantain. This powder is brought into Europe, under the name of *terra ſigillata lemnia*. The woody bark of the fruit, and the fruit itſelf, when ſpoiled, helps to ſupply the negroes with an excellent ſoap, which they make by drawing a ley from the aſhes, and boiling it with palm-oil that begins to be rancid. The trunks of ſuch of theſe trees as are decayed, the negroes hollow out into burying places for their poets, muſicians, and buffoons. Perſons of theſe characters they eſteem greatly while they live, ſuppoſing them to derive their ſuperior talents from ſorcery, or a commerce with demons; but they regard their bodies with a kind of horror when dead, and will not give them burial in the uſual manner, neither ſuffering them to be put into the ground, nor thrown into the ſea or any river, becauſe they imagine that the water would not then nouriſh the fiſh, nor the earth produce its fruits. The bodies ſhut up in theſe trunks become perfectly dry without rotting, and form a kind of mummies without the help of embalmment. The baobab is very diſtinct from the calabaſh-tree of America, with which it has been confounded by father Labat.

ADAR, in the Hebrew chronology, is the twelfth month of their eccleſiaſtical year, and the ſixth of their civil year. It contains only nine and twenty days, and anſwers to our February, and ſometimes enters into the month of March, according to the courſe of the moon. On the ſeventh and thirteenth days of this month the Jews obſerve two faſts; the former on account of the death of Moſes; and the latter, called that of Eſther, in commemoration of the affair of Haman. The feaſt of *purim* is celebrated on the fourteenth day. Eſther ix. 17.

ADDER. The Engliſh name of the Genus Coluber in amphibiology. See COLUBER.

ADDITION, the act of joining one thing to another, or of augmenting a thing by the acceſſion of others.

ADDITION, in arithmetic, is the firſt of the four fundamental rules, or operations, of that art. Addition conſiſts in finding the amount of ſeveral numbers, or quantities, ſeverally added one to another. Or, addition is the invention of a number, from two or more homogeneous ones given, which is equal to the given numbers taken jointly, or together. For a full and practical explanation of this rule, ſee the SYSTEM. Chap. II. Sect. I.

ADDITION *of numbers of different denominations*, for inſtance, of pounds, ſhillings, and pence, is performed by adding or ſumming up each denomination by itſelf, always beginning with the loweſt; and if, after the addition, there is enough to make one of the next higher denomination, for inſtance, pence enough to make one or more ſhillings, they muſt be added to the figures of that denomination, that is, to the ſhillings; only reſerving the odd remaining pence to be put down in the place of pence. See the SYSTEM, Chap. III. Sect. I.

ADDITION *of decimals* is performed after the ſame manner as that of whole numbers. See the Syſtem of ARITHMETIC, Chap. V. Sect. III.

ADDITION, in algebra, or the addition of ſpecies, is performed by connecting the quantities to be added, by their proper ſigns; and alſo by uniting into one ſum thoſe that can be ſo united. See the SYSTEM, Sect. I.

ADDITION, in muſic. The note or mark of addition is a dot placed on the right ſide of a note, to ſignify, that the time of the ſound of ſuch note is to be lengthened half as much more as it would otherwiſe be. Thus a ſemibreve, when marked with a dot, is to be as long as three minims; the minim, with the like dot, to be as long as three crotchets; the crotchet, as three quavers, &c.

ADDITION, in diſtilling, is a name given to ſuch things as are added

added to the wash, or liquor, while in a state of fermentation, in order to improve the vinosity of the spirit, procure a larger quantity of it, or give it a particular flavour. All things, of whatever kind, thus added in the time of fermentation, are called by those of the business, who speak most intelligently, additions; but many confound them with things of a very different nature, under the name of ferments. The additions used in the distillery may be reduced to four general heads. 1. Salts. 2. Acids. 3. Aromatics. 4. Oils. A little tartar, nitre, or common salt, finely powdered, may be added to the liquor while fermenting, especially in the beginning of the operation; or in their stead, a little of the vegetable, or finer mineral acids, may be dropped in at different times, when found necessary. These are of great use, especially in the fermenting solutions of treacle, honey, and the like sweet and rich vegetable juices, which either wholly want an acid in themselves, or have it in too small a proportion, or have been robbed or divested of it. The proper acids for this purpose are, the juice of Seville oranges, or lemons, or the spirit of sulphur, or Glauber's spirit of salt, or, what is greatly preferable to all these, a particular aqueous solution of tartar, a succedaneum for which may be tamarinds, or the robs of some very acid fruits, or the *media substantia vini*. On this foundation stands that ingenious practice of using a suitable proportion of the still bottoms, or the remaining wash, in the subsequent brewing. After the same manner, a very considerable quantity of any essential vegetable oil may, by proper management, be converted into a surprising large quantity of inflammable spirit; but great care in this case must be had not to drop it in too fast, nor too much at a time, as this might damp the fermentation; and, indeed, the adding a large quantity of oil at once is the common way of stopping the fermentation at any point required. The best method of introducing the oil, so as to avoid all inconvenience, is to reduce it first to an elæosaccharum, by grinding it in a mortar, with a due quantity of fine sugar in powder. The oil thus added, with its particles disunited and in form of powder, will readily mix with the liquor, and immediately ferment with it. A large proportion of rectified spirit, or of any other spirit, may, by prudent management, be also introduced into the fermenting liquor; and this will always come back with a larger addition to the quantity of spirit, that would otherwise have arisen from the distillation. Shaw.

ADDRESS, in a general sense, is used for skill and good management, and of late has been adopted from the French, and is used in genteel phrase, and also in commerce, as synonymous with direction to a person or place. The word is formed of the French verb *addresser*, to direct any thing to a person. Address means also a discourse presented to the king, in the name of a considerable body of his people, to express or notify their sentiments of joy, satisfaction, or the like, on some extraordinary occasion. We say the lords' address, the commons' address. Addresses were first set on foot under the administration of Oliver Cromwell. At Paris, their office of intelligence is called *bureau d'addresse*.

ADDUCENT *Muscles*, or *Adductors*, are those which bring forward, close, or draw together, the parts of the body whereto they are annexed. Such as the adductor pollicis, adductor pollicis pedis, adductor indicis, &c. For the origin, insertion, and uses of these several muscles, see the System of Anatomy. Table of Muscles, Art. 23 and 27, Plate II. *Fig.* 1.

ADENOGRAPHY is that branch of anatomy which describes the glands, and the glandular parts of the body. The word is compounded of αδην, gland, and γραφω, I describe. Adenography is the same with what some others call *adenology*, or the adenological part of anatomy. See the Introduction to the System, No. III.

ADEPS, among physicians, *fat*. This is an animal oil, secreted from the blood, and contained in the *membrana adiposa*, or, as Boerhaave calls it, the *membrana cellulosa*; which is not a single membrane, but a congeries of a great number of membranous, laminæ, joined irregularly to each other at different distances, so as to form numerous interstices of different capacities, which communicate with each other. These interstices have been named cellulæ, and the substance made up of them, the cellulous substance. These cellular interstices are so many little bags or satchels, filled with an unctuous or oily juice, more or less liquid, which is called fat; the different consistence of which depends not only on that of the oily substance, but on the size, extent, and subdivision of the cells.

Neumann divides fats, from their consistence, into three kinds. The first, called *pinguedo*, is soft and thin, and becomes liquid in a very small heat; such is that which we meet with in birds, reptiles, and fishes, (the very large fishes excepted.) The second is thick, liquifies less readily, and is denominated *axungia*. The third is more hard and firm: when taken from the animal it is called *adeps*; and when freed from the skins, &c. *sevum*. The two last kinds of fat are chiefly found in quadrupeds. In some parts of the body, the fat serves for a cushion, pillow, or matrass; (as on the *nates*, where the laminæ and cells are very numerous. In other parts this membrane has few or no laminæ, and consequently little or no fat; as on the forehead, elbows, &c. In the young fœtus there is scarce any fat; but in the older fœtus, fat begins to appear. When the child is born, and for some years after, it hath much fat immediately beneath the skin. In men, the fat is most abundantly spread on the glutei muscles. See the Articles Corpulency, Fat, and the System of Anatomy, Part II. Sect. I. Art. VIII. Fats taken freely as food, are difficult of digestion; relax and weaken the tone of the stomach and intestines, and are supposed likewise to render the juices tenacious, and to increase the bile. The medical virtues of fats, as manifested by experience, are such as arise from their use in external applications, for softening and suppling, for abating pains and spasms, and for promoting maturation. Those that are principally used are the fat of vipers, hog's lard, and mutton suet.

ADEPTS, a denomination given to the professors in alchemy; particularly to those who pretend to the secrets of the philosopher's stone, and the universal medicine. The word is formed from the verb *adipisci*, to obtain. Ripley, Lulley, Paracelsus, Helmont, Hollandus, Sendivoglus, &c. are the principal among the adepti. It is a sort of tradition among the alchemists, that there are always twelve adepti; and that their places are immediately supplied by others, whenever any of the fraternity die.

The term adepts is sometimes more generally applied to those who are proficients in any kind of science.

ADEQUATE, something equal to, or co-extended with, another; and filling the whole measure and capacity thereof. In this sense the word stands opposed to *inadequate*.

ADES, or Hades, ἅδης, from α and ἰδω, denotes the invisible state. In the heathen mythology it comprehends all those regions that lie beyond the river Styx, viz. Erebus, Tartarus, and Elysium. See Hell.

ADFECTED *equation*, is that where the unknown quantity is found in two or more different degrees or powers. For the definitions, resolutions, and construction of Equations in Algebra, see the System, Sect. V. and VI.

ADHESION, Adherence, in physics, the state of two bodies which are joined or fastened to each other, either by the mutual impression of their own parts, or the compression of external bodies. See Cohesion.

The word is compounded of *ad*, to, and *herere*, to stick. Anatomists sometimes observe prosphyses, or adhesions of the lungs to the side of the thorax, the pleura, and diaphragm, which give occasion to various disorders. We also read of adhesions of the dura mater to the oranium; of the stone to the bladder; though some consider this last as a chimera: at least the instances of it appear to be rare. We have also several cases of adhesions of the intestines, mentioned in the Philosophical Transactions, Number 481.

The adhesions of two polished planes, and two hemispheres, are phenomena urged in behalf of the weight and pressure of the atmosphere. The argument drawn from the adhesion of two polished planes, urged in behalf of the weight and pressure of the atmosphere, might be objected to, as this pressure is not sufficient to produce the effect, and that polished bodies will adhere very strongly, even in an exhausted receiver. However, it is certain, that the air contributes in part to this adhesion. Dr. Desaguliers has given experiments of the adhesion of leaden bullets to each other: the cause of which is resolved into the principle of attraction. Phil. Trans. N° 389.

Adhesion, or Adherence, is also used for the persisting in a former opinion or resolution. After the free conference between the two houses, concerning the bill for preventing occasional conformity, when the lords retired, and it came to the final vote of adhering, they were so equally divided, that, in three questions put to different heads, the adhering was carried but by one vote in every one, and by a different person each time. The commons likewise adhered; and thus the bill was lost.

ADIAPHOROUS, Adiaphorus, is a name given by Mr. Boyle to a kind of spirit distilled from tartar, and some other vegetable bodies; and which is neither acid, vinous, or urinous; but in many respects different from any other sort of spirit.

ADJECTIVE, in grammar, a kind of noun joined with a substantive, either expressed or implied to shew its qualities or accidents. The word is formed of the Latin *adjicere*, to add to; as designed to be added to a substantive, without which it has no precise signification. See the Treatise on Grammar, Part I. Chap. III. Art. IV.

ADJOURNMENT, in law, the putting off a court or meeting, and appointing it to be kept at another time or place. The word is formed of the Latin *ad*, to; and the French *jour*, day, q. d. another day. In which sense, we meet with the phrase adjournment in eyre, for an appointment of a day when the justices in eyre intend to sit again. Adjournments in parliament differ from prorogations; and each house has the privilege of adjourning itself.

ADIPOSUS, fat, or fatty. The word is chiefly used in anatomy, as an epithet of certain cells, ducts, membranes, and vessels, e. g. *membrana & vasa adiposa*, *cellulæ adiposæ ductus adiposi*, &c. See Adeps.

ADJUNCT, among philosophers, signifies something added to another, without being any necessary part of it. Thus water absorbed

abſorbed by cloth or a ſponge, is an adjunct, but no neceſſary part of either of theſe ſubſtances.

ADJUNCT, in metaphyſics, ſome quality belonging to either the body or mind, whether natural or acquired. Thus, thinking is an adjunct of the mind, and growth an adjunct of the body. In ethics, we uſually reckon ſeven adjuncts, popularly called *circumſtances*; *quis, quid, ubi, quibus, auxiliiis, cur, quomodo, quando*. Adjunct, in muſic, is a word which is employed to denominate the connexion or relation between the principal mode and the modes of its two-fifths, which, from the intervals that conſtitute the relation between them and it, are called its adjuncts. Adjunct is alſo uſed to ſignify a colleague, or ſome perſon aſſociated with another as an aſſiſtant. Adjuncts, in rhetoric and grammar, ſignify certain words or things added to others, to amplify or augment the force of the diſcourſe.

ADJUTANT, in the military profeſſion, is an officer in the army, whoſe buſineſs is to aid and aſſiſt the major. Adjutant is the ſame that we otherwiſe call *aid-major*. In the cavalry, each regiment has an adjutant, and in the infantry, each battalion. The adjutant receives the orders every night from the brigade-major, which, after he has carried to the colonel, he delivers out to the ſerjeants. Where detachments are to be made, he gives the number each company muſt furniſh, and aſſigns the hour and place of rendezvous. He alſo places the guards, receives and diſtributes ammunition to the companies, and, by the major's orders, regulates the price of bread, beer, &c. Adjutant is ſometimes uſed by the French for an aid-de-camp. See the Treatiſe on MILITARY AFFAIRS, Sect. IV.

ADMINISTRATION imports the government or direction of affairs, and particularly the exerciſe of diſtributive juſtice. Princes confide the adminiſtration of public affairs to their miniſters. Civil wars are uſually raiſed on pretence of mal-adminiſtration, or of abuſes committed in the exerciſe of juſtice, &c. The two criterions of a good adminiſtration in England, according to Trenchard, are, the keeping the nation out of foreign broils, and paying off the public debts; the latter of which depends on the former.

ADMINISTRATION, in the Engliſh law, ſignifies the act or office of an adminiſtrator, in managing and diſpoſing of a man's goods, or eſtate, that died inteſtate, or without any will, with an intent to give an account thereof. In this caſe, inſtruments, or powers, called letters of adminiſtration, are taken out in the prerogative court. On granting adminiſtration, bonds with ſureties are to be taken for the adminiſtrator, to make and exhibit an inventory of the goods of the deceaſed, to render a juſt account thereof, and to make a diſtribution of the ſurpluſage after the debts are paid, according to law, &c. Stat. 22 and 23 Car. II. cap. 10. See ADMINISTRATOR, EXECUTOR, INTESTATE.

ADMINISTRATOR, in law, is he to whom the ordinary commits the adminiſtration of the goods of a perſon deceaſed, in default of an executor. An action lies for or againſt an adminiſtrator, as for or againſt an executor; and he ſhall be accountable to the value of the goods of the deceaſed, and no farther; unleſs there be waſte, or other abuſe chargeable on him. If the adminiſtrator dies, his executors are not adminiſtrators; but the court is to grant a new adminiſtration. If a ſtranger, who is neither adminiſtrator or executor, takes the goods of the deceaſed, and adminiſters, he ſhall be charged and ſued as an executor, not as an adminiſtrator. The origin of adminiſtrators is derived from the civil law. Their eſtabliſhment in England is owing to a ſtatute made in the thirty-firſt year of Edward III. Till then no office of this kind was known, beſide that of executor; in caſe of a want of which, the ordinary had the diſpoſal of goods of perſons inteſtate, &c. There are divers ſorts of adminiſtrators. If a woman have goods thus committed to her charge, or adminiſtration, ſhe is called *adminiſtratrix*; and is accountable, &c. in like manner as an adminiſtrator.

ADMINISTRATOR is alſo uſed for a prince who enjoys the revenue of a ſecariſed biſhoprick. Yet this title does not hold univerſally: the king of England, as elector of Brunſwick Lunenburg, for inſtance, is not called adminiſtrator, but Duke of Bremen and Verden; and the king of Pruſſia is not adminiſtrator, but Duke of Magdeburg, and Prince of Halberſtadt. Adminiſtrator is alſo uſed for the regent or protector of a kingdom, during the minority of its proper prince, or even a vacancy of the throne. The pope pretends to the adminiſtration of the empire during the vacancy by cenſure or ſuſpenſion.

ADMIRAL is a great officer or magiſtrate, who has the government of a navy, and the hearing of all maritime cauſes. Authors are divided with regard to the origin and denomination of this important officer, whom we find eſtabliſhed in moſt kingdoms that border on the ſea. But the moſt probable opinion is that of Sir Henry Spelman, who thinks, that both the name and dignity were derived from the Saracens, and, by reaſon of the holy wars, brought amongſt us; for admiral, in the Arabian language, ſignifies a prince, or chief ruler, and was the ordinary title of the governors of cities, provinces, &c. and therefore they called the commander of the navy by that name, as a name of dignity and honour. Indeed, there are no inſtances of admirals in this part of Europe before the year 1284, when Philip of France, who had attended St. Lewis in the wars againſt the Saracens, created an admiral. Du Cange aſſures us, that the Sicilians were the firſt and the Genoeſe the next, who gave the denomination of admiral to the commanders of their naval armaments; and that they took it from the Saracen and Arabic *emir*, a general name for every commanding officer. As for the exact time when the word was introduced among us, it is uncertain; ſome think it was in the reign of Edward I. Sir Henry Spelman is of opinion that it was firſt uſed in the reign of Henry III. becauſe neither the laws of Oleron, made in 1266, nor Bracton, who wrote about that time, make any mention of it; and that the term admiral was not uſed in a charter in the eighth of Henry III. wherein he granted this office to Richard de Lacey, by theſe words, *Maritimam Angliæ*; but in the 56th year of the ſame reign, not only the hiſtorians, but the charters themſelves, very frequently uſe the word admiral. Anciently there were generally three or four admirals appointed in the Engliſh ſeas, all of them holding the office *durante bene placito*; and each of them having particular limits under their charge and government; as admirals of the fleet of ſhips, from the mouth of the Thames, northward, ſouthward, or weſtward. Beſides theſe, there were admirals of the Cinque Ports, as in the Reign of Edward III. when one William Latimer was ſtyled *Admiralis Quinque Portuum*; and we ſometimes find that one perſon has been admiral of the fleets to the ſouthward, northward, and weſtward; but the title of *Admiralis Angliæ* was not frequent till the reign of Henry IV. when the king's brother had that title given him, which in all commiſſions afterwards was granted to the ſucceeding admirals. It may be obſerved, that there was a title above that of admiral of England, which was, *Locum-tenens Regis ſuper Mare*, the king's lieutenant-general of the ſea. This title we find mentioned in the reign of Richard II. Before the word admiral was known the title of *Cuſtos Maris* was made uſe of.

Lord High ADMIRAL *of England*, in ſome ancient records called *Capitanus Maritimarum*, is an officer of great antiquity and truſt, as appears by the laws of Oleron, ſo denominated from the place they were made at by Richard I. The firſt title of Admiral of England, expreſsly conferred upon a ſubject, was given by a patent of Richard II. to Richard Fitz-Allen, junior, Earl of Arundel and Surrey; for thoſe who before enjoyed this office where ſimply termed admirals, though their juriſdiction ſeems as large, eſpecially in the reign of Edward III. when the court of admiralty was firſt erected. This great officer has the management of all maritime affairs, and the government of the royal navy, with power of deciſion in all maritime caſes, both civil and criminal. He judges of all things done upon or beyond the ſea, in any part of the world; upon the ſea-coaſts; in all ports and havens, and upon all rivers below the firſt bridge from the ſea. By him, vice-admirals, rear-admirals, and all ſea-captains, are commiſſioned; all deputies for particular coaſts; and coroners to view dead bodies found on the ſea-coaſts, or at ſea. He alſo appoints the judges for his court of admiralty, and may impriſon, releaſe, &c. All ports and havens are *infra corpus comitatus*, and the admiral hath no juriſdiction of any thing done in them. Between high and low water-mark, the common-law and the high-admiral have juriſdiction by turns, one upon the water, and the other upon the land. The lord-admiral has power, not only over the ſeamen ſerving in his ſhips of war, but over all other ſeamen, to arreſt them for the ſervice of the ſtate; and if any of them run away without leave of the admiral, he hath power to make a record thereof, and certify the ſame to the ſheriffs, mayors, bailiffs, &c. who ſhall cauſe them to be apprehended and impriſoned. To the lord high-admiral belong all penalties and amercements of all tranſgreſſions at ſea, on the ſea ſhore, in ports and havens, and all rivers below the firſt bridge, from the ſea; the goods of pirates and felons condemned or enſlaved, ſea-wrecks, goods floating on the ſea, or caſt on the ſhore (not granted to lords of manors adjoining to the ſea,) and a ſhare of lawful prizes; alſo all great fiſhes, commonly called royal fiſhes, except whales and ſturgeons: to which add a ſalary of 7000l. a-year. In ſhort, this is ſo great an office, in point of truſt, honour and profit, that it has been uſually given to princes of the blood, or the moſt eminent perſon among the nobility. We have had no high admiral for ſome years; the office being put in commiſſion, or under the adminiſtration of the lords commiſſioners of the admiralty, who, by ſtatute, have the ſame power and authority as the lord high admiral.

Lord High ADMIRAL *of Scotland* is one of the great officers of the crown, and ſupreme judge in all maritime caſes within that part of Britain.

ADMIRAL alſo implies the commander in chief of any ſingle fleet or ſquadron; or, in general, any flag officer whatever. The commander of a fleet carries his flag at the main-top-maſt head. Thus we ſay, the admiral of the red, the admiral of the white, the admiral of the blue. See SQUADRON.

Vice ADMIRAL is the commander of the ſecond ſquadron, and carries his flag at the fore-top-maſt head.

Rear ADMIRAL is the commander of the third ſquadron, and carries his flag at the mizen-top-maſt head.

Vice ADMIRAL is alſo an officer appointed by the lords commiſſioners of the admiralty. There are ſeveral of theſe officers eſtabliſhed in different parts of Great Britain, with judges and marſhals

tials under them, for executing jurisdiction within their respective limits. Their decrees, however, are not final, an appeal lying to the court of admiralty in London.

ADMIRAL is likewise the name of a principal vessel of a fleet, on board of which is the admiral. When two ships of war, bearing the same colours, meet in the same port, that which arrived first has the title and prerogative of admiral; and the other, though of greater strength and rate, shall only be accounted vice-admiral. It is pretty much the same with the vessels in the cod and whale fishery. That which arrives first, in any harbour or creek of Newfoundland, takes the title and quality of admiral, which it retains during the whole fishing season. Such ship may secure to herself so much beech, or flakes, or both, as are necessary for the number of boats she shall use, with an overplus of one boat only more than she uses. The master of the second ship is vice-admiral; and the master of the third, rear-admiral.

ADMIRAL, in conchology, the name given to a very beautiful and precious shell, of the *voluta* kind. See the SYSTEM, Genus. XXIII. Of these the curious reckon four species. 1. The grand-admiral. 2. The vice-admiral. 3. The orange-admiral. And, 4. The extra-admiral. The first of these is the most esteemed, and a single shell has been sold, in Holland, for five hundred florins. It is of a very elegant and bright white enamel, and is variegated with bands of yellow, representing in some degree the colours of the flags of a man of war at sea; hence it obtained its name. It is of a very curious shape, and formed with particular elegance about the head; the clavicle being exerted. There runs along the centre of the large yellow band in this shell a fine denticulated line, which is its distinguishing character. The vice-admiral is an elegant shell, but its head is less beautifully wrought than in the admiral, and its broad band wants the dentated line so remarkable in that. The orange-admiral has more yellow than either of the others. The extra-admiral has the same bands with these, but they run one into another, and form a more mixed clouding.

ADMIRALTY properly signifies the office of lord high-admiral, whether discharged by one single person, or by joint commissioners, called *lords of the admiralty*.

Court of ADMIRALTY is a sovereign court, held by the lord high-admiral, or lords of the admiralty, where cognizance is taken in all maritime affairs, whether civil or criminal. All crimes committed on the high-seas, or on great rivers below the first bridge next the sea, are cognizable in this court only, and before which they must be tried by judge and jury. But in civil cases the mode is different, the decisions being all made according to the civil law. From the sentences of the admiralty-judge an appeal always lays, in ordinary course, to the king in chancery, as may be collected from statute 25 Hen. VIII. c. 19. which directs the appeal from the archbishop's courts to be determined by persons named in the king's commission, "like as in case of appeal from the admiral-court." But this is also expressly declared by statute 8 Eliz. c. 5. which enacts, that, upon an appeal made to the chancery, the sentence definitive of the delegates appointed by commission shall be final. Appeals from the vice-admiralty courts in America, and our other plantations and settlements, may be brought before the courts of admiralty in England, as being a branch of the admiral's jurisdiction, though they may also be brought before the king in council. But in case of prize-vessels, taken in time of war, in any part of the world, and condemned in any courts of admiralty or vice-admiralty as lawful prize, the appeal lies to certain commissioners of appeals, consisting chiefly of the privy council, and not to judges delegates; and this by virtue of divers treaties with foreign nations, by which particular courts are established in all the maritime countries of Europe for the decision of this question, Whether lawful prize or not? for this being a question between subjects of different states, it belongs entirely to the law of nations, and not to the municipal law of either country to determine.

ADMIRATION, in ethics. See PASSIONS, and the Treatise on DRAWING, Sect. VII. and Plate. I.

ADIMRATION, in grammar, a note or character, intimating something worthy to be admired, or wondered at. It is expressed thus (!). See the SYSTEM, Art. II. Chap. IV.

ADMISSION, in the ecclesiastical law, is an act whereby a bishop, upon examination, admits or allows a clerk to be able or competently qualified for the office; which is done by the *formula admitto te habilem*. All persons are to have episcopal ordination before they are admitted to any parsonage or benefice; and if any shall presume to be admitted, not having such ordination, &c. he shall forfeit 100l. Stat. 14. Car. II. No person is to be admitted into a benefice, with cure of 30l. per annum in the king's books, unless he is a bachelor in divinity at least, or a preacher lawfully allowed by some bishop, &c.

ADNATA, in anatomy, is a thick white membrane, investing the ball of the eye, and making the outermost coat thereof; called also *circumossalis* and *circumcalvalis*. It is the *tunica adnata*, that makes what we commonly call the white of the eye; whence it is also called the albuginea. The adnata springs from the *pericranium*. and grows to the exterior part of the *tunica cornea*, serving to connect the whole eye both to the *palpebræ*, and the adjacent bones, and thus keep it fast in the socket; whence it is also called *conjunctiva*. To leave room for the visible species to pass through it, a little round aperture is left in the fore-part, called the sight, through which the *iris* and *pupilla* appear. See the SYSTEM, Part VI. Sect. XI. The adnata abounds with veins an arteries, which, though ordinarily not visible, are conspicuous in ophthalmics, which are properly inflammations of this part.

ADOLESCENCE, ADOLESCENTIA, is the state of growing youth; or that period of a person's age commencing from his infancy, and terminating at his full stature or manhood. The word is formed of the Latin *adolescere*, to grow. The state of adolescence lasts so long as the fibres continue to grow, either in magnitude or firmness. It is commonly computed to be between fifteen and twenty-five, or even thirty, years of age; though in different constitutions its terms are very different. The Romans usually reckoned it from twelve to twenty-five in boys; and to twenty-one in girls, &c. And yet, among their writers, *juvenis* and *adolescens* are frequently used indifferently for any person under forty-five years. The fibres, being arrived at a degree of firmness and tension sufficient to sustain the parts, no longer yield and give way to the efforts of the nutritious matter to extend them: so that their farther accretion is stopped from the very law of their nutrition.

ADONAI, one of the names of God in Scripture. This word signifies properly *my lords*, in the plural number; as *adon* signifies *my lord* in the singular number. The Jews, who, either out of respect or superstition, do not pronounce the name of Jehovah, read Adonai in the room of it, as often as they meet with Jehovah in the Hebrew text. But the ancient Jews were not so scrupulous; there is no law which forbids them to pronounce the name of God. Calmet.

ADONIS, son to Cinyras, king of Cyprus, the darling of the goddess Venus. Among Shakespeare's poems is a long one on the subject of Venus's affection for Adonis. The text of the vulgate in Ezekiel, viii. 14. says, that this prophet saw women sitting in the temple, and weeping for Adonis; but, according to the reading of the Hebrew text, they are said to weep for Temmuz, or the *hidden one*. Among the Egyptians, Adonis was adored under the name of Osiris, the husband of Isis. But he was sometimes called by the name of Ammuz, or Tammuz, *the concealed*, to denote probably his death or burial. The Hebrews, in derision, call him sometimes *the dead*, Psal. cvi. 28. and Lev. xix. 28. because they wept for him, and represented him as one dead in his coffin; and at other times they call him *the image of jealousy*, Ezek. viii. 3. 5. because he was the object of the god Mars's jealousy. The Syrians, Phœnicians and Cyprians call him Adonis; and F. Calmet is of opinion, that the Ammonites and Moabites gave him the name of Baal-peor.

ADONISTS, a sect or party among divines and critics, who maintain, that the Hebrew points ordinarily annexed to the consonants of the word Jehovah, are not the natural points belonging to that word, nor express the true pronunciation of it, but are the vowel points, belonging to the words adonai and elohim, applied to the consonants of the ineffable name Jehovah; to warn the readers, that, instead of the word Jehovah, which the Jews were forbid to pronounce, and the true pronunciation of which had been long unknown to them, they are always to read adonai. They are opposed to Jehovists; of whom the principal are Druſius, Capellus, Buxtorf, Alting, and Reland, who have published a collection of their writings on this subject.

ADOPTION, an act by which any one takes another into his family, owns him for his son, and appoints him for his heir. The custom of adopting was very familiar among the ancient Romans, who had an express formula for it. They first learnt it from the Greeks, among whom it was called *θεσις*, filiation. The Romans had two forms of adoption: the one before the pretor; the other at an assembly of the people, in the times of the commonwealth; and afterwards by a rescript of the emperor. In the first, the natural father addressed himself to the pretor, declaring that he emancipated his son, resigned all his authority over him, and consented he should be translated into the family of the adopter. The latter manner of adoption was practised where the party to be adopted was already free; and this was called adrogation. The person adopted changed all his names; assuming the prename, name, and surname, of the person who adopted him. Besides the formalities prescribed by the Roman law, divers other methods have taken place, which have given denominations to divers species of adoptions, among the Gothic nations in different ages.

ADOPTION *by baptism* is that spiritual affinity which is contracted by god-fathers and god-children in the ceremony of baptism. This kind of adoption was introduced into the Greek church, and came afterwards into use among the ancient Franks, as appears by the Capitulars of Charlemagne. In reality, the god-father was so far considered as adoptive father, that his god-children were supposed to be entitled to a share in the inheritance of his estate. Du Cange.

ADOPTION *by hair*, was performed by cutting off the hair of a person, and giving it to the adoptive father. It was thus that pope John VIII. adopted Boson, king of Arles; which, perhaps,

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is the only inſtance in hiſtory of adoption in the order of eccleſiaſtics; a law that profeſſes to imitate nature, not daring to give children to thoſe in whom it would be thought a crime to beget any.

ADOPTION *by teſtament*, is that performed by adopting a perſon heir by will, on condition of his aſſuming the name, arms, &c. of the adopter. Of which kind we meet with divers inſtances in the Roman hiſtory.

Among the Turks, by the law of Mahomet, adoption is no impediment of marriage. The ceremony of adoption is performed by obliging the perſon adopted to paſs through the ſhirt of the adopter. Hence, among thoſe people, to adopt is expreſſed by the phraſe, *to draw another through my ſhirt*. It is ſaid that ſomething like this has alſo been obſerved among the Hebrews; where the prophet Elijah adopted Eliſha for his ſon and ſucceſſor, and communicated to him the gift of prophecy, by letting fall his cloak, or mantle, on him. But adoption, properly ſo called, does not appear to have been practiſed among the ancient Jews. Adoption is now in moſt countries aboliſhed.

ADOPTION is alſo uſed, in theology, for a federal act of God's free grace; whereby thoſe that are regenerate by faith, are admitted into his houſhold, and intitled to a ſhare in the inheritance of the kingdom of heaven. Adoption is ſometimes alſo uſed, in ſpeaking of the ancient clergy, who had a cuſtom of taking a maid or widow into their houſes, under the denomination of an adoptive or ſpiritual ſiſter, or niece. Du Cange. In eccleſiaſtical writers we find adoptive women or ſiſters, (*adoptivæ fœminæ*, or *ſorores*,) uſed for thoſe handmaids of the ancient clergy, otherwiſe called *ſub-introductæ*.

ADOPTIVE *arms* are thoſe which a perſon enjoys by the gift or conceſſion of another, and to which he was not otherwiſe entitled. They ſtand contradiſtinguiſhed from arms of *alliance*.

ADORATION, the act of rendering divine honours; or of addreſſing God, or a being, as ſuppoſing it a god. See WORSHIP.

The ceremony of adoration among the ancient Romans was thus: the devotee, having his head covered, applied his right hand to his lips, the fore finger reſting on the thumb, which was erect, and thus bowing his head, turning himſelf round from left to right. The kiſs thus given was called *oſculum labratum*; for ordinarily they were afraid to touch the images of their gods themſelves with their profane lips. Sometimes, however, they would kiſs their feet, and even knees, it being held an incivility to touch their mouths; ſo that the affair paſſed at ſome diſtance. Others pretend, that they firſt ſtretched out the hand, and afterwards drew it back to their lips; but it rather appears that the contrary order was obſerved. Saturn, however, and Hercules, were adored with the head bare; whence the worſhip of the laſt was called *inſtitutem peregrinum*, and *ritus Græcanicus*, as departing from the Roman cuſtomary method, which was to ſacrifice and adore with the face veiled, and the cloaths drawn up to the ears, to prevent any interruption in the ceremony, by the ſight of unlucky objects. Sometimes alſo proſtration, or falling on the face, and ſometimes kneeling, were practiſed: ſometimes they turned towards the ſun, and ſometimes to the eaſt. Other circumſtances of adoration were, the putting crowns, garlands, and the like, on the ſtatues or images adored; ſitting down by them, praying to them in ſoft trembling murmurs, to be favourable, *faveas mihi*. The Romans practiſed adoration at ſacrifices, and other ſolemnities; in paſſing by temples, altars, groves, &c. at the ſight of ſtatues, images, or the like, whether of ſtone or wood, wherein any thing of divinity was ſuppoſed to reſide. Uſually there were images of the gods placed at the gates of cities, for thoſe who went in, or out, to pay their reſpects to. The Gauls, inſtead of turning about to the right hand, after the Roman manner, thought it more religious to turn to the left. In the ſymbols of Pythagoras, adoration is enjoined to be performed in a ſitting poſture, genuflexion being then unknown. The Jewiſh manner of adoration was by proſtration, bowing, and kneeling. Pinchon has a diſcourſe expreſs on the form of the Jewiſh adoration. The Chriſtians adopted the Grecian rather than the Roman method, and adored always uncovered. The ordinary poſture of the ancient Chriſtians was kneeling, but on Sundays, ſtanding. In this they conformed to the heathens, that a peculiar regard was had to the eaſt, to which point they ordinarily directed their prayers; which occaſioned a belief among the heathens as if they adored the ſun. Something of this uſage is ſtill retained, as appears by the poſition of our churches. A modern author has diſcovered an error of the builders in this reſpect; many of our ancient churches being found to vary ſeveral degrees from the true eaſt and weſt. Plott's Hiſt. Staff. chap. ix. §. 55. p. 362. Adoration is more particularly uſed for the act of praying, or preferring our requeſts or thankſgivings to Almighty God.

ADORATION is alſo uſed for certain extraordinary civil honours, or reſpects, which reſemble thoſe paid to the Deity, yet are given to men. We read of adoration paid to kings, princes, emperors, popes, biſhops, abbots, &c. Adorations paid to the purple, to the perſon. Adoration by kneeling, by falling proſtrate, kiſſing the foot, hand, garment, &c. The Perſian manner of adoration, introduced by Cyrus, was by bending the knee, and falling on the face at the prince's feet, ſtriking the earth with the forehead, and kiſſing the ground. The ceremony, which the Greeks called προσκυνειν, Conon refuſed to perform to Artaxerxes, and Caliſthenes to Alexander the Great, as reputing it impious and unlawful. The adoration performed to the Roman and Grecian emperors, conſiſted in bowing or kneeling at the prince's feet, laying hold of his purple robe, and preſently withdrawing the hand, and clapping it to the lips. Some attribute the origin of this practice to Conſtantius. It was only perſons of ſome rank or dignity that were intitled to the honour. Bare kneeling before the emperor, to deliver a petition, was alſo called adoration. It is particularly ſaid of Dioclefian, that he had gems faſtened to his ſhoes, that divine honours might be more willingly paid him, by kiſſing his feet. The like uſage was afterwards adopted by the popes, but it has ſome time been laid aſide.

ADORATION was alſo uſed in the court of Rome, for the ceremony of kiſſing the pope's foot. Theſe prelates finding a vehement diſpoſition in the people to fall down before them, and kiſs their feet, procured crucifixes to be faſtened on their ſlippers; by which ſtratagem, the adoration intended for the pope's perſon, is ſuppoſed to be transferred to Chriſt. Divers acts of this adoration we find offered even by princes to the pope. We are told that, in the ancient church, the ſame ceremony was practiſed to all biſhops; people kiſſed their feet, and ſaluted them with the phraſe προσκυνω σε, *I adore thee*. The practice of adoration may be ſaid to be ſtill ſubſiſting in England, in the ceremony of kiſſing the king's or queen's hand, and in ſerving them at table, both being performed kneeling.

ADORATION is alſo uſed for a method of electing a pope without ſcrutiny or voting. In the election by adoration, the cardinals ruſh haſtily, as if agitated by ſome ſpirit, and fall immediately to the adoration of ſome one among them, and proclaim him pope. In the election by ſcrutiny, adoration is the laſt thing, and follows the election; as in the other it is the election itſelf, or rather ſuperſedes the election.

ADORATION is more particularly uſed for kiſſing one's hand in preſence of another, as a token of reverence. The Jews adored by kiſſing their hands, and bowing down their heads; whence in their language kiſſing is properly uſed for adoration. Calmet.

Supreme ADORATION, the higheſt degree of religious honour or worſhip rendered to a being, as ſuppoſing him the ſupreme God; in oppoſition to ſubordinate worſhip, given to inferior beings.

Relative ADORATION is that worſhip paid to an object, as belonging to, or repreſentative of, another. In which ſenſe the Romaniſts profeſs to adore the croſs, not ſimply or immediately, which they allow would be idolatry, but in reſpect of Jeſus Chriſt, whom they ſuppoſe to be on it. The Jeſuits in China carry an image of Chriſt under their cloaths, and to this refer mentally the public adoration they offer to Chacinchoan. Vide Paſcal. Lettr. Provinc. 5.

Barbarous ADORATION is a term uſed in the laws of king Canute, for that performed after the heathen manner, who adored idols. The Phœnicians adored the winds, on account of the terrible effects produced by them. The ſame was adopted by moſt of the other nations, Perſians, Greeks, Romans, &c. The Troglodytes adored tortoiſes, as ſomething peculiarly ſacred. Several people adored weapons and inſtruments of war. The Scythians, &c. adored ſwords; the Romans, axes; the Arabs, ſtones; the Indians vipers; the Bengaleſe and Canadeſe, the ſun, the latter of which nations is alſo ſaid to adore the croſs. The Manta, a Peruvian people in the iſland of Puna, anciently adored a huge emerald, of the bigneſs of an oſtrich's egg, by offering to it other emeralds of a leſſer ſize; all which the prieſts kept for their own uſe; the doctrine, as Garcilaſſo obſerves, being founded on their avarice. The Perſians chiefly paid their adorations to the ſun and fire; ſome ſay alſo to rivers, the wind, &c. The motive of adoring the ſun was the benefits they received from that glorious luminary, which, of all things created, has doubtleſs the beſt pretenſions to ſuch homage. The inſtitution of the fire worſhip is uſually referred to Zoroaſter. The retainers to it are called *ignicolæ*; by the Perſians, Ghebr, Areſch, Pereſh. Dr. Hyde reduces the Perſian fire worſhip to the ſubordinate king of honour, or ſervice, which he calls *pyrodulia*, defending that people from any charge of *pyrolatria*, or idolatry of fire. A late traveller into theſe parts, Gemelli Careri, does the ſame. The Greeks and Romans alſo adored fire under the name of *veſta*. Pliny mentions the method of adoring lightning, which was by poppiſms, or gentle clappings of the hands. The Jews have been charged by heathens with adoring the vine, an aſs's head, &c. By Chriſtians, with adoring the book of the law; a charge which one of their rabbins, Manaſſ. Ben Iſrael, has been at the pains to remove. The adoration of the golden calf, into which they fell in the wilderneſs, ſeems to have been borrowed, like many others of their ceremonies, from the Egytians. The Egyptians are ſaid to have paid adoration to divers animals, plants, fiſhes, &c. the crocodile, the ibis, onions, &c. But thoſe were only ſymbolical, or relative acts of homage. They adored the ſun in a more peculiar manner, under the name of Oſiris. It is diſputed whether the Chineſe pay divine or only civil honours to the ſtatues of Confucious, and their anceſtors. That people, however, appear to adore heaven; whence the inſcription in all their temples, and which even the Chriſtians are ſaid to have retained in their churches *king tien*, i. e. adore heaven. The Indians are ſaid to adore the devil. Some charge the ſame on the Bramins.

ADOSCULATION,

ADOSCULATION is uſed, by ſome naturaliſts, for a ſpecies of copulation, or impregnation, by mere external contact between the genital part of the two ſexes, without intermiſſion. Such is that of plants, by the falling of the *farina fœcundans* on the piſtil, or uterus. See the Syſtem of Botany, Sect. III. For the manner in which impregnation in this ſenſe is effected, ſee the Treatiſe on Gardening, Article Kitchen Garden, Month of April.

Divers kinds of birds and fiſhes are alſo impregnated by adoſculation. Grew. Anat. of Plants, chap. v. § 9.

ADOSSÉE is uſed, in heraldry, to denote two figures of bearings, placed back to back. The arms of the duchy of Bar are two bars *adoſſée*. See the Syſtem, Plate V.

AD PONDUS *Omnium*, to the weight of the whole; an abbreviation among phyſicians, &c. ſignifying, that the laſt preſcribed ingredient is to weigh as much as all the others put together.

ADSTRICTION, among phyſicians, is uſed to denote the two great rigidity and cloſeneſs of the emnuctories of the body, particularly the pores of the ſkin: alſo to ſignify the ſtyptic quality of medicines. See Astringents.

ADUAR, a kind of ambulatory village, wherein Arab families inhabit, in a ſort of tents, moveable on occaſion, as forage and proviſions ſuit. Some alſo write the word adouar, and adouard. There are reckoned thirty thouſand aduars in the kingdom of Algiers.

ADVANCE-GUARD, or Van-guard, in the military art, is the firſt line or diviſion of an army, ranged or marching in battle array; or that part of it which is next the enemy, or which marches firſt towards them. The whole body of an army is divided into advance-guard, rear-guard, and main-body. The word is ſometimes alſo applied to a ſmall party of horſe, viz. fifteen or twenty, commanded by a lieutenant, beyond, and in ſight of, the main-guard.

ADVENT, in the calendar, is the time immediately preceding Chriſtmas; anciently employed in pious preparation for the *adventus*, or coming on of the feaſt of the nativity. Advent includes four Sundays, or weeks; commencing either from the Sunday which falls on St. Andrew's day, or that next before or after it, i. e. from the Sunday which falls between the 27th of November, and the 3d of December inclufive. But it is to be noted, this rule has not always obtained. In the Ambroſian office, there are ſix weeks marked for advent; and St. Gregory, in his Sacramentary, allows five. The firſt week of advent, in our way of reckoning, is that wherein it begins; but it was anciently otherwiſe; the week next Chriſtmas being reputed the firſt, and the numeration carried backwards. Great auſterity was practiſed in the ancient church during this ſeaſon. At firſt they faſted three days a week; but they were afterwards obliged to faſt every day, whence the ſeaſon is frequently called, in ancient writers *Lent*, and *Quinquageſimi S. Martini*. The courts of juſtice were at one time all ſhut. Advent is alſo one of the times from the beginning whereof, to the end of the octaves of the Epiphany, the ſolemnizing of marriage is forbid, without expreſs licence.

ADVENTITIOUS, ſomething accruing or befalling a perſon or thing, from without. Thus, adventitious matter is ſuch matter as doth not properly belong to any body, but is caſually joined to it.

ADVENTURE, an extraordinary and ſurpriſing enterpriſe, or accident, either real or fictitious. The word is French, and literally denotes an event or accident. Novels, romances, &c. are chiefly taken up in relating the adventures of cavaliers, lovers, &c.

Adventure in commerce. A bill of adventure is a writing ſigned by a merchant, atteſting that the property of goods ſhipped, or ſent away in his name, belongs to another; the adventure or chance whereof the ſaid perſon is to ſtand, with a covenant to account to him for the produce of it.

ADVERB, Adverbium, in grammar, is a particle joined to a verb, adjective, or particle, to explain their manner of acting or ſuffering; or to mark ſome circumſtance or quality ſignified by them. The word is formed from the propoſition *ad*, to, and *verbum*, a verb; and ſignifies literally a word joined to a verb, to ſhew how, when, or where, one is, does, or ſuffers; as, the boy paints *neatly*, writes *ill*, the houſe ſtands *there*, &c. See the Syſtem, Part II. Chap. III. No. IV.

ADVERSATIVE, in grammar. A particle adverſative is that which expreſſes ſome difference, or oppoſition, between what goes before and what follows. Thus, in the phraſe *he loves knowledge*, but *has no application*, the word *but* is an adverſative conjunction; between which and a disjunctive one there is this difference, that the firſt ſenſe may hold good, without the ſecond oppoſed to it; which is otherwiſe in regard to disjunctive conjunctions.

ADULT, Adultus, one who is arrived at years of diſcretion, and entered upon manhood, or the age of adoleſcence, and is old enough to have underſtanding and diſcernment.

ADULTERATION, in a general ſenſe, is the act of corrupting or debaſing a thing that is pure, by ſome improper admixture. The word is Latin, formed of the verb *adulterare*, to corrupt, by mingling ſomething foreign to any ſubſtance. We have laws againſt the adulteration of coffee, tea, tobacco, ſnuff, wine, beer, bread, wax, hair-powder, &c. See Stat. 13 W. III. cap. 5.=11 Geo. I. cap. 30.=1 Geo. I. cap. 46.=1 W. & M. cap. 34.=23 El. cap. 8.=10 Ann. cap. 26.=3 Geo. III. cap. 11.

Adulteration *of coin* properly imports the making or caſting of a wrong metal, or with too baſe or too much alloy.=Adulterations of coins are effected divers ways, as by forging another ſtamp or inſcription; by mixing impurer metals with the gold or ſilver; moſt properly, by making uſe of a wrong metal, or an undue alloy, or too great an admixture of the baſer metals, with gold or ſilver. Counterfeiting the ſtamp, or clipping and leſſening the weight, do not ſo properly come under the denomination of adulterating. Evelyn gives rules and methods, both of adulterating and detecting adulterated metals, &c. Adulterating is ſomewhat leſs extenſive than debaſing, which includes diminiſhing, clipping, &c. To adulterate or debaſe the current coin, is a capital crime in all nations. The ancients puniſhed it with great ſeverity. Among the Egyptians both hands were cut off; and, by the civil law, the offender was thrown to wild beaſts. The emperor Tacitus enacted, that counterfeiting the coin ſhould be capital; and under Conſtantine it was made treaſon, as it is alſo among us. The adulterating of gems is a curious art, and the methods of detecting it no leſs uſeful. Nichols, Lapid. p. 18.

Adulteration, in pharmacy, denotes a fraudulent corruption of drugs, or medicines, by ſubſtituting ingredients of leſs value, for the ſake of greater gain. This practice the dealers in all the parts of medicine are but too well acquainted with. Pharmaceutical authors give numerous inſtances of adulterations, both in ſimple and compound medicines.

ADULTERESS, is a woman who commits adultery. See Adultery.

ADULTERY, a crime committed by married perſons againſt the faith pledged to each other in marriage, by having carnal commerce with ſome other; or even by a perſon not married, who has the ſame intercourſe with another that is. Moraliſts canoniſts, and divines, have diſtinguiſhed ſeveral ſpecies of adultery; as,

Occult or *ſecret* Adultery; that kept concealed from the knowledge of the world, and only divulged to a confeſſor, or the like. In the canon law this is moſt favourably dealt with: perſons were admitted to penance for this, and abſolved, who were refuſed it for the open kind. Du-Cange.

Preſumptive Adultery is that which is only diſcovered or inferred from certain ſigns or indications. Such are the parties being found in bed together *nudus cum nuda*.

It has been diſputed whether adultery be *malum in ſe*, or only *malum prohibitum*; i. e. evil in itſelf, or only rendered evil by virtue of poſitive laws and prohibitions. St. Ambroſe, and ſome others, have maintained, that adultery was not criminal before the Moſaic law. Hobbes de Civ. cap. 6. § 16. Budd. Iſag. lib. ii. cap. 4. It has likewiſe been a diſpute, whether it be lawful for one of the parties married to commit adultery, with the conſent of the other, for the ſake of having children? Of which we have inſtances in Abraham, who, on this account, converſed with Agar; and likewiſe among the Greeks and Romans. Pollman, a German profeſſor, has a diſſertation on the huſband's right to alienate his wife's body to another's uſe.

Puniſhments have been annexed to adultery in moſt ages and nations, though of different degrees of ſeverity. In many it hath been capital; in others venial, and attended only with ſlight pecuniary mulcts. Some of the penalties are ſerious, and even cruel? others of a jocoſe and humorous kind. Among the Egyptians, adultery by conſent was puniſhed in the man by a thouſand laſhes, given with rods; and in the woman, with the loſs of her noſe. Nevertheleſs, adulteries were not unfrequent among the Egyptians. The Grecian laws expreſs great indignation againſt adultery. In the earlier times of Athens, the puniſhment of adultery ſeems to have been arbitrary. In other parts of Greece adultery was ſeverely puniſhed. The Spartans, indeed, may, in one ſenſe, be ſaid to have tolerated adultery, ſince they laughed at thoſe who thought the violation of the marriage-bed an unſupportable affront: they allowed other men the liberty of embracing their wives, which freedom they took with others in their turn. Nay, even ſtrangers, as well as citizens of Sparta, were allowed the ſame freedom with their wives. Yet we find that their kings were exempt from this cuſtom, that the royal blood might be preſerved unmixed, and the government remain in the ſame lineal deſcent. But notwithſtanding this liberty, which was founded on mutual conſent, they accounted all other adulteries the moſt heinous crime in the world; and while they adhered to their ancient laws, they were wholly ſtrangers to them. See Potter's Arch. lib. iv. cap. 12. By the Jewiſh law adultery was puniſhed by death in both parties, where they were both married, or only the woman. The Jews had a particular method of trying, or rather purging, an adultreſs, or a woman ſuſpected of the crime, by making her drink the bitter water of jealouſy; which, if ſhe were guilty, made her ſwell. Among the Mingrelians, adultery is puniſhed with the forfeiture of a hog, which is uſually eaten in good friendſhip between the gallant, the adultereſs,

treſs and the cuckhold. Chardin. Voy. tom. i. p. 47. In ſome parts of the Indies, it is ſaid any man's wife is permitted to proſtitute herſelf to him who will give an elephant for the uſe of her; and it is reputed no ſmall honour to her to have been rated ſo high. Montaigne's Eſſ. lib. iii. cap. 4. Adultery is ſaid to be ſo frequent at Ceylon, that there is hardly a woman but practiſes it, notwithſtanding its being puniſhable with death. Bibl. Univ. tom. xxiii. p. 237. Among the Chineſe there is reaſon to conclude that adultery is not capital; for it is ſaid, that fond parents will make a contract for their daughters' future huſbands to allow them the uſe of a gallant.

Some of our Engliſh law-books ſpeak of adultery as a thing temporal againſt the peace. The adultreſs, by our law, undergoes no temporal puniſhment whatever, except the loſs of her dower; and ſhe does not even loſe that, if her huſband is weak enough to be reconciled to her, and cohabit with her after the offence is committed. 13 Ed. I. cap. 34.

In Britain, adultery is reckoned a ſpiritual offence; that is, cognizable by the ſpiritual courts, where it is puniſhed by fine and penance. The common law takes no farther notice of it, than to allow the party grieved an action and damages. This practice is often cenſured by foreigners, as making too light of a crime, the bad conſequences of which, public as well as private, are ſo great. It has been anſwered, that perhaps this penalty, by civil action, is more wiſely calculated to prevent the frequency of the offence, which ought to be the end of all laws, than a ſeverer puniſhment. He that, by a judgment of law, is, according to circumſtances, ſtripped of great part of his fortune, thrown into priſon till he can pay it, or forced to fly his country, will, no doubt, in moſt caſes, own that he pays dearly for his amuſement. As to the moral turpitude of this offence, ſome have vainly endeavoured to deny or explain it away by various arguments, and even by an appeal to ſcripture. On the part of the man who ſolicits the chaſtity of a married woman, it certainly includes the crime of ſeduction, and is attended with miſchief ſtill more complicated and extenſive. It creates a new ſufferer, the injured huſband, upon whoſe ſimplicity and affection is inflicted a wound the moſt painful and incurable that human nature knows. The infidelity of the woman is aggravated by cruelty to her children, who are generally involved in their parents ſhame, and always made unhappy by their quarrel. It has been argued, that theſe conſequences ought leſs to be attributed to the crime than to the diſcovery. But, in the firſt place, the crime could not be diſcovered unleſs it were committed, and the commiſſion is never ſecure from diſcovery. Secondly, If adulterous connexions were allowable whenever the parties could hope to eſcape detection, which is the concluſion to which this argument leads, the huſband would be left no other ſecurity for his wife's chaſtity, than her want of opportunity or temptation; which would probably deter moſt men from marrying; or render marriage a ſtate of continual jealouſy and alarm to the huſband, which would end in the ſlavery and confinement of the wife. The marriage vow is "witneſſed before God," and accompanied with circumſtances of ſolemnity and religion which approach to the nature of an oath. The married offender, therefore, incurs a crime little ſhort of perjury; and the ſeduction of a married woman is little leſs than a ſubornation of perjury: and this guilt is independent of the diſcovery. But the uſual apology for adultery, is the prior tranſgreſſion of the other party; and ſo far, indeed, as the bad effects of adultery are anticipated by the conduct of the huſband or wife who offends firſt, the guilt of the ſecond offender is extenuated. But this can never amount to a juſtification; unleſs it could be ſhown, that the obligation of the marriage vow depends upon the condition of reciprocal fidelity; a conſtruction which appears founded neither in expediency, nor in the terms of the vow, nor in the deſign of the legiſlature, which preſcribed the marriage-rite. The way of conſidering the offence upon the footing of provocation and retaliation is a childiſh trifling with words. "Thou ſhalt not commit adultery," was an interdict delivered by God himſelf; yet ſcripture has been adduced as giving countenance to the crime. As Chriſt told the woman taken in adultery, "Neither do *I condemn thee*," we muſt believe, it is ſaid, that he deemed her conduct either not criminal, or at leaſt not a crime of the heinous nature we repreſent it to be. But, from a more attentive examination of the caſe, it will be evident, that nothing can be concluded from it favourable to ſuch an opinion. The tranſaction is thus related: "Early in the morning Jeſus came again into the temple, and all the people came unto him; and he ſat down and taught them; and the Scribes and Phariſees brought unto him a woman taken in adultery; and when they had ſet her in the midſt, they ſaid unto him, Maſter, this woman was taken in adultery, in the very act: now Moſes in the law commanded that ſuch ſhould be ſtoned; but what ſayeſt thou? This they ſaid tempting him, that they might have to accuſe him: but Jeſus ſtooped down and with his finger wrote on the ground, as though he heard them not. So when they continued aſking him, he lift up himſelf, and ſaid unto them, He that is without ſin among you, let him firſt caſt a ſtone at her; and again he ſtooped down, and wrote on the ground: and they which heard it, being convicted by their own conſcience, went out one by one, beginning at the eldeſt, even unto the laſt; and Jeſus was left alone, and the woman ſtanding in the midſt. When Jeſus had lift up himſelf, and ſaw none but the woman, he ſaid unto her, Woman, where are thoſe thine accuſers? Hath no man condemned thee? She ſaid unto him, No man, Lord: and he ſaid unto her, *Neither do I condemn thee*; go, and ſin no more." "This they ſaid tempting him, that they might have to accuſe him;" that is, to draw him into an exerciſe of judicial authority, that they might have to accuſe him before the Roman governor, of uſurping or intermeddling with the civil government. This was their deſign; and Chriſt's behaviour throughout the whole affair proceeded from a knowledge of this deſign, and a determination to defeat it. He gives them at firſt a cold and ſullen reception, well ſuited to the inſidious intention with which they came: "he ſtooped down, and with his finger wrote on the ground, as though he heard them not." "When they continued aſking him," when they teaſed him to ſpeak, he diſmiſſed them with a rebuke, which the impertinent malice of their errand, as well as the ſecret character of many of them, deſerved: "he that is without ſin (that is, this ſin) among you, let him firſt caſt a ſtone at her." This had its effect. Stung with the reproof, and diſappointed of their aim, they ſtole away one by one, and left Jeſus and the woman alone. And then follows the converſation, which is the part of the narrative moſt material to our preſent ſubject. "Jeſus ſaith unto her, Woman, where are thoſe thine accuſers? Hath no man condemned thee? She ſaid, No man, Lord. And Jeſus ſaid unto her, Neither do I condemn thee; go, and ſin no more." Now, when Chriſt aſked the woman, "Hath no man *condemned* thee?" he certainly ſpoke, and was underſtood by the woman to ſpeak, of a legal and judicial condemnation; otherwiſe her anſwer, "No man, Lord," was not true. In every other ſenſe of condemnation, as blame, cenſure, reproof, private judgment, and the like many had condemned her; all thoſe, indeed, who brought her to Jeſus. If, then, a judicial ſentence was what Chriſt meant by *condemning* in the queſtion, the common uſe of language requires us to ſuppoſe that he meant the ſame in his reply, "Neither do I condemn thee:" *i. e.* I pretend to no judicial character or authority over thee; it is no office or buſineſs of mine to pronounce, to execute the ſentence of the law. When Chriſt adds, "Go, and ſin no more," he, in effect, tells her that ſhe had ſinned already; but as to the degree or quality of the ſin, or Chriſt's opinion concerning it, nothing is declared, nor can be inferred, either way.

It has been controverted, whether adultery may be lawfully committed in war, with the enemies wives? The anſwer is in the negative, and the authoriſed practice of civilized nations is agreeable to this. It has alſo been a well known queſtion, whether it be lawful for a woman to commit adultery with the conſent of her huſband, and for the procuring ſome great good to him? St. Auſtin apparently allows of it; at leaſt, does not condemn it.

It is much diſputed, whether adultery diſſolves the bond of matrimony, and is a ſufficient cauſe of divorce, ſo that the parties may marry again. This was allowed in the ancient church, and is ſtill continued in the Greek, as well as the Lutheran and Calviniſt churches. Romaniſts, however, diſallow of it: and the Council of Trent even anathematized thoſe who maintained it; though the canon of anathemization was mitigated, in deference to the republic of Venice, in ſome of whoſe dominions, as Zant, Cephalonia, &c. the contrary uſage obtains. The eccleſiaſtical courts in England ſo far agree with the Papiſts, that they only grant a divorce *a menſa et thoro*, in caſe of adultery; ſo that a complete divorce, to enable the parties to marry again cannot be had without an act of parliament.

ADVOCATES, in the Engliſh courts, are more generally called *counſel*. See COUNSEL.

Faculty of ADVOCATES, in Scotland, a reſpectable body of lawyers, who plead in all cauſes before the Courts of Seſſion, Juſticiary, and Exchequer. They are alſo intitled to plead in the houſe of peers, and other ſupreme courts in England. In the year 1660 the faculty founded a library upon a very extenſive plan, ſuggeſted by that learned and eminent lawyer Sir George M'Kenzie, of Roſchaugh, advocate to king Charles II. and king James VII. who enriched it with ſeveral valuable books. It has been daily increaſing ſince that time, and now contains not only the beſt collection of law-books in Europe, but a very large and ſelect collection of books on all ſubjects. Beſides, this library contains a great number of original manuſcripts; and a vaſt variety of Jewiſh, Grecian, Roman, Scots, and Engliſh coins and medals. The faculty at preſent conſiſts of above two hundred members. As an advocate or lawyer is eſteemed the genteeleſt profeſſion in Scotland, many gentlemen of fortune take the degree of advocate, without having any intention of practiſing at the bar. This circumſtance greatly increaſes their number, gives dignity to the profeſſion, and enriches their library and public fund It is from this reſpectable body that all vacancies on the bench are generally ſupplied.

Lord ADVOCATE, or *King's Advocate*, one of the eight great officers of ſtate in Scotland, who as ſuch ſat in parliament without election. He is the principal crown-lawyer in Scotland. His buſineſs is to act as a public proſecutor, and to plead in all cauſes that concern the crown; but particularly in ſuch as are of a criminal nature. The office of king's advocate is not very an-

cient, it seems to have been established about the beginning of the 16th century.

ADVOWSON, or ADVOUZEN, in canon law, signifies a right to present to a vacant benefice. Advowson is so called, because the right of presenting to the church was first gained by such as were founders, benefactors, or maintainers of the church.

Though the nomination of fit persons to officiate in every diocese was originally in the bishop, yet they were content to let the founders of churches have the nomination of the persons to the churches so founded, reserving to themselves a right to judge of the qualification of the persons so nominated. Gibs. 2. ed. 756.

Advowsons were formerly most of them appendant to manors, and the patrons were parochial barons: the lordship of the manor, and patronage of the church, were seldom in different hands, until advowsons were given to religious houses. But of late times the lordship of the manor, and advowson of the church, have been divided. Advowsons are also presentative, collative, or donative. Presentative, where the patron presents or offers his clerk to the bishop of the diocese, to be instituted in his church: collative, where the benefice is given by the bishop, as original patron thereof, or by means of a right he has acquired by lapse: donative, as where the king, or other patron, does, by a single donation in writing, put the clerk into possession, without presentation, institution, or induction. Sometimes, anciently, the patron had the sole nomination of the prelate, abbot, or prior; either by investiture (i. e. delivery of a pastoral staff,) or by direct presentation to the diocesan; and if a free election was left to the religious, yet a *congé d' elire*, or licence of election, was first to be obtained of the patron, and the person elected was confirmed by him. If the founder's family became extinct, the patronage of the convent went to the lord of the manor. Unless the several colleges in the universities be restrained in the number of advowsons they may receive, it is argued they will, in time, require such a stock, as to frustrate the design of their foundation, (which is the education of youth,) by creating too quick a succession of fellows; so that there will not be in the colleges a sufficient number of persons, of competent age, knowledge, and experience, to instruct and form the minds of the youth. In some colleges the number of advowsons is said to be already two thirds, or more, of the number of fellows. It is objected, on the other side, that the succession of fellows may be too slow, as well as too quick; whereby persons well qualified may be detained so long in colleges, as not to have strength or activity enough left for the discharge of parochial functions. Colleges holding more advowsons in number than a moiety of the fellows, are not capable of purchasing more. Grants of advowsons by Papists are void. 9 Geo. II. c. 36. § 5. 11 Geo. II. c. 17. § 5.

Advowsons are temporal inheritances, and lay fees; they may be granted by deed or will, and are assets in the hands of heirs or executors. Presentation to advowsons, for money, or other reward, are void. 13 Eliz. cap. 6. See Burn's Eccl. Law, vol. I.

AE, or Æ, a diphthong, or double vowel, compounded of A and E. Authors are by no means agreed as to the use of the *æ* in English words. Some, out of regard to etymology, insist on its being retained in all words, particularly technical ones, borrowed from the Greek and Latin; while others, from a consideration that it is no proper diphthong in our language, its sound being no other than that of the simple *e*, contend that it ought to be entirely disused, and, in fact, the simple *e* has of late been adopted instead of the Roman *æ*; as the word *equator*, &c.

ÆGILOPS is a tumor, or rather ulcer, in the great angle of the eye; either with or without an inflammation. The word is compounded of *ait*, *goat*, and *ωψ*, *eye*; as goats are supposed extremely liable to this distemper. Authors frequently use the word *ægilops*, *anchilops*, and *fistula lachrymalis*, promiscuously; but the more accurate, after Ægineta, make a difference. The tumor, before it becomes ulcerous, is properly called *anchilops*; and after it is got into the lachrymal passages, and has rendered the *os lachrymale* carious, *fistula lachrymalis*. If the ægilops be accompanied with an inflammation, it is supposed to take its rise from the abundance of blood, which a plethoric habit discharges on the corner of the eye. If it be without an inflammation, it is supposed to proceed from a viscous pituitous humor, thrown upon this part. The method of cure is the same as that of the *ophthalmia*. But before it has reached the lachrymal passages, it is managed like other ulcers. If the ægilops be neglected, it bursts, and degenerates into a *fistula*, which eats into the bone.

ÆGYPTIACUM, in medicine, is a name given to divers unguents of the detergent or corrosive kind. We meet with a black, a red, a white, a simple, a compound, and a magistral Ægyptiacum. The simple Ægyptiacum, which is that usually found in our shops, is a composition of verdigrise, vinegar, and honey, boiled to a consistence. The prescription is Mesue's. It is usually supposed to take its name from its dusky colour, wherein it resembles that of the natives of Ægypt. It is improperly called an unguent, as there is no oil, or rather fat in it. Some chuse to call it *Mel Ægyptiacum*. It is chiefly used in eating off rotten flesh, and cleansing foul ulcers; particularly venereal ones in the throat, &c. It also destroys those cancerous eruptions apt to grow in children's mouths.

ÆNEID, the name of Virgil's celebrated epic poem. The subject of the Æneid, which is the establishment of Æneas in Italy, is extremely happy. Nothing could be more interesting to the Romans than to look back to their origin from so famous a hero. While the object was splendid itself, the traditionary history of his country opened interesting fields to the poet, and he could glance at all the future great exploits of the Romans, in its ancient and fabulous state. As to the unity of action, it is perfectly well preserved in the Æneid. The settlement of Æneas, by the order of the gods, is constantly kept in view. The episodes are linked properly with the main subject. The nodus, or intrigue of the poem, is happily managed. The wrath of Juno, who opposes Æneas, gives rise to all his difficulties, and connects the human with the celestial operations throughout the whole poem. One great imperfection of the Æneid, however, is, that there are almost no marked characters in it. Achates, Cloanthes, Gyas, and other Trojan heroes, who accompanied Æneas into Italy, are insipid figures. Even Æneas himself is without interest. The character of Dido is the best supported in the whole Æneid. The principal excellency of Virgil is tenderness. His soul was full of sensibility. He must have felt himself all the affecting circumstances in the scenes he describes; and he knew how to touch the heart by a single stroke. In an epic poem this merit is the next to sublimity. The second book of the Æneid is one of the greatest master-pieces that ever was executed. The death of old Priam, and the family-pieces of Æneas, Anchises, and Creusa, are as tender as can be conceived. In the fourth book, the unhappy passion and death of Dido are admirable. The episodes of Pallas and Evander, of Nisus and Euryalus, of Lausus and Mezentius, are all superlatively fine. In his battles, Virgil is far inferior to Homer. But in the important episode, the descent into Hell, he has outdone Homer by many degrees. There is nothing in antiquity to equal the 6th book of the Æneid.

ÆNIGMA is a proposition put in obscure, ambiguous, and generally contradictory terms, to puzzle and exercise the wit, in finding out its meaning; or, an obscure discourse, covering some common well known thing, under remote and uncommon terms.

ÆOLIC, or ÆOLIAN, in grammar, denotes one of the five dialects of the Greek tongue. It was first used in Bœotia; whence it passed into Æolia, and was that which Sappho and Alcæus wrote in. The Æolic dialect generally throws out the aspirate or sharp spirit, and agrees in so many things with the Doric dialect, that the two are usually confounded together. The *Æolic digamma* is a name given to the letter F, which the Æolians used to prefix to words beginning with vowels; as Fανασσα, for ανασσα, also to insert between vowels; as αFιος, for αιος.

ÆOLIPILE, an hydraulic instrument, consisting of a hollow metallic ball, with a slender neck, or pipe, arising from it. This being filled with water, and thus exposed to the fire, produces a vehement blast of wind. This instrument Des Cartes, and others, have made use of, to account for the natural cause, and generation, of wind. And hence its name, *Æolipila*, q. d. *pila Æoli*, Æolus's ball; or, *Aulea ventorum*, the gates of Æolus; Æolus being reputed the god of the winds.

ÆOLUS's *Harp*, an instrument so named, from its producing an agreeable melody merely by the action of the wind. For the construction of this instrument, and the manner in which tones are produced from it, see the system of ACOUSTICS, Chap. I.

ÆRA, in chronology, is a fixed point of time, from whence to begin a computation of the years ensuing. Æra amounts to the same with *epocha*; though some authors make a difference between them; but wherein it consists they do not agree. A late critic assigns this difference, that, in strictness of speech, epocha is that fixed point where an æra made use of commences. Thus the 20th of February, 747, (abating fifty-seven days,) before the Christian æra, may be said to be the epochas of the æra of Nabonassar. Within this æra other epochas may be noted; as that of the death of Augustus, that of the death of Alexander, &c. But these cannot properly be called epochas of the æra of Nabonassar. Bibl. Germ. tom. v. p. 172. Vallemont makes another difference, viz. that an epocha is a point fixed by chronologers, and an æra a like point, only fixed by the popular usage of a country, or nation. Perhaps it might not be amiss, if chronologers would keep to this difference; but it is certain most of them have hitherto used the two words promiscuously. See EPOCHA.

Christian ÆRA. It is generally allowed by chronologers that the computation of time from the birth of Christ was not introduced till the sixth century, in the reign of Justinian, and is commonly ascribed to Dionysius Exiguus. This computation then came in use in deeds, &c. before which time either the olympiads, the year of Rome, or that of the reign of the emperors, were used for these ends.

AERIAL, AERIUS, something that consists of, or has relation to air. The Essenі, the most refined and rational sect among the Jews, held that the human soul consisted of an aerial substance.

AEROGRAPHY, from αηρ, *air*, and γραφω, *I describe*, a description of the air, or atmosphere, its limits, dimensions, properties, &c. This amounts to much the same with aerology, unless we suppose the latter to enter into the rational, and the former to confine itself to a description of the more obvious, affections thereof. See ATMOSPHERE.

SYSTEM of AEROLOGY.

AEROLOGY is the doctrine or ſcience of *air*, its nature and different ſpecies, with their ingredients, properties, phenomena, and uſes. Air, in a general ſenſe, is that inviſible fluid every where ſurrounding this globe; on which depends not only animal but vegetable life; and which ſeems, in ſhort, to be one of the great agents employed by nature in carrying on her operations throughout the world. Though the attention of philoſophers has, in all ages, been engaged, in ſome meaſure, by enquiries concerning the nature of the atmoſphere, yet, till within theſe laſt thirty years, little more than the mere mechanical action of this fluid was diſcovered, with the exiſtence of ſome anomalous and permanently elaſtic vapours, whoſe properties, and relation to the air we breathe, were almoſt entirely unknown. Within the above-mentioned period, however, the diſcoveries concerning the conſtituent parts of the atmoſphere itſelf, as well as the nature of the different permanently elaſtic fluids which go under the general name of air, have been ſo numerous and rapid, that they have at once raiſed this ſubject to the dignity of a ſcience, and now form a very conſiderable, as well as important, part of the modern ſyſtem of natural philoſophy. Thoſe diſcoveries, indeed, have not been more intereſting to philoſophers, than uſeful to ſcience, and beneficial to ſociety. Many perplexing proceſſes in chymiſtry have been explained in conſequence of them, ſeveral have been facilitated, and a number of new and uſeful ones have been introduced. The phenomena attending metallic calcinations and reductions have been greatly elucidated. The knowledge of the uſe of the air in reſpiration, the method of aſcertaining its purity and fitneſs for that function, the inveſtigation of dephlogiſticated air, and the method of impregnating water with fixed air, are all calculated to anſwer purpoſes of the higheſt utility. The medicinal properties of fixed air have been, in a great meaſure, aſcertained; and its antiſeptic qualities, in other reſpects, promiſe to be of conſiderable advantage. The method of aſcertaining the purity of the air of a place, and the manner of ventilating an appartment, are of great uſe to thoſe concerned in public buildings. In ſhort, there is, perhaps, no ſtation in life where ſome knowledge of this ſubject may not be of uſe.

SECT. I. *Of the general Conſtitution, Mechanical Properties, and Operations of the Air.*

§ 1. *The general Conſtitution of the Air we breathe.*—For many ages this fluid was ſuppoſed to be ſimple and homogeneous; its common operations to depend on its heat, cold, moiſture, or dryneſs; and any effects which could not be explained by theſe (ſuch as the appearance of peſtilential diſeaſes) were reckoned to be entirely ſupernatural, and the immediate effects of Divine power. But, however ſimple and homogeneous this fluid may have been thought in former times, it is ſo far from poſſeſſing the ſimplicity of an element, that it is the receptacle of all kinds of effluvia produced from terreſtrial ſubſtances, either naturally or artificially. Hence, whatever may be the nature of the aerial fluid, when abſolutely pure, that which we breathe, and commonly goes under the name of air, muſt be conſidered as an exceeding heterogeneous mixture, various at various times, and which it is by no means poſſible to analyſe with accuracy. Though, in this view, air ſeems to be a kind of ſink, or common ſewer, where all the poiſonous effluvia, ariſing from putrid and corrupted matters, are depoſited; yet it has a wonderful facility of purifying itſelf, and one way or other of depoſiting thoſe vapours contained in it; ſo that it never becomes noxious, except in particular places, and for a ſhort time; the general maſs remaining, upon all occaſions, pretty much the ſame. The way in which this purification is effected is different, according to the nature of the vapour with which the air is loaded. That which moſt univerſally prevails is water; and from experiments, it appears, that the quantity of aqueous vapour contained in the atmoſphere is immenſe. Dr. Halley, from an experiment on the evaporation from a fluid ſurface heated to the ſame degree with that given by our meridian ſun, has calculated, that the evaporation from the Mediterranean ſea alone is ſufficient to yield all the water of the rivers which run into it. Dr. Watſon, in his Chymical Eſſays, has given an account of ſome experiments made with a view to determine the quantity of water raiſed from the earth itſelf in time of drought. He informs us, that, when there had been no rain for above a month, and the graſs was become quite brown and parched, the evaporation from an acre was not leſs than 1600 gallons in twenty-four hours. Making afterwards two experiments, when the ground had been wetted by a thunder-ſhower the day before, the one gave 1073, the other 1905, gallons in twelve hours. From this the air is every moment purified by the aſcent of the vapours, which, flying off into the clouds, thus leaves room for the exhalation of freſh quantities; ſo that, as the vapour is conſiderably lighter than the common atmoſphere, and of conſequence aſcends with great velocity, the air during all this time is ſaid to be dry, notwithſtanding the vaſt quantities of aqueous fluid that paſſes through it. Nor is it only from the aqueous vapour that the air is purified at this time. Much of that vapour ariſing from decayed and putrid animal and vegetable ſubſtances, and which, by ſome modern philoſophers, is called phlogiſton, attaches itſelf to the aqueous vapour, and aſcends along with it. Another part is abſorbed by vegetables: for the phlogiſtic vapour is probably the food of plants. The phlogiſtic vapours, which aſcend along with the waters probably continue there, and deſcend along with the rain; whence the fertilizing qualities of rain-water above thoſe of any other. Thus we may ſee why a dry air, whether cold or hot, muſt always be wholeſome: but as the atmoſphere cannot always receive vapours, it is obvious, that, when great rains come on, eſpecially if attended with heat, the lower regions of the air muſt be overloaded with vapours both of the aqueous and phlogiſtic kind, and of conſequence be very unwholeſome. But, beſides the aqueous and phlogiſtic vapours, both of which are ſpecifically lighter than common air, there are others, which, being ſpecifically heavier, cannot be carried off in this manner. Hence theſe groſs vapours contaminate certain places of the atmoſphere, rendering them not only unhealthy, but abſolutely poiſonous. Of theſe are, 1. Sulphureous, acid, and metalline exhalations. Theſe are produced principally by volcanoes; and as they deſcend, in conſequence of their ſpecific gravity, they ſuffocate and ſpread deſtruction all around them, poiſoning not only animals, but vegetables alſo. 2. The vapours ariſing from houſes where lead and other metals are ſmelted, have the ſame pernicious qualities; inſomuch that the men who breathe them, the cattle who eat the graſs, and the fiſhes who inhabit the waters on which they fall, are poiſoned by them, if taken into the body in a certain proportion. 3. The ſame kind are the *mofetes*, or emanations of fixed air, which ſometimes proceed from old lavas, or perhaps from ſome other places even of the ſurface. See the Article GROTTO in the Alphabet. From all theſe the air ſeems not capable of purifying itſelf, otherwiſe than either by diſperſing them by winds, or by letting them ſubſide, by their ſuperior gravity, till they are abſorbed either by the earth or water, according as it is their nature to unite with one or other of theſe elements. 4. Of this kind alſo ſeem to be the vapours which are called properly peſtilential. The contagion of the plague itſelf ſeems to be of an heavy ſluggiſh nature, incapable of ariſing in the air, but attaching itſelf to the walls of houſes, bed-clothes, and wearing apparel. Hence ſcarce any conſtitution of the atmoſphere can diſpel theſe noxious effluvia; nor does it ſeem probable that peſtilential diſtempers ever ceaſe until the contagion has operated ſo long, and been ſo frequently communicated from one to another, that, like a ferment much expoſed to the atmoſphere, it becomes vapid, communicates a milder infection, and at laſt loſes its ſtrength altogether.

§ 2. *Mechanical Properties of the Air.*—In common with water, the air we breathe poſſeſſes gravity, and conſequently will perform every thing in that way which water can do, making allowance for the great difference between the ſpecific gravity of water and of air. This difference, indeed, is exceedingly great, and has been variouſly calculated. By means of its gravity, the air preſſes with great force upon all bodies, according to the extent of their ſurface. M. Paſcal has computed the quantity of this preſſure to be no leſs than 2232 pounds upon every ſquare foot of ſurface, or upwards of fifteen pounds on every ſquare inch. According to ſome experiments made by M. Amontons and de la Hire, a column of air on the ſurface of earth, and thirty-ſix fathoms high, is equal in weight to three lines depth of mercury. From the barometer, however, we know that the whole preſſure of the atmoſphere is very different; ſometimes being equal only to a column of twenty-eight inches, and varying from thence to thirty-one inches. The whole quantity of preſſure muſt thus be immenſe, and has been computed equal to a globe of lead ſixty miles in diameter. By means of its gravity, the atmoſphere accompliſhes many uſeful purpoſes in nature. It prevents the arterial veſſels of animals, and the ſap-veſſels of plants, from being too much diſtended by the expanſive power (whatever it is) which has a perpetual tendency to ſwell them out. Thus we ſee that, in the operation of cupping, where the preſſure of the air is taken off from a particular part, the expanſive force inſtantly acts, and ſwells out the veſſels to a great degree. Hence alſo, when animals are put into an air pump, their whole bodies ſwell. By its gravity, the air promotes the union of fluid bodies, which would inſtantly ceaſe *in vacuo*. Thus oils and ſalts, which remain united in air, ſeparate as ſoon as that fluid is extracted. Hence alſo, when hot water is put under an exhauſted receiver, it boils violently; becauſe the preſſure of the air being now taken off, the particles of ſteam, which exiſted inviſibly among the water, and which the gravity of the atmoſphere prevented from flying off ſo ſoon, are now hurried up with great velocity, by means of the exceſſive comparative gravity of the aqueous fluid. On the gravity of the air depend the aſcent of water in pumps, ſyphons, &c. and likewiſe all the phenomena of the barometer. Beſides its gravity, which the air has in common with water and other fluids, there is another which it has only in common with ſteam or vapour. This is called its *elaſticity*; by which, like a ſpring, it allows itſelf to be compreſſed into a ſmaller bulk, and then returns again to its original ſize upon removing the preſſure.

The elaſticity of the air was firſt aſcertained by ſome experiments of Lord Bacon, who, upon this principle, conſtructed the

the firſt thermometer, which he called his *vitrum calendare*. Of this power we have numerous proofs. Thus, a blown bladder being ſqueezed in the hand, we find the included air ſenſibly reſiſt; ſo that, upon ceaſing to compreſs, the cavities or impreſſions made in its ſurface are readily expanded again, and filled up. The ſtructure and office of the *air-pump* depend on this elaſtic property. Every particle of air always exerts a niſus or endeavour to expand, and thus ſtrives againſt an equal endeavour of the ambient particles; whoſe reſiſtance happening by any means to be weakened, it immediately diffuſes itſelf into an immenſe extent. Hence it is that thin glaſs bubbles, or bladders filled with air, and exactly cloſed, being included in the exhauſted receiver of an air-pump, burſt by the force of the air they contain; and a bladder almoſt quite flaccid, ſwells in the receiver, and appears full. The ſame effect alſo takes place, though in a ſmaller degree, on carrying the flaccid bladder to the top of a high mountain. It has been queſtioned among philoſophers, whether this elaſtic power of the air is capable of being deſtroyed or diminiſhed. Mr. Boyle made ſeveral experiments, with a view to diſcover how long air would retain its ſpring after having aſſumed the greateſt degree of expanſion his air-pump would give it; but he was never able to obſerve any ſenſible diminution. Deſaguliers found that air, after having been encloſed for half a year in a wind-gun, had loſt none of its elaſticity: and Roberval, after preſerving it in the ſame manner for ſixteen years, obſerved, that its expanſive projectile force was the ſame as if it had been recently condenſed. Nevertheleſs, Mr. Haukſbee concludes from a later experiment, that the ſpring of the air may be diſturbed, by a violent preſſure, in ſuch a manner as to require ſome time to return to its natural tone. Dr. Hales inferred, from a number of experiments, that the elaſticity of the air is capable of being impaired and diminiſhed by a variety of cauſes.

The weight or preſſure of the air has no dependence on its elaſticity; but would be the ſame whether it had ſuch a property or not. The air, however, being elaſtic, is neceſſarily affected by the preſſure, which reduces it into ſuch a ſpace, that the elaſticity, which re-acts againſt the compreſſing weight, is equal to that weight. In effect, the law of this elaſticity is, that it increaſes as the denſity of the air increaſes; and the denſity increaſes as the force increaſes by which it is preſſed. Now there muſt neceſſarily be a balance between the action and re-action; i. e. the gravity of the air, which tends to compreſs it, and the elaſticity by which it endeavours to expand, muſt be equal. Hence the elaſticity increaſing, or diminiſhing univerſally, as the denſity increaſes or diminiſhes, it is no matter whether the air be compreſſed and retained in ſuch a ſpace by the weight of the atmoſphere, or by any other means; it muſt endeavour in either caſe to expand with the ſame force. And hence, if air near the earth be pent up in a veſſel, and all communication with the external fluid cut off, the preſſure of the encloſed air will be equal to the weight of the atmoſphere at the time the quantity was confined. Accordingly, we find mercury ſuſtained to the ſame height by the elaſtic force of air encloſed in a glaſs veſſel, as by the whole atmoſpherical preſſure. On the ſame principle air may be artificially condenſed; and hence the ſtructure of the *air-gun*.

The utmoſt limits to which air of the denſity which it poſſeſſes at the ſurface of the earth is capable of being compreſſed, have not been aſcertained. Mr. Boyle made it thirteen times more denſe. Dr. Halley ſays, that he has ſeen it compreſſed ſo as to be ſixty times denſer than in its natural ſtate, which is farther confirmed by M. Papin and M. Huygens. Dr. Hales, by means of a preſs, condenſed it thirty-eight times; and by forcing water in an iron ball or globe, into 1551 times leſs ſpace than it naturally occupies. However, Dr. Halley has aſſerted, in the Philoſophical Tranſactions, Arb. vol. ii. p. 17. that, from the experiments made at London, and by the Academy del Cimento at Florence, it might be ſafely concluded, that no force whatever is able to reduce air into 800 times leſs ſpace than that which it naturally poſſeſſes on the ſurface of our earth. In anſwer to this, M. Amontons, in the Memoirs of the French Academy, maintains, that there is no fixing any bounds to its condenſation; that greater and greater weights will ſtill reduce it into leſs and leſs compaſs; that it is only elaſtic in virtue of the fire which it contains; and that, as it is impoſſible ever to drive all the fire out of it, it is impoſſible ever to make the utmoſt condenſation.

The dilation of the air, by virtue of its elaſtic force, is found to be very ſurpriſing; and yet Dr. Wallis ſuggeſts, that we are far from knowing the utmoſt of which it is capable. In ſeveral experiments made by Mr. Boyle, it dilated firſt into nine times its former ſpace; then into thirty-one times; then into ſixty; then into 150. Afterwards it was brought to dilate into 8000 times its ſpace; then into 10,000; and even at laſt into 13,679 times its ſpace; and this altogether by its own expanſive force, without the help of fire. On this depend the ſtructure and uſe of the *manometer*. Hence it appears, that the air we breathe, near the ſurface of the earth, is compreſſed, by its own weight, into at leaſt the 13,679th part of the ſpace it would poſſeſs *in vacuo*. But if the ſame air be condenſed by art, the ſpace it will take up when moſt dilated, to that it poſſeſſes when condenſed, will be, according to the ſame author's experiments, as 550,000 to one.

M. Amontons, and others, we have already obſerved, attribute the rarefaction of the air wholly to the fire contained in it; and, therefore, by increaſing the degree of heat, the degree of rarefaction may be carried ſtill farther than its ſpontaneous dilatation. Air is expanded one third of its bulk by boiling water. Dr. Hales found that the air in a retort, when the bottom of the veſſel was juſt beginning to be red-hot, was expanded through twice its former ſpace; and in a white, or almoſt melting heat, it occupied thrice its former ſpace: but Mr. Robins found it was expanded by the heat of iron, juſt beginning to be white, to four times its former bulk. On this principle depend the ſtructure and office of the *thermometer*. M. Amontons firſt diſcovered that air will expand in proportion to its denſity with the ſame degree of heat. On this foundation the ingenious author has a diſcourſe to prove, "that the ſpring and weight of the air, with a moderate degree of warmth, may enable it to produce even earthquakes, and other of the moſt vehement commotions of nature." See the article EARTHQUAKE.

The elaſtic power of the air, then, is the ſecond great ſource of the effects of this important fluid. Thus it inſinuates into the pores of bodies; and, by poſſeſſing this prodigious faculty of expanding, which is ſo eaſily excited, it muſt neceſſarily put the particles of bodies into which it inſinuates itſelf into perpetual oſcillations. Indeed, the degree of heat, and the air's gravity and denſity, and conſequently its elaſticity and expanſion, never remaining the ſame for the leaſt ſpace of time; there muſt be an inceſſant vibration, or dilatation and contraction, in all bodies. We obſerve this reciprocation in ſeveral inſtances, particularly in plants, the air-veſſels of which do the office of lungs; for the contained air alternately expanding and contracting, according to the increaſe or diminution of the heat, alternately preſſes the veſſels, and eaſes them again; thus keeping up a perpetual motion in their juices. Hence we find, that no vegetation or germination will proceed *in vacuo*. Indeed, beans have been obſerved to grow a little-tumid therein; and this has led ſome to attribute that to vegetation which was really owing to no other cauſe than the dilatation of the air within them. The air is very inſtrumental in the production and growth of vegetables, not only by invigorating their ſeveral juices, while in an elaſtic active ſtate, but alſo by greatly contributing, in a fixed ſtate, to the union and firm connection of their ſeveral conſtituent parts. From the ſame cauſe it is, that the air contained in bubbles of ice, by its continual action burſts the ice. Thus alſo entire columns of marble ſometimes cleave in the winter time, from the increaſed elaſticity of ſome little bubble of air contained in them. From the ſame principle ariſe all putrefaction and fermentation; neither of which will proceed, even in the beſt diſpoſed ſubjects, *in vacuo*. Since we find ſuch great quantities of elaſtic air generated in the ſolution of animal and vegetable ſubſtances, a good deal muſt conſtantly ariſe from the diſſolution of theſe aliments in the ſtomach and bowels, which is much promoted by it; and, in reality, all natural corruption and alteration ſeem to depend on air.

§ 3. *Effects of the different Ingredients of Air.*—This fluid acts not only by its common properties of gravity and elaſticity, but produces numerous other effects, ariſing from the peculiar ingredients of which it conſiſts. Thus, it not only diſſolves and attenuates bodies by its preſſure and attrition, but as a chaos containing all kinds of menſtrua, and conſequently poſſeſſing powers for diſſolving all bodies. It is known that iron and copper readily diſſolve and become ruſty in air, unleſs well defended with oil. Boerhaave aſſures us, that he has ſeen pillars of iron ſo reduced by air, that they might be crumbled to duſt between the fingers; and as for copper, it is converted by the air into a ſubſtance much like the verdigriſe produced by vinegar. Mr. Boyle relates, that, in the ſouthern Engliſh colonies, the great guns ruſt ſo faſt, that, after lying in the air for a few years, large cakes of crocus martis may be ſeparated from them. Acoſta adds, that in Peru the air diſſolves lead, and conſiderably increaſes its weight. Yet gold is generally eſteemed indiſſoluble by air, being never found to contract ruſt, though expoſed to it ever ſo long. In the laboratories of chymiſts, however, where aqua regia is prepared, the air becoming impregnated with a quantity of the vapour of this menſtruum, gold contracts a ruſt like other bodies. Stones alſo undergo the changes incident to metals. Thus Purbeck ſtone, of which Saliſbury cathedral conſiſts, is obſerved gradually to become ſofter, and to moulder away in the air; and Mr. Boyle gives the ſame account of Blackington ſtone. He adds, that air may have a conſiderable operation on vitriol, even when a ſtrong fire could act no farther upon it. And he has found that the fumes of a corroſive liquor work more ſuddenly and manifeſtly on a certain metal, when ſuſtained in the air, than the menſtruum itſelf did, that emitted fumes on thoſe parts of the metal which it covered; referring to the effects of the effluvia of vinegar on copper. The diſſolving power of air is increaſed by heat, and by other cauſes. It combines with water; and by acceſs of cold, depoſits part of the matter which was kept diſſolved in it by a greater degree of heat. Hence the water, by being depoſited and condenſed upon any cold

cold body, ſuch as glaſs, &c. in windows, forms fogs, and becomes viſible.

In the various operations of chymiſtry, air is a very neceſſary and important agent; the reſult of particular proceſſes depending on its preſence or abſence, on its being open or incloſed. Thus, the parts of animals and vegetables can only be calcined in open air; in cloſe veſſels they never become any other than black coals. And theſe operations are effected by the changes to which the air is liable. Many inſtances might be adduced to this purpoſe. Let it ſuffice to obſerve, that it is very difficult to procure oil of ſulphur, *per campanam*, in a clear dry atmoſphere; but in a thick moiſt air it may be obtained with greater eaſe, and in larger quantities. So pure, well-fermented wine, if it be carried to a place where the air is repleniſhed with the fumes of new wine then fermenting, will begin to ferment afreſh.

The changes in the air ariſe from various cauſes, and are obſervable, not only in its mechanical properties, ſuch as gravity, denſity, &c. but in the ingredients that compoſe it. Thus, at Faſhlun, in Sweden, noted for copper-mines, the mineral exhalations affect the air in ſuch a manner as to diſcolour the ſilver coin in purſes; and the ſame effluvia change the colour of braſs. In Carniola, Campania, &c. where are mines of ſulphur, the air ſometimes becomes very unwholeſome, which occaſions frequent epidemic diſeaſes, &c. The effluvia of animals alſo have their effect in varying the air, as is evident in contagious diſeaſes, plagues, murrains, and other mortalities, which are ſpread by an infected air. For the vivifying principle of air, ſee the article BLOOD.

SECT. II. *Account of the principal Diſcoveries concerning the Compoſition of Atmoſpherical Air, and other Aerial Fluids.*

While the preceding diſcoveries were making concerning the mechanical and other properties of the air, little notice ſeems to have been taken of the elementary parts of the air itſelf, or the different kinds of fluid which go under that name. It was known, indeed, that air was ſeparable from terreſtrial bodies by means of fire, fermentation, &c. but this was commonly reckoned to be the ſame with that we breathe. Van Helmont, a diſciple of Paracelſus, was the firſt who undertook to make enquiries concerning this ſpecies of air. He gave it the name of *gas ſylveſtre*, from the Dutch word *ghoaſt*, ſignifying ſpirit; and obſerves that ſome bodies reſolve themſelves almoſt entirely into it. "Not (ſays he) that it had been actually contained in that form in the bodies from which it was ſeparated, but it was contained under a concrete form, as if fixed, or coagulated." According to this author, the gas ſylveſtre is the ſame with what is ſeparated from all ſubſtances by fermentation; from vegetables by the action of fire: from gun-powder when it explodes; and from charcoal when burning. On this occaſion he aſſerts, that ſixty-two pounds of charcoal contains ſixty-one pounds of gas, and only one pound of earth. To the effluvium of gas he alſo attributes the fatal effects of the Grotto del Cani, in Italy, [ſee an account of this grotto in the alphabet] and the ſuffocation of workmen in mines. He aſſerts, that it is to the corruption of the aliment, and the gas diſcharged from it, that we are to attribute wind, and the diſcharges of it from the bowels. Upon the ſame principles he accounts for the ſwelling of dead bodies which have remained for a time under water, and for the tumours which ariſe on ſome parts of the body in certain diſeaſes. He alſo determines, that this gas is different from the air we breathe; that it has a greater affinity with water: and he imagined it might conſiſt of water reduced to vapours, or a very ſubtile acid combined with volatile alkali.

Mr. Boyle repeated all Van Helmont's experiments to more advantage than he himſelf had performed them; but ſeems not to have proceeded further in his diſcoveries than Van Helmont did: only he found ſome bodies, ſuch as ſulphur, amber, camphor, &c. diminiſh the volume of air in which they burn.

Dr. Hales firſt attempted to determine the quantity of air produced from different bodies; for which purpoſe he made experiments on almoſt every known ſubſtance in nature, examining them by diſtillation, fermentation, combuſtion, combinations, &c. He alſo firſt ſuſpected, that the briſkneſs and ſparkling of the waters, called *acidulous*, were owing to the air they contained. But, notwithſtanding all his diſcoveries concerning the quantity of elaſtic fluid obtained from different bodies, he did not imagine there was any eſſential difference between this fluid and the air we breathe; only that the former was loaded with noxious vapours, foreign to its nature. His ſuſpicion concerning this impregnation was confirmed by M. Venel, profeſſor of chymiſtry at Montpellier, in a Memoir read before the Royal Academy of Sciences in 1750.

It was not long before the diſcovery of this ſpecies of air ſuggeſted new theories in phyſiology and natural philoſophy. Mr. Haller had inferred, from Dr. Hales's experiments, that air is the real cement of bodies: which, fixing itſelf in the ſolids and fluids, unites them to each other, and ſerves as a bond by which they are kept from diſſolution. In 1764, Dr. Macbride, of Dublin, publiſhed a number of experiments in ſupport of this doctrine. From his work it appears, that fixed air is ſeparated not only from all ſubſtances in fermentation, but alſo from all animal ſubſtances as they begin to putrefy; and this air is capable of uniting itſelf to all calcareous earths, as well as alkalis, both fixed and volatile, and reſtoring to them the property of effervescing with acids, when they have by any means been deprived of it. But though theſe opinions have ſince been found erroneous, the concluſions drawn by him from his numerous experiments ſtill hold good, viz. that fixed air is an elaſtic fluid, very different from the common air we breathe: that it is poſſeſſed of a ſtrong antiſeptic quality, and may be introduced with ſafety into the inteſtinal canal, and other parts of the animal œconomy, where common air would have fatal effects; but is mortal, if breathed into the lungs, &c.

The diſcoveries of Dr. Black concerning fixed air had not been long publiſhed, when they were violently attacked by ſome foreign chymiſts, while his cauſe was as eagerly eſpouſed by others. The principal opponents were Mr. Meyer, apothecary at Oſnabruck, Mr. Crans, phyſician to his Ruſſian Majeſty, and Mr. de Smeth at Utrecht. Their arguments, however, were effectually anſwered at the time by Mr. Jacquin, botanical profeſſor at Vienna; and the numerous diſcoveries made ſince that time have given ſuch additional confirmation to his doctrine, that it is now univerſally adopted by chymiſts, both in Britain and other countries. It was reſerved, however, for Dr. Prieſtley to make the great diſcovery concerning the nature of our atmoſphere; and to inform the world, that it is compoſed of two fluids: the one abſolutely noxious, and incapable of ſupporting animal life for a moment; the other extremely ſalutary, and capable of preſerving animals alive and healthy, for a much longer time than the pureſt air we can meet with. This may be conſidered as the ultimate period of our hiſtory: for, ſince that time, the diſcoveries of philoſophers ſtill living, in many different countries, have been ſo rapid, that it is difficult to aſcertain the dates of them by any authentic documents; eſpecially as, by reaſon of ſuch numerous experiments, the ſame things have not unfrequently been diſcovered by different perſons unknown to each other. We ſhall therefore proceed to give an account of the different kinds of ærial fluids, beginning with thoſe which are known, or ſuppoſed, to conſtitute a part of our atmoſphere.

SECT. III. *Of Dephlogiſticated Air.*

§ 1. *Diſcovery and Methods of procuring this Kind of Air.*—Dephlogiſticated air was firſt obtained by Dr. Prieſtley on the 1ſt of Auguſt, 1774. The circumſtances which led him to the diſcovery were his having always procured inflammable air from ſpirit of ſalt, by adding to it ſpirit of wine, oil of olives, oil of turpentine, charcoal, phoſphorus, bees-wax, and even ſulphur. Hence he ſuſpected that the common air we breathe might be compoſed of ſome kind of acid united with phlogiſton. On this ſuppoſition he extracted air from mercurious calcinatus *per ſe*, by expoſing it to the focus of a burning glaſs twelve inches in diameter; and having repeated the experiment with red precipitate and minium, he found that, though a quantity of fixed air was always produced, yet, after that was ſeparated, the remainder ſupported flame much more vigorouſly than common air; for a candle burned in it with a flame very much enlarged, and with a crackling noiſe, at the ſame time that it appeared fully as much diminiſhed by the teſt of nitrous air; whence he concluded, that it was reſpirable; and, on making the experiment, found that it actually was ſo, for a mouſe lived a full half hour in a quantity of this fluid; which, had it been common air, would only have kept it alive half that time. Nor did the animal ſeem to be otherwiſe injured than by the cold; as it preſently revived on bringing it near the fire; and the remainder of the air ſtill appeared better than that of the atmoſphere, when the teſt of nitrous air was applied to it. This pure kind of air being diſcovered, the Doctor next proceeded to name it *dephlogiſticated*, from his opinion that common air, in the act of burning, abſorbed phlogiſton; of conſequence, he ſuppoſed, that which abſorbed the moſt, or which moſt vigorouſly, and for the greateſt length of time, ſupported flame, was ſuppoſed to contain the ſmalleſt quantity of this ſubſtance. In the courſe of his enquiries why this kind of air comes to be ſo much dephlogiſticated, he fell upon a method of extracting it from a great variety of ſubſtances; viz. by moiſtening them with the ſpirit of nitre, and then diſtilling them with a ſtrong heat. Thus he obtained it from the flowers of zinc, chalk, quicklime, ſlacked lime, tobacco-pipe clay, flint, Muſcovy tales, and even glaſs. He then found that, by ſimply diſſolving any metal in the nitrous acid, and then diſtilling the ſolution, he could obtain very pure air: and Mr. Warltire found even the trouble of diſtillation unneceſſary; nothing more being requiſite than to moiſten red lead with the ſpirit of nitre, and then pour upon it the oil of vitriol, which inſtantly diſengaged the dephlogiſticated air, without applying any more heat than what was generated by the mixture.

While diſcoveries of this kind engaged Dr. Prieſtley in England, Mr. Scheele was employed in a ſimilar manner in Sweden; and had actually obtained the ſame kind of air, without knowing any thing of what Dr. Prieſtley had done. The latter had the merit of the prior diſcovery: but Mr. Scheele's method was more ſimple, conſiſting only in the diſtillation of nitre with a ſtrong heat; by which means it is now found that dephlogiſticated air may be obtained in a very conſiderable quantity, and in as great purity, as by the more expenſive proceſſes. The pure air from nitre had, indeed, partly been obtained by Dr. Hales long before this time; ſince he informs us, that half a cubic inch of nitre

yielded ninety cubic inches of air, which was undoubtedly the fluid we ſpeak of; but as he neglected to proſecute the diſcovery, nothing farther was known at that time. As the nitrous acid was univerſally concerned in the firſt proceſſes for obtaining this kind of air, it was for ſome time generally believed to be a peculiar property of that acid alone to produce it; but the indefatigable genius of Dr. Prieſtley ſoon found, that it might not only be procured where no nitrous acid was employed, but where the ſubſtances were treated with vitriolic acid. It was, indeed, evident, from the very firſt experiment, that nitrous acid was not eſſentially neceſſary, ſince pure air was procured from precipitate *per ſe*, in the preparations of which no nitrous acid is employed. The mode of applying heat has alſo a very conſiderable effect on the quantity of air produced. Thus, Dr. Prieſtley remarks, that "from equal quantities of red lead, without any mixture of ſpirit of nitre, and uſing the ſame apparatus for diſtilling, he obtained, by means of heat applied ſuddenly, more air than, when ſlowly applied, in the proportion of ten to ſix. The proportion of fixed air was the ſame in both caſes, and the remainder equally dephlogiſticated."

The reſult of experiments, made by philoſophers in different countries, was, that dephlogiſticated air may be obtained from a vaſt variety of mineral and metallic ſubſtances, by means of the vitriolic and nitrous acids. It now remained only to diſcover in what manner this fluid, ſo eſſentially neceſſary to the ſupport of animal life, is naturally produced in quantities ſufficient for the great expence of it throughout the world, by the breathing of animals, the ſupport of fires, &c. This diſcovery, indeed, had been made before even the exiſtence of dephlogiſticated air itſelf was known. Dr. Prieſtley, after having tried various methods of purifying contaminated air unſucceſsfully, found, at laſt, that ſome kinds of vegetables anſwered this purpoſe very effectually; for which diſcovery he received the thanks of the Royal Society. Among the vegetables employed on this occaſion, he found mint anſwer the purpoſe very effectually. "When air," ſays he, "has been freſhly and ſtrongly tainted with putrefaction, ſo as to ſmell through the water, ſprigs of mint have preſently died upon being put into it, their leaves turning black; but if they do not die preſently, they thrive in a moſt ſurpriſing manner. In no other circumſtances have I ſeen vegetation ſo vigorous as in this kind of air, which is immediately fatal to animal life. Though theſe plants have been crowded in jars filled with this kind of air, every leaf has been full of life; freſh ſhoots have branched out in various directions, and grown much faſter than other ſimilar plants growing in the ſame expoſure in common air." Having, in conſequence of this obſervation, rendered a quantity of air thoroughly noxious, by mice breathing and dying in it, he divided it into two receivers inverted in water, introducing a ſprig of mint into one of them, and keeping the other receiver unaltered. About eight or nine days after, he found that the air of the receiver into which he had introduced the ſprig had become reſpirable; for a mouſe lived very well in this, whereas it died the moment it was put into the other.

From theſe experiments the Doctor at firſt concluded, that, in all caſes the air was meliorated by the vegetation of plants: but even in his firſt volume he obſerves, that ſome experiments of this kind did not anſwer ſo well towards the end of the year as they had done in the hot ſeaſon; and a ſecond courſe ſeemed to be almoſt entirely contrary to the former. Having tried the power of ſeveral ſorts of vegetables upon air infected by reſpiration, or by the burning of candles, he found that it was generally rendered worſe by their vegetation; and the longer the plants were kept in the infected air, the more they phlogiſticated it; though in ſeveral caſes it was undoubtedly meliorated, eſpecially by the ſhoots of ſtrawberries, and ſome other plants, introduced into the vials containing foul air, and inverted in water, which were placed near them, whilſt the roots continued in the earth in the garden. Sometimes the infected air was ſo far mended by the vegetation of plants, that it was in a great meaſure turned into dephlogiſticated air. "On the whole," ſays Dr. Prieſtley, "I ſtill think it probable, that the vegetation of healthy plants, growing in ſituations natural to them, have a ſalutary effect on the air in which they grow: for one inſtance of the melioration of air in theſe circumſtances ſhould weigh againſt an hundred in which the air is made worſe by it, both on account of the diſadvantages under which all plants labour, in the circumſtances in which theſe experiments muſt be made, as well as the great attention, and many precautions, that are requiſite in conducting ſuch a proceſs."

At the time Dr. Prieſtley made theſe experiments, he ſuppoſed that the air was meliorated merely by the abſorption of phlogiſton from that which had been tainted: but the experiments of Dr. Ingenhouſz, made in 1779, ſhowed that this was accompliſhed, not only by the abſorption juſt mentioned, but by the emiſſion of dephlogiſticated air. He obſerved, in general, that plants have a power of correcting bad air, and even of improving common air in a few hours, when expoſed to the light of the ſun; but, in the night-time, or when they are not influenced by the ſolar rays, they contaminate the air. This property, however, does not belong in an equal degree to all kinds of plants: nor is it poſſible to diſcover, by the external properties of a plant, whether it be fit for this purpoſe or not; as ſome, which have a bad ſmell, and are entirely unfit for food, ſhow themſelves much ſuperior to others whoſe external appearance would ſeem preferable. His method of making the experiment was, to fill a vial with air, fouled either by reſpiration or combuſtion; after which a ſprig of any plant was introduced, by paſſing it through the water in which the vial was immerſed. The vial was then ſtopped; or it was removed into a ſmall baſon full of water, and expoſed to the ſun, or ſituated in ſome other proper place, as occaſion required. Air phlogiſticated by breathing, and in which a candle could not burn, after being expoſed to the ſun for three hours, with a ſprig of peppermint in it, was ſo far corrected, as to be again capable of ſupporting flame. The following experiment, however, made with a muſtard plant, may be looked upon as deciſive. A plant of this kind was put into a glaſs receiver containing common air, and its ſtem cut off even with the mouth of the receiver. The veſſel was then inverted into an earthen pan, containing ſome water to keep the plant alive, and the whole apparatus was ſet over-night in a room. Next morning the air was found ſo much contaminated, that it extinguiſhed the flame of a wax taper. On expoſing the apparatus to the ſun for a quarter of an hour, the air was found to be ſomewhat corrected; and after an hour and an half it was ſo far improved, that, by the teſt of nitrous air, it appeared conſiderably better than common air.

Before we proceed farther in the account of Dr. Ingenhouſz's experiments, it will be neceſſary to relate ſome obſervations made by Dr. Prieſtley; from which it appears, that dephlogiſticated air, in a very conſiderable quantity, may, in certain circumſtances, be procured from water alone. The ſubſtance of theſe is, that water, eſpecially pump-water, when expoſed to the light of the ſun, emits air ſlowly; but after ſome time a green matter appears on the bottom and ſides of the glaſs; after which it emits very pure air in great quantity, and continues to do ſo for a very long time, even after the green matter has ſhown ſome ſymptoms of decay, by becoming yellow. He obſerved that the water which naturally contained the greateſt quantity of fixed air, yielded alſo the greateſt quantity of that which was dephlogiſticated; but that the quantity of the latter much exceeded that of the fixed air contained even in any water. The light of the ſun was found to be an eſſential requiſite in the formation of this air, as very little, and that of a much worſe quality, was produced in the dark.

As the green matter produced in Dr. Prieſtley's glaſſes was by himſelf, as well as others, conſidered as belonging to the vegetable kingdom, Dr. Ingenhouſz improved upon his proceſs, by putting the leaves of plants into water, and expoſing them to the ſun. All plants were not equally fit for producing dephlogiſticated air by this method, more than by the other. Some poiſonous plants, as the hyoſcyamus, lauro-ceraſus, night-ſhade, the tobacco-plant, a triplex vulvaria, cicuta aquatica, and ſabina, were found very fit for the purpoſe: but the pureſt kind of air was extracted from ſome aquatic vegetables, the turpentine trees, and eſpecially from the green matter he collected in a ſtone trough, which was kept continually filled from a ſpring near the high-road. The purity of this dephlogiſticated air, he ſays, was equal, if not ſuperior, to that procured by the beſt chymical proceſſes, as it ſometimes required eight times its own quantity of nitrous air to ſaturate it. All parts of the plants were not found equally proper for the production of dephlogiſticated air; the full grown leaves yielded it in the greateſt quantity and purity, eſpecially from their under ſurface. It was alſo procured from the green ſtalks. The roots of plants, he ſays, when kept out of the ground, generally yield bad air, and at all times contaminate common air, a few only excepted. Flowers and fruits, in general, yield a very ſmall quantity of noxious air, and contaminate a great quantity of common air at all times, eſpecially in the night, and when kept in the dark. Two dozen of young and ſmall French beans, kept in a quart jar of common air for a ſingle night, contaminated the air to ſuch a degree, that a very lively chicken died, by being confined in it, in leſs than half a minute.

The obſervations of Dr. Ingenhouſz, on the whole, ſays Mr. Cavallo, clearly ſhow, "that the vegetation of plants is one of the great means employed by nature to purify the atmoſphere, ſo as to counteract, in a great meaſure, the damage done by animal reſpiration, combuſtion, &c. It may only be ſaid, that vegetation does not appear to be ſufficient to remedy entirely that damage." The Doctor himſelf, however, ſpeaks very highly of the powers of vegetables in this reſpect. He informs us, that their office, in yielding dephlogiſticated air, begins a few hours after the ſun has made his appearance in the horizon, or rather after it has paſt the meridian, and ceaſes with the cloſe of day; excepting ſome plants, which continue it a ſhort time after ſun-ſet. The quantity of dephlogiſticated air, yielded by plants in general, is greater in a clear day than when it is ſomewhat cloudy. It is alſo greater when the plants are more expoſed to the ſun, than when they are ſituated in ſhady places. He obſerves, moreover, that the damage done by plants in the night is more than counterbalanced by the benefits they afford in the day-time. "By a rough calculation (ſays he) I found the

poiſonous

pulfonous air, yielded by any plant during the whole night, could not amount to the one hundredth part of the dephlogifticated air which the fame plant yielded in two hours time in a fair day." It does not appear, however, that plants yield dephlogifticated air by any kind of generation of that fluid, but only by filtrating the common air, which all plants abforb through their pores; the phlogiftic part becoming part of their fubftance, and probably being the true vegetable food. Dry plants have little or no effect upon the air until they are moiftened. On all thefe experiments, however, it muft be obferved, that they have fometimes failed in the hands of thofe whom we cannot but fuppofe very capable of trying them; as Mr. Scheele, Mr. Cavallo, and the Abbé Fontana.

After the publication of Dr. Ingenhoufz's experiments, it became generally believed, that the atmofphere was meliorated by the common procefs of vegetation, and that plants abforbed the phlogiftic part as their food, difcharging the pure dephlogifticated air as an excrement; which is juft the reverfe of what happens to animals, who abforb the pure part in refpiration, and reject the phlogiftic. In the Philofophical Tranfactions for 1787, however, we find a number of experiments related by Sir Benjamin Thompfon, which feem to render this matter dubious. One very confiderable objection is, that the green matter, already mentioned in Dr. Prieftley's experiments, when carefully obferved by a good microfcope, appears not to be of a vegetable, but of an animal nature. "The colouring matter of the water (fays he) is evidently of an animal nature; being nothing more than the aflemblage of an infinite number of very fmall, active, oval-formed animalcules, without any thing refembling *tremella*, or that kind of green matter, or water-mofs, which forms upon the bottom and fides of the veffel, when this water is fuffered to remain on it for a confiderable time, and into which Dr. Ingenhoufz fuppofes the animalcules above mentioned to be actually transformed." This gentleman has alfo found, that feveral animal fubftances, as well as vegetables, have a power of feparating dephlogifticated air from water when expofed to the light of the fun, and that for a very great length of time. Not that the fame quantity of water will always continue to furnifh air; but the fame animal fubftance being taken out, waffied, and again put into frefh water, feems to yield dephlogifticated air, without any kind of limitation. Raw filk poffeffes a remarkable power of this kind. To determine it, Sir Benjamin introduced thirty grains of this fubftance, previoufly waffied in water, into a thin glafs globe, four inches and a half in diameter, having a cylindrical neck three fourths of an inch wide, and twelve inches long, inverting the globe into a jar filled with the fame kind of water, and expofing it to the action of the fun in the window. It had not been ten minutes in this fituation, when the filk became covered with an infinite number of air-bubbles, gradually increafing in fize, till, at the end of two hours, the filk was buoyed up, by their means, to the top of the water. By degrees they began to feparate themfelves, and form a collection of air in the upper part of the globe; which, when examined by the teft of nitrous air, appeared to be very pure. In three days he had collected 3¼ cubic inches of air; into which a wax taper being introduced, that had juft before been blown out, the wick only remaining red, it inftantly took fire, and burned with a bright and enlarged flame. In making thefe experiments, as it was found fomewhat troublefome to invert the globes in water, they were at laft only kept in an inclined pofture on the table, as reprefented in *Fig.* 17. Plate I. in the Syftem of PNEUMATICS, in the defcription of which is laid down the eafieft method of procuring dephlogifticated air.

The following experiments were made with a view to determine the quantity and quality of air produced by means of the heat and light of the fun from water alone. A large jar of clear glafs, containing 455 cubic inches, being waffied very clean, was filled with frefh fpring water, inverted in a glafs bafon of the fame, and expofed to the weather for twenty-eight days. At the fame time, another fimilar jar was filled with water, taken from a pond in a garden, in which many aquatic plants were growing, and expofed in the fame place, and during the fame period. The latter began to yield air in pretty large quantities on the third day, and continued to do fo till the fourteenth: the former yielded little or none till the fourteenth, when it began to emit air, and continued to do fo till the twenty-fecond. On removing the air produced, that from the fpring water was 14 inches in quantity, and 138 in quality; but from the pond water, 31¼ in quantity, and 252 in quality. The colour of the waters was not changed; but both of them had depofited a confiderable quantity of earth, which was found adhering to the furfaces of the glafs bafons in which the jars were inverted. As the bafons, however, were very thick, and confequently had but little tranfparency, the fediment of the water was in a great meafure deprived of the benefit of the fun's light: the experiment was therefore repeated with the following variation: in a large cylindrical jar of very fine tranfparent glafs, 10 inches in diameter, and 12 inches high, filled with fpring-water, a conical jar, 9¼ inches in diameter at the bottom, and containing 344 inches, was inverted, and the whole expofed to the fun for twenty-one days. Little air was furnifhed till the feventh day, when the liquor aflumed a greenifh caft; and a fine flimy fediment of the fame colour, the green matter of Dr. Prieftley, beginning to be formed on the bottom, air was generated in abundance, and was furnifhed in pretty large quantities the eighteenth, when it entirely ceafed. The whole amounted to 40 cubic inches, and the quality 213.

Sir Benjamin Thompfon obferves, that, as he never was thoroughly fatisfied with the opinion of Dr. Ingenhoufz, that the dephlogifticated air was *elaborated* in the veffels of the plant, he found his doubts rather confirmed than diminifhed by experiments. "That the frefh leaves of certain vegetables (fays he) expofed in water to the fun's rays, cauſe a certain quantity of pure air to be produced, is a fact which has been put beyond all doubt: but it does not appear to me by any means fo clearly proved, that this air is elaborated in the plant by the powers of vegetation; phlogifticated or fixed air being received by the plant as food, and the dephlogifticated air rejected as an excrement: for, befides that, many other fubftances, and in which no elaboration or circulation can poffibly be fuppofed to take place, cauſe the water, in which they are expofed to the action of the light, to yield dephlogifticated air as well as plants, and even in much greater quantities, and of a more eminent quality. The circumftances of the leaves of a vegetable, which, accuftomed to grow in air, are feparated from its ftem, and confined in water, are fo unnatural, that I cannot conceive that they can perform the fame functions in fuch different fituations. Among many facts which have been brought in fupport of the received opinion of the elaboration of air in the veffels of plants, there is one upon which great ſtreſs is laid, which, I think, requires further examination. The frefh healthy leaves of vegetables, feparated from the plant, and expofed in water to the action of the fun's rays, appear, by all the experiments which have hitherto been made, to furnifh air only for a fhort time. After a day or two, the leaves, changing colour, ceafe to yield air. This has been conceived to arife from the powers of vegetation being deſtroyed, or, in other words, the death of the plant: and from hence it has been inferred, with fome degree of plauſibility, not only that the leaves actually retained their vegetative powers for fome time after they were feparated from their ſtock, but that it was in conſequence of the exertion of thoſe powers, that the air yielded in the experiment was produced. But I have found, that, though the leaves, expoſed in water to the light, actually do ceaſe to furniſh air after a certain time, yet that they regain this power after a ſhort interval, when they furniſh (or rather cauſe the water to furniſh) more, and alſo better, air than at firſt; which can hardly be accounted for upon the ſuppoſition that the air is elaborated in the veſſels of the plants."

On making other trials with leaves immerſed in water already green, and prepared to yield dephlogifticated air, it was found that they produced air in great quantity: but our author is of opinion, that all the appearances may be ſolved, by ſuppoſing that the air was produced in the maſs of water by the green matter; and that the leaves, ſilk, &c. did no more than aſſiſt in making its eſcape, by affording a convenient ſurface to which it could attach itſelf, in order to collect together, and aſſume its elaſtic form. Thus we ſee, that nature is provided with abundant reſources for the ſupplying of this pure part of the atmoſphere which is ſubject to ſuch continual waſte; and there is not the leaſt doubt, that, in a great number of caſes, the light of the ſun produces pure air from water as well as from vegetables. It is probable, alſo, that even the waters of the ocean contribute towards this ſalutary purpoſe; as Dr. Dobſon, of Liverpool, found, that ſea water contained air ſuperior in quality to that of the atmoſphere. As dephlogiſticated air is found to ſupport animal life for a much longer time than common air, it has been ſuppoſed that it might anſwer valuable purpoſes in medicine, provided any cheap method of procuring it in large quantities could be projected. With this view, Mr. Cavallo propoſes to diſtil it from nitre, with a ſtrong heat.

§ 2. *Properties of Dephlogifticated Air.*—This kind of air poſſeſſes ſome of the properties of common air in a very eminent degree, but is deficient in others. Thoſe in which it excels are the ſupport of flame and of animal life. It is equally elaſtic, or rather more ſo, than common air; as it likewiſe exceeds it a little in ſpecific gravity, the proportion betwixt it and common air being that of 160 to 152. On introducing a lighted candle into dephlogiſticated air, the flame not only grows larger, but becomes exceeding bright; and when the air is very pure, the candle burns with a crackling noiſe, as if the air contained ſome combuſtible matter, at the ſame time that the wax or tallow waſtes ſurpriſingly faſt. The heat of the flame is in proportion to its light. If we fill a bladder with dephlogiſticated air, and then faſten to its neck a glaſs tube, whoſe aperture is drawn to a fine point, the dephlogiſticated air, if driven out by preſſing the bladder, will augment the heat of a candle to ſuch a degree, that, if any ſmall bits of metal, placed on a piece of charcoal, be held in the apex of the flame, they will almoſt inſtantly be melted. Even grains of platina may by this means be melted; and in a large fire there is no doubt that the effects of burning mirrors might be equalled. On mixing dephlogiſticated and inflammable air together, an explo-ſion takes place as on mixing common and inflammable air, but with much greater violence. If an ounce vial, which, for this

purpoſe,

purpoſe, ſhould be very ſtrong, be filled with a little more than one third of dephlogiſticated, and the reſt inflammable, air, and the flame of a candle preſented to its mouth, it will explode nearly as loud as a ſmall piſtol. All phlogiſtic proceſſes are promoted much better by dephlogiſticated than common air. Dr. Prieſtley put a quantity of pyrophorus into one of the ſmall jars uſed for making experiments upon air in quickſilver; then filling up the veſſel with that fluid, he inverted it in a baſon of the ſame, and threw in dephlogiſticated air at different times. It always occaſioned a ſudden and vehement accenſion, like the flaſhing of gunpowder, and the air was greatly diminiſhed.

Dephlogiſticated air is much inferior to that of the common atmoſphere in ſupporting vegetable life. This has been aſcertained by the experiments of Dr. Prieſtley, Mr. Fontana, Mr. Scheele, Dr. Ingenhouſz, &c. Dr. Prieſtley took three ſprigs of mint, and having put all the roots into vials containing the ſame pump-water which had been for ſome time expoſed to the atmoſphere, introduced one of them into a jar of dephlogiſticated air, another into a jar of common air, and a third into that which had been phlogiſticated with nitrous air ſeveral months before, and in ſuch a ſtate, that one meaſure of it, and one of nitrous air, occupied the ſpace of 1¼ meaſures. This was done in April; and on examining them on the 12th of May following, it was found that the plant in phlogiſticated air had grown remarkably, much better than that in common air; while the plant in dephlogiſticated air had a very ſickly appearance. Examining them on the 26th of the ſame month, the appearance continued nearly as before; but it was now found, that, though the plant in phlogiſticated air had grown ſo well, the air was not ſenſibly improved by it, though the dephlogiſticated air was injured by the plant which grew in it.

§ 3. *Of the Compoſition of Dephlogiſticated Air.*—After a variety of experiments, it is concluded, by the moſt celebrated philoſophers and chymiſts, That dephlogiſticated air is one of the conſtituent and elementary parts of water, inflammable air being the other: though the opinion is ſtill conteſted by ſome foreign chymiſts.

The whole of Doctor Prieſtley's opinions on the component parts of this kind of air are ſummed up in the following ſentence in his *Obſervations relating to Theory*. "The only kind of air that is thought to be properly elementary, and to conſiſt of a ſimple ſubſtance, is dephlogiſticated air; with the addition at leaſt of the principle of heat, concerning which we know very little; and as it is not probable that this adds any thing to the weight of bodies, it can hardly be called an element in their compoſition. Dephlogiſticated air appears to be one of the elements of water, of fixed air, of all the acids, and many other ſubſtances, which, till lately, have been thought to be ſimple.

The experiments of the French philoſophers were of the ſame nature with thoſe of Mr. Cavendiſh, but conducted on a larger ſcale. The inference drawn from them was the ſame with that already mentioned, viz. that dephlogiſticated and inflammable air, in all caſes, are the two conſtituent parts of water. This opinion is adopted by Mr. Kirwan, in his *Treatiſe on Phlogiſton*. "The experiments of Mr Cavendiſh, and of Mr. Monge (ſays he) appear to me to leave no room to doubt, that, when very pure dephlogiſticated and inflammable air are inflamed, the product is mere water; for when theſe airs are employed in the proper proportion, only one of the mixture of both airs retains its aerial form. Now it is impoſſible to ſuppoſe that all the water obtained pre-exiſted in theſe airs; that is, that forty-nine parts in fifty were mere water."

Notwithſtanding theſe poſitive concluſions, however, by ſome of the moſt reſpectable names in this country, the evidences adduced have been unſatisfactory to ſome French chymiſts, who maintain, that Meſſrs Cavendiſh, Prieſtley, and Kirwan, are totally miſtaken with regard to the production of water from dephlogiſticated and inflammable air, contending, that the water obtained had previouſly exiſted in the air, and was not originally produced in the operation.

SECT. IV. *Of Phlogiſticated Air.*

The univerſal prejudice in favour of the exiſtence of that principle named phlogiſton, firſt ſuggeſted by Stahl, gave riſe, on the firſt appearance of Dr. Prieſtley's diſcoveries, to a theory, concerning the action of this ſubſtance upon air, and other bodies. As it has been obſerved, that air was diminiſhed in ſome caſes at leaſt, by burning, univerſally by reſpiration, and by ſome other proceſſes, it was imagined that phlogiſton was a body of ſuch a ſingular nature, that, when mixed with air, it always diminiſhed its bulk, inſtead of enlarging it, which might have been more naturally expected from the mixture of any vapour whatever. It was alſo ſuppoſed by ſome, that the phlogiſton was not only entirely devoid of gravity, but that it was a principle of poſitive levity; ſo that the abſolute weight of bodies was diminiſhed by an union with it, and augmented when it was expelled, though their ſpecific gravity was diminiſhed. Various other ſurpriſing properties were attributed to phlogiſton; ſuch as that of giving elaſticity to air, conſtituting flame by a chymical combination with air, &c. Its emiſſion into the atmoſphere was ſuppoſed to be always attended with a diminution of air; and therefore, all proceſſes in which air was diminiſhed, and become noxious, ſuch as that by liver of ſulphur, a mixture of iron filings and brimſtone, &c. were called phlogiſtic proceſſes. Reſpiration of animals was taken into the ſame account; but neither in this, or in combuſtion, was it allowed that any kind of vital ſpirit was abſorbed by the blood, or ſeparated from the air by the burning body. On the contrary, it was ſtrenuouſly argued, that all this was performed by the emiſſion of phlogiſton from the lungs, or the inflamed ſubſtance, which depraved the air, and diminiſhed it in bulk; and as all air was ſuppoſed to contain phlogiſton, it was likewiſe imagined, that, in all caſes where air was mended, as by the growing of vegetables, or agitation in water, the emendation was accompliſhed, not by the emiſſion of any thing into the atmoſphere, but by the mere abſorption of phlogiſton. In other reſpects, this ſubſtance was thought to be an exceedingly powerful principle in nature; the light of the ſun itſelf, and the electric fluid, being ſaid to be modifications of it, the different kinds of airs to be phlogiſtic vapours, &c. ſo that the whole ſyſtem of nature ſeemed ready to be abſorbed by it at once.

The formidable powers of this principle were firſt checked by the diſcoveries of Mr. Lavoiſier, though the latter erred equally on the contrary ſide; and, not content with keeping the phlogiſtic principle within due bounds, would needs deny its exiſtence altogether. In a treatiſe, publiſhed in the year 1782, he firſt impugns Dr. Prieſtley's theory of reſpiration, and denies that "the reſpiration of animals has the property of phlogiſticating air in a manner ſimilar to what is effected by the calcination of metals, and many other chymical proceſſes; and that it ceaſes not to be reſpirable till the inſtant when it becomes ſurcharged, or at leaſt ſaturated, with phlogiſton."

From theſe experiments, and many others ſimilar, it appears that the doctrine of phlogiſton had been carried too far by Dr. Prieſtley, and other Britiſh philoſophers, and that the air conſiſts of two kinds of fluids; one perfectly ſalutary, and friendly in the higheſt degree to animal life; the other altogether unfit for it. Theſe two appear incapable of being converted directly into one another by any proceſs, natural or artificial: for though both are deſtructible, yet they are always converted into other ſubſtances; from which, indeed, either the one or the other may be extracted at pleaſure, by employing the proper methods.

The other properties of it are, that it is extremely fatal to animal life, and friendly to that of vegetables, inſomuch that it is now generally believed to be the true and proper nouriſhment of the latter. It ſeems to exiſt originally, in a very large quantity, in our atmoſphere. It may be ſeparated from the common maſs of air by combuſtion, by reſpiration, by putrefaction, and in ſhort, by every ſpecies of phlogiſtic proceſs; neither is there any other ſpecies of air but what may be converted into this by means of fire, dephlogiſticated air alone excepted.

Phlogiſticated air is now generally believed to be a combination of the nitrous acid with phlogiſton; and that, in its gradual progreſs towards this, which is its ultimate ſtage, it firſt aſſumes the character of phlogiſticated nitrous acid; then of nitrous air, in which it readily parts with its phlogiſton to the atmoſphere, or rather to the dephlogiſticated part of it; and, laſtly, it becomes phlogiſticated air, in which the union betwixt the principles is ſo ſtrong, that it cannot be broken by ſimple expoſure to dephlogiſticated air without heat; though the experiments of Mr. Cavendiſh ſhow, that this may be done by means of the electric ſpark, which produces the moſt violent heat we can imagine.

It muſt be remembered, that the common air conſiſts of one part of dephlogiſticated, and four of phlogiſticated air; ſo that a mixture of five parts of pure dephlogiſticated air, and three of common air, is the ſame thing as a mixture of ſeven parts of dephlogiſticated air with three of phlogiſticated.

As far as the experiments hitherto publiſhed extend, we ſcarcely know more of the nature of the phlogiſticated part of the atmoſphere, than that it is not diminiſhed by lime water, cauſtic alkalis, or nitrous air; that it is unfit to ſupport fire, or maintain life in animals; and that its ſpecific gravity is not much leſs than that of common air; ſo that, though the nitrous acid, by being united to phlogiſton, is converted into air poſſeſſed of theſe properties; and, conſequently, though it was reaſonable to ſuppoſe, that part at leaſt of the phlogiſticated air of the atmoſphere conſiſts of this acid united to phlogiſton; yet it might be fairly doubted whether the whole is of this kind, or whether there are not, in reality, many different ſubſtances confounded by us under the name of phlogiſticated air.

SECT. V. *Of Fixed Air.*

This kind of air was firſt diſcovered by Van Helmont, who gave it the name of *gas ſylveſtre*, from its being emitted in great quantity by burning charcoal. Subſequent diſcoveries ſhowed, that a fluid of the ſame kind was plentifully produced by fermenting liquor, in almoſt every kind of combuſtion, and naturally generated in a vaſt quantity in mines and coal-pits, where it is known by the name of the *choak-damp*; that it exiſts in a concrete ſtate, in alkaline ſalts, chalk, lime-ſtone, the ſhells of marine animals, magneſia alba, &c. in a very large proportion, conſtituting one half, and ſometimes more, of their weight; and that it might always be extracted from the atmoſphere, in unlimited quantity, by expoſing certain ſubſtances to it. On examining the nature of this fluid, it was found ſo manifeſtly

manifeſtly acid, that it has now obtained a place among theſe ſubſtances, under the name of *aerial acid*; or, more improperly, *cretaceous acid*, from its being contained in great quantities in chalk, as has been already mentioned. Fixed air is the heavieſt of all permanently elaſtic fluids, excepting thoſe derived from the mineral acids. Mr. Kirwan determines it to be to common air as 1500 to 1000, the barometer being at 29.85, the thermometer at 64, and the fixed air being extracted from calcareous ſpar, by marine acid, whoſe ſpecific gravity was 1.0145. He obſerves, however, that though this air was obtained in the drieſt manner poſſible, and that the globe which contained it appeared perfectly free from moiſture, yet, when carried into a room 27 degrees colder, the inſide of the globe was covered with dew, which ſoon formed viſible drops. In its concrete ſtate, fixed air is one of the heavieſt bodies in nature. Mr. Kirwan, in the 71ſt volume of the Philoſophical Tranſactions, gives an account of his ingenious method of finding the ſpecific gravity of fixed air in its fixed ſtate, when combined with calcareous earth; from which it appears, that fixed air, in that ſtate, is prodigiouſly concentrated, and, were it poſſible to exiſt by itſelf in that concentrated ſtate, it would be the heavieſt body known, gold and platina excepted. Fixed air differs conſiderably in its properties from the airs already mentioned. Its acidity is manifeſt to the taſte, and ſtill more from its neutralizing both fixed and volatile alkalis; which it will do in ſuch a manner as not only to deſtroy their cauſticity, but to give them a manifeſtly acid taſte, and will moreover enable them to form cryſtals of a neutral or acidulous ſalt. It has a conſiderable antiſeptic power, and will even check the putrefaction of animal ſubſtances; though it has been obſerved, that in this caſe it acts only by abſorbing the putrid effluvia already emitted from the body, and becomes itſelf very offenſive, while it ſweetens the other. When taken into the lungs, it is equally poiſonous with phlogiſticated or any other noxious air, and extinguiſhes flame as effectually; but, when mixed with dephlogiſticated air, may be inſpired without any danger, and even in its pure ſtate may be ſwallowed in large quantities, not only without danger, but with the moſt ſalutary effects in ſome diſeaſes, whence it has now become an article of the Materia Medica. As an acid it ſtands in the loweſt rank, being expelled from alkalis by every other; though it is capable of ſeparating oils, ſulphur, and the colouring matter of Pruſſian blue, from the ſubſtances with which they are combined. In conſidering this ſubject farther, it occurred to Dr. Prieſtley, that his experiments, in which charcoal was uſed, lay open to an objection, that ſince dry wood, and imperfectly made charcoal, yield fixed air, it might be ſaid, that all the elements of fixed air are contained in charcoal; and though this ſubſtance alone, even with the aſſiſtance of water, will not yield fixed air, this might be effected by treating it with other ſubſtances without their imparting any thing to it; eſpecially as the inflammable air procured from charcoal by means of water, appears to contain fixed air when decompoſed with the dephlogiſticated kind. In order to expel all the fixed air from charcoal, he made a quantity of it from dry oak, and pounding it while hot, inſtantly mixed four meaſures of it with one of red precipitate; and putting them into an earthen retort, got, with a heat no greater than what was ſufficient to revive the mercury, a large quantity of air, half of which was fixed. Afterwards the proportion of fixed air was leſs, and at laſt no fixed air at all was obtained; but as the reſiduum was worſe than the common atmoſphere, he is thence inclined to believe, notwithſtanding Mr. Cavendiſh's experiments, that phlogiſticated air may be compoſed of phlogiſton and dephlogiſticated air.

Fixed air was alſo produced from red precipitate mixed with braſs filings with zinc, from turbith mineral with iron filings, and from the black powder into which mercury mixed with lead is eaſily converted. In this laſt caſe the Doctor ſuppoſes that the fixed air was produced from the dephlogiſticated kind abſorbed by the metals and the phlogiſton of the lead; and this is confirmed by an obſervation, that the fixed air always comes firſt in the proceſs, when the phlogiſton is moſt readily ſeparated, but afterwards the produce becomes quite pure and dephlogiſticated. In attempting, however, to increaſe the quantity of fixed air by heating this black powder in dephlogiſticated air, he found only an augmentation of the quantity of dephlogiſticated air, and that of the pureſt kind. That dephlogiſticated air actually enters into the compoſition of the fixed air, is evident from the weight of the latter, which far exceeds that of the charcoal diſperſed in the proceſs. For, in an experiment made, the weight of the fixed air produced was 4.95 grains. Conſequently, ſuppoſing the charcoal to be wholly phlogiſton, as it is very nearly ſo, fixed air may be ſaid to conſiſt of 3.45 parts of dephlogiſticated air, and 1.5 of phlogiſton; ſo that the dephlogiſticated air is more than three times the proportion of phlogiſton in it. I muſt not conclude (ſays the Doctor) without obſerving, that, in one experiment, I never failed to produce fixed air; though it is not eaſy to ſee how one of its ſuppoſed elements, viz. dephlogiſticated air, could enter into it. This is by heating iron in vitriolic acid air. In one of theſe experiments, four ounce meaſures of the vitriolic acid air were reduced to 0.65 of an ounce meaſure; and of the quantity loſt three and an half meaſures were fixed air abſorbed by lime water, and the remainder weakly inflammable. With regard to the quantity of fixed air which may be expelled from different ſubſtances, Dr. Prieſtley obſerves, that, from ſeven ounces of whiting, the pureſt calcareous ſubſtance we are acquainted with, he expelled by heat 630 ounce meaſures of air; by which means the whiting was reduced to four ounces. One third of this was ſomewhat phlogiſticated, the ſtandard being 1.36 and 1.41. Repeating the experiment, he obtained 440 ounce-meaſures of air from ſix ounces of whiting; about one half of which was fixed air, and the remainder of the ſtandard of 1.4. On moiſtening ſome calcined whiting with water impregnated with vitriolic acid air, he obtained 90 ounce-meaſures; of which the firſt portion were three fourths fixed air, and the ſtandard of the reſiduum 1.5; the latter had leſs fixed air, and the ſtandard of the reſiduum was 1.44.

SECT. VI. *Inflammable Air.*

We owe the knowledge of the exiſtence, and of ſome remarkable properties, of this air, to Mr. Cavendiſh, by whom they were firſt publiſhed in 1767. Its effects, however, had long before been fatally experienced by miners; in whoſe ſubterraneous habitations it is often collected in ſuch quantities as to produce the moſt dreadful effects. It is produced in abundance from putrid animal and vegetable ſubſtances; and, in general, by all thoſe which part with their phlogiſton eaſily. Being much lighter than common air, it always riſes to the top of thoſe places where it is generated; ſo that it cannot be confined except in ſome vaulted place, but always ſtrives to aſcend and mix with the atmoſphere. By itſelf it is very noxious, and will inſtantly put an end to animal life; but when mixed with atmoſpherical air, may be breathed in a much greater quantity than fixed air. Its great inflammability in this ſtate, however, renders it very dangerous to bring any lights, or even to ſtrike a flint with ſteel, in thoſe places where it abounds. But this only takes place when the inflammable air is mixed with common atmoſpherical, or with dephlogiſticated air; in which caſe, the exploſion is much more violent than the former; for pure inflammable air extinguiſhes flame as effectually as fixed or phlogiſticated air. Beſides the ſubterraneous places already mentioned, this kind of air is found in ditches; over the ſurface of putrid waters, out of which it eſcapes; in burying-places, in houſes of office, where putrid animal and vegetable matters are accumulated; and may, by ſtanding or boiling, be extracted from the waters of moſt lakes and rivers, eſpecially thoſe in which great quantities of fermenting and putrefying matters are thrown: and as putrefaction thus ſeems to be the principal ſource of inflammable air, it thence happens, that much more of it is produced in warm than in cold climates. In thoſe countries, we are informed by Dr. Franklin, that if the mud at the bottom of a pond be well ſtirred, and a lighted candle brought near to the ſurface of the water immediately after, a flame will inſtantly ſpread a conſiderable way over the water, from the aſcenſion of the inflammable air, affording a very curious ſpectacle in the night-time. In colder climates, the generation of inflammable air is not ſo plentiful as to produce this phenomenon; nevertheleſs, Mr. Cavallo informs us, that it may be plentifully procured in the following manner, in all the ponds about London. "Fill a wide-mouthed bottle with the water of the pond, and keep it inverted therein; then, with a ſtick, ſtir the mud at the bottom of the pond, juſt under the inverted bottle, ſo as to let the bubbles of air which come out of it enter into the bottle; which air is inflammable. When by thus ſtirring the mud in various places, and catching the air in the bottle until this is filled, a cork or glaſs ſtopper muſt be put over it whilſt ſtanding in water; and then the bottle muſt be taken home, in order to examine the contained inflammable fluid at leiſure."

The great quantity of inflammable air produced in warm climates has given occaſion to ſome philoſophers to ſuppoſe, that it may poſſibly have ſome ſhare in producing certain atmoſpherical meteors. The weak lightnings without any exploſion, which are ſometimes perceived near the horizon in ſerene weather, are by them conjectured to proceed from inflammable air fired by electric exploſions in the atmoſphere. Mr. Volta ſuppoſes that the *ignes fatui* are occaſioned by the inflammable air which proceeds from marſhy grounds, and is ſet on fire by electric ſparks; but theſe phenomena can be accounted for in a more probable manner from the action of the electric fluid itſelf. This kind of air is more common than any of the other noxious airs; for there is hardly any inflammable ſubſtance on earth out of which it may not be extracted by one means or other. The fluids, however, which go by the general name of *inflammable air*, have ſcarce any other property in common to them all, beſides thoſe of inflammability, and being ſpecifically lighter than the common atmoſpherical air. In other reſpects, the differences between them are very conſiderable. The ſmell, weight, power of burning, of preſerving their properties, and the phenomena attending their combuſtion, are by no means the ſame in them all; ſome burning in an exploſive manner; others quietly, and with a lambent flame of a white or blue colour. It is, however, neceſſary to make a proper diſtinction between an inflammable elaſtic fluid or inflammable gas, which may be properly called ſo, and that which is evidently made by combining an inflammable ſubſtance with common air; which being eaſily ſeparable from the air, leaves that fluid in the ſtate it was before. Thus a drop of ether, put into a quantity of common

air, mixes itself with it, and takes fire on the approach of flame, like a mixture of inflammable and common air; but, if the air to which ether is added be washed in water, the latter is soon separated from it. Common air becomes also inflammable by being transmitted through several essential oils; and thus the air contiguous to the plant called *fraxinella* becomes inflammable in calm and hot weather, by the emission of its inflammable air.

By heat alone, a considerable quantity of this kind of air may be extracted from most inflammable substances, and even from some of the metals. Dr. Hales obtained inflammable air by simply distilling wax, pitch, amber, coals, peafe, and oyster shells; and Mr. Fontana informs us, that he obtained a considerable quantity of inflammable air from spathose iron, by the action of fire only applied to it in a matrafs. Dr Prieftley, however, obtained it from a vaft number of other fubftances, by diftilling them in a gun barrel; to the extremity of which was luted a tobacco pipe, or fmall glafs tube, with a flaccid bladder tied on the end. He obferves, that the heat muft be fuddenly applied, in order to get a conftderable quantity of air from thefe fubftances. "Notwithftanding (fays he) the fame care be taken in luting, and in every other refpect, fix, or even ten times more air may be got by a fudden heat than by a flow one, though the heat that is laft applied be as intenfe as that which was applied fuddenly. A bit of dry oak, weighing about twelve grains, will generally yield a fheep's bladder full of inflammable air with a brifk heat, when it will only yield two or three ounce meafures if the fame heat be applied gradually." When he wanted to extract inflammable air from metals, a glafs was ufed, the focus of which afforded a more intenfe heat than any furnace he could apply: and in this way he obtained inflammable air from feveral metals; as iron, brafs, and tin: but with the metallic calces he had no fuccefs.

"With refpect to inflammable air (fays Dr. Prieftley) I have obferved, that when fufficient care is taken to free it from any acid vapour that may be accidentally contained in it, it is not in the fmalleft degree affected by a mixture of alkaline air. On the whole, therefore, I have at prefent no doubt, but that pure inflammable air, though it certainly contains water, does not neceffarily contain any acid: yet an acid vapour may be eafily diffufed through it, and may perhaps, in many cafes, be obftinately retained by it, as no kind of air feems to be capable of fo great a variety of impregnations as inflammable air is."

In his analyfis of different kinds of inflammable air, the Doctor obferves, that the difference moft commonly perceived is, that fome of them burn with a lambent flame, fometimes white, fometimes yellow, and fometimes blue; while another kind always burns with an explofion, making more or lefs of a report when a lighted candle is dipped into a jar filled with it. The inflammable air extracted from metals by means of acids is of this laft kind; and that from wood, coal, or other inflammable fubftances, by means of heat, belongs to the former. It has alfo been obferved, that thefe kinds of inflammable air have different fpecific gravities: the pureft, or that which is extracted from iron, &c. being about ten times as light as common air; but fome of the other kinds not more than twice as light.

There is an aftonifhing variety in the different kinds of inflammable air, the caufe of which is very imperfectly known. The lighteft, and therefore probably the pureft kind, feems to conftft of phlogifton, and water only. But it is probable that *oil*, and that of different kinds, may be held in folution in feveral of them, and be the reafon of their burning with a lambent flame, and alfo of their being fo readily refolved into fixed air when they are decompofed by dephlogifticated air. When inflammable and dephlogifticated air are burned together, the weight of the water produced is feldom or ever found quite equal to that of both kinds of air. May not the light, therefore, emitted from the flame, be part of the phlogifton of the inflammable air united to the principle of heat? And as light accompanies the electric fpark, may not this alfo be the real accenfion of fome phlogiftic matter, though it is not eafy to find the fource of it?

The French chymifts, who deny the exiftence of phlogifton, are of opinion, that inflammable air is a fimple uncompounded element;—but for a more full difcuffion of this fubject, fee the Article PHLOGISTON.

Inflammable air is abforbed by water in conftderable quantity, but by the application of heat may be expelled again in equal quantity. By agitation in water Dr. Prieftley was formerly of opinion that this kind of air might be rendered as good as common air; but this undoubtedly proceeds from the atmofpherical air tranfmitted by the water, as is the cafe with phlogifticated air. After a quantity of water, which had abforbed as much inflammable air as it could, had been fuffered to ftand a month, it was expelled by heat, and found to be as ftrongly inflammable as ever. The water, after the procefs, depofited a kind of filmy matter, which he fuppofed to be the earth of the metal that had been employed in producing it.

Plants in general grow tolerably well in inflammable air, and the willow plant has been obferved to abforb great quantities of it. Its inflammability is not diminifhed by the putrefaction of animal fubftances, nor does their putrefaction feem to be retarded by it. Animals confined in it are killed almoft as foon as in fixed air: but infects, which can live a conftderable time in phlogifticated air, live alfo a conftderable time in this kind of air; but at laft they become torpid, and appear to be dead, though they will ftill recover if removed into the open air. Mr. Cavallo relates, that the Abbé Fontana, having filled a large bladder with inflammable air, began to breathe it in his prefence; after having made a very violent expiration, in which cafe the effects are moft powerful. The firft infpiration produced a great oppreffion in his lungs, the fecond made him look very pale, and the third was fcarce accomplifhed when he fell on his knees through weaknefs. Birds and fmall quadrupeds, inclofed in fmall veffels of this air, died after a very few infpirations. The inflammability of this fpecies of air has given occafion to various projects concerning it; fuch as that of employing it to give light and heat; and lamps have been defcribed, which may be lighted by the electric fpark in the night time. By its means alfo very pretty artificial fires are made, with glafs tubes bent in various directions, and pierced with a great number of fmall apertures. The inflammable gas is introduced into thefe tubes, from a bladder filled with that fluid, and fitted with a copper cock. When the bladder is preffed, the inflammable air, being made to pafs into the tube, iffues out of all the fmall apertures, and is fet on fire by a lighted taper. None of thefe contrivances, however, have ever been applied to any ufe; and the fcheme of Mr. Volta, who propofed to fubftitute its explofive force inftead of gunpowder, is found infufficient, on account of the weaknefs of the explofion, except when the two airs are fired in very great quantity, which would be incompatible with the fmall bulk neceffary for warlike engines.

SECT. VII. *Sulphurated Inflammable Air.*

Dr. Prieftley difcovered the properties of this kind of air by means of red hot tubes: Having, among other experiments, treated manganefe in this manner, by ftopping one end of the heated tube with a cork before the fteam was applied, he received forty ounce-meafures of air, of which one fixth was fixed air, and the reft of the ftandard of 1.7, lambently inflammable. Having then opened the other end of the tube, in order to admit the fteam, air was produced more copioufly than before. Of fifty ounces of this air, one feventh was fixed, and the reft of the ftandard of 1.8, explofively inflammable. The laft portions were very turbid; and the fcent, efpecially that of the laft portion, was very fulphureous, tinging the water of a very dark colour, by depofiting in it a quantity of blackifh water. However, the air itfelf became prefently tranfparent, and had no other appearance than that of any other kind of air. On looking at the jar in about ten minutes after, it was quite black and opaque; fo that nothing could be feen in the infide of it. Filling afterwards another jar with the fame kind of air, in order to obferve the progrefs of this uncommon phenomenon, he found, that when the water was well fubfided, black fpecks began to appear in different places, and, extending themfelves in all directions, at length joined each other, till the whole jar was become perfectly black, and the glafs opaque. When this was done, he tranfferred the air into another jar, and it foon produced a fimilar effect upon this, though it never became fo black as the jar in which it had been firft received. It alfo frequently happened, that only the lower part of the jar would become black, as if the matter with which it was loaded had kept fubfiding, though invifibly, in the mafs of air, and occupied only the lower regions, leaving the upper part entirely free from it. On expofing to the open air the veffels thus turned black, the colour prefently difappeared, and a yellow or brown incruftation was left upon it. The fame change took place when the veffels were inverted in water, in order to obferve the alteration of the air within them; but, on examining this air, no fenfible change was perceived. In fome cafes, indeed, he thought the air was injured, but it was much lefs fo than he had expected. After depofiting the black matter, the air ftill retained its fulphureous fcent, and he did not imagine that it would ever leave it entirely.

On trying other fpecimens of manganefe, no air of this kind was obtained; but fome time after, having occafion to make a large quantity of inflammable air, he ufed, inftead of frefh iron, fome that had been already melted in vitriolic acid air. Diffolving this with a conftderable quantity of frefh metal in diluted vitriolic acid, he found that the water in which the air was received became very black, and depofited more fediment than had appeared in the experiment with the manganefe. The jars were as black as ink, but became yellow on expofure to the air as before; fo that there could be no doubt of its being the fame thing he had got before. On burning a quantity of it, this kind of air appeared to contain fome vitriolic acid, the balloon being filled with a very denfe white fume, which rendered the water fenfibly acid to the taft. On decompofing it with dephlogifticated air, however, he found the diminution exactly the fame as when common inflammable and dephlogifticated air were ufed; fo that it appeared to contain neither more nor lefs phlogifton than the other; only there was a fmall quantity of fixed air produced, which is never the cafe with common inflammable air from vitriolic acid and iron.

SECT.

SECT. VIII. *Of Alkaline Air.*

This was procured by Dr. Prieſtley, in the beginning of his experiments, from common ſpirit of ſal-ammoniac with quick-lime, or the materials from which it is made. He did not at that time proſecute the diſcovery farther than by impregnating water with it; by which means he could make a much ſtronger alkaline ſpirit than any to be met with in the ſhops. His method of procuring it was by mixing one part of pounded ſal-ammoniac with three parts of ſlacked lime; and for common experiments the ſame quantity of materials would laſt a conſiderable time. This kind of air, when pure, is inſtantly fatal to animal life, and extinguiſhes flame; though, when mixed with common atmoſpherical air, it is ſlightly inflammable, and alſo medicinal in faintings and other caſes of debility. A candle dipped into a jar of this air is extinguiſhed, but juſt before the flame goes out, it is enlarged by the addition of another flame of a pale yellow colour, and ſometimes a weak flame ſpreads for a conſiderable way, or even through the whole body of the alkaline air. The electric ſpark taken in it appears of a red colour. Every ſpark taken in it augments its bulk, and by degrees turns the whole into inflammable air. It is remarkable that copper, which is ſo eaſily corroded by the common volatile alkalis, is not affected by alkaline air. The ſpecific gravity of this kind of air is, by Mr. Kirwan, determined to be to that of common air as 600 to 1000; though, as he juſtly obſerves, this muſt differ very conſiderably according to the quantity of moiſture it contains.

In examining the phenomena which attend the converſion of alkaline air into the inflammable kind, Dr. Prieſtley was induced to believe it was occaſioned by heat alone, without the concurrence of light. The effects of the former were firſt perceived on heating ſome ochre of iron in alkaline air; when, though the matter turned black, as in an incipient reduction of the metal, he found a conſiderable increaſe of quantity inſtead of decreaſe in the air, as he had expected; and, on examining the quality of it, he found that it contained no fixed air, but was entirely inflammable. With ſcales of iron a ſimilar enlargement was perceived; but in this way he could never increaſe the quantity to more than double that which had been originally employed; and, even after this, the whole ſmelled ſtrongly of volatile alkali; the iron had undergone no change. The Doctor now, concluding from theſe experiments that the change of alkaline into inflammable air was produced by this cauſe alone, proceeded to repeat experiments; in all of which, however, with a burning-glaſs, as a ſtrong light was alſo concerned, he heated a quantity of alkaline air in a green glaſs retort, receiving in a glaſs tube, filled with water, all the air that could be expelled from it by heat. At firſt it was all abſorbed by the water, being merely alkaline air expelled by the rarefaction; but when the bulb of the retort became red-hot, he found that the bubbles driven out were not wholly abſorbed, and at laſt none of them were ſo. Theſe were altogether inflammable: ſo that no doubt remained of the change being produced by heat alone, without any intervention of light.

SECT. IX. *Of Nitrous Air.*

This kind of air is plentifully obtained in all caſes where the nitrous acid is combined with phlogiſton: thus, when it is mixed with metals, or animal or vegetable ſubſtances, nitrous air is produced in great quantities; but very ſparingly when treated with metallic calces, earths, or other matters which are ſaid to contain little or no phlogiſton. All the metals, excepting gold, platina, and regulus of antimony, which are not ſoluble in the pure nitrous acid, yield nitrous air on being treated with it; and even from theſe, when diſſolved in aqua regia, ſome quantity of this air may be obtained. Every metal, however, does not yield it in equal quantity, with equal facility, or equally good. Silver, copper, iron, braſs, biſmuth or nickel, when put into nitrous acid, yield this air in conſiderable quantity: mercury yields it but ſlowly without the application of heat, though no great degree of it is neceſſary. Copper and iron, eſpecially the latter, require the acid to be cautiouſly applied on account of the violent emiſſion of fumes. Gold, platina, and regulus of antimony, when put into aqua regia, yield nitrous air pretty readily; but lead yields it in ſmaller proportion than any other metal, and zinc does the ſame among the ſemi-metals, the elaſtic fluid produced from it being moſtly phlogiſticated air. In the production of this kind of air great differences are perceived by a diverſity in the ſtrength of the acid. Thus, if we diſſolve copper in ſtrong nitrous acid, no nitrous air is produced, though the ſame materials will yield air in great quantity by the mere affuſion of water to dilute the acid. This is very properly explained by Dr. Prieſtley, from the property that the nitrous acid has of attracting phlogiſton, which is evident from what happens in the ſolution of mercury.

In common experiments, no other degree of heat is neceſſary than that produced by the effervescence itſelf, except mercury be uſed, which requires the application of ſome degree of heat; but when the metal expoſes a very great ſurface to the acid, as is the caſe when the filings of the metal are uſed, the effervescence and production of nitrous air are often much quicker than can be conveniently managed. Nitrous air by itſelf is equally tranſparent and inviſible with common air, excepting at its firſt production, when it is ſomewhat coloured, owing to a little ſuperfluous nitrous acid, or to ſome earthy particles which are carried up with it. Its ſcent reſembles that of nitrous acid, or indeed is the very ſame; becauſe, in paſſing through the common air to our noſtrils, it is decompoſed, and converted into nitrous acid. Nitrous air ſeems to be the moſt fatal to animal life of any. Even inſects, which can bear phlogiſticated and inflammable air, generally die the moment they are put into it. Frogs, ſnails, and other animals which do not reſpire very frequently, die in a few minutes, and generally do not recover even when taken out of this noxious fluid before they are dead. Plants periſh very ſoon in nitrous air, and even in common air ſaturated with nitrous air; but Dr. Prieſtley informs us, that "though in general plants die almoſt immediately in water impregnated with nitrous air, yet, in one caſe of this kind, when the ſuperfluous nitrous air was let out under water, ſo that no part of it was decompoſed in contact with the water, the plant grew in it remarkably well."

One of the moſt remarkable properties of nitrous air, is its diminution with dephlogiſticated air; by which means it becomes a teſt of the quantity of that kind of air contained in the atmoſphere. With pure dephlogiſticated air, the diminution is almoſt to nothing, at the ſame time that ſome quantity of nitrous acid is re-produced by the decompoſition of the nitrous air: but as our atmoſphere is always mixed with a conſiderable quantity of phlogiſticated air, on which nitrous air has no effect, the diminution in this caſe is never ſo conſiderable. Upon this principle the *Eudiometer* is conſtructed. Another very remarkable property of nitrous air is its ſtrong antiſeptic power: inſomuch that animal matter may, by its means, be preſerved for many months without corruption. This property, it was thought, might have been extremely uſeful on many occaſions; but Dr. Prieſtley, after a number of experiments on the ſubject, concludes in the following manner. "Nitrous air will indeed preſerve meat from putrefaction; but after long keeping, it becomes very offenſive both to the noſtrils and palate, though the ſcent is not altogether that of putrefaction; and indeed the ſubſtance continuing quite firm, it could not be properly putrid. Having formerly experienced the remarkable antiſeptic power of nitrous air, I propoſed an attempt to preſerve anatomical preparations, &c. by means of it; but Mr. Key, who made the trial, found, that, after ſome months, various animal ſubſtances were ſhrivelled, and did not preſerve their forms in this kind of air.

"In reviewing the experiments I had formerly made on this kind of air, I could not recollect any of them in which the pure nitrous acid was produced, excepting that with dephlogiſticated air, beſides the experiment in which it was decompoſed by the electric ſpark; which furniſhes a ſtrong objection to this hypotheſis." To aſcertain the matter more fully, the following experiments were made.

"When nitrous air is decompoſed by iron, or by a mixture of iron and ſulphur, the water over which the proceſs is conducted, acquires no acidity; but I had ſuppoſed that all the acid was abſorbed by the iron. Having by me a quantity of this iron which had been reduced to perfect ruſt in nitrous air, and which, I knew, muſt have imbibed more than its weight of this air, I thought the acid might be obtained from it by diſtillation; but a quantity of this ruſt of iron, diſtilled in an earthen retort, yielded neither nitrous air nor nitrous acid, at leaſt in any quantity that could favour the common hypotheſis. I then endeavoured to decompoſe nitrous air by heating iron in it with a burning lens; and in this proceſs I ſucceeded far beyond my expectation: for the air was preſently diminiſhed in quantity, while the iron became of a darker colour, was ſometimes melted into balls, and gathered conſiderable weight, though it had no appearance of containing any nitrous acid. In the firſt experiment, the original quantity of nitrous air was diminiſhed to about one third; and after this, it was increaſed." The increaſe was found to ariſe from a production of inflammable and dephlogiſticated nitrous air.

The Doctor proceeded to try various other experiments on the decompoſition of nitrous air, particularly that of burning Homberg's pyrophorus; but without any ſucceſs, or obtaining the ſmalleſt particle of nitrous acid. His concluſions from the whole are the following.

"Water ſeems to be a neceſſary ingredient in nitrous as well as inflammable air; at leaſt, without a quantity of water, nitrous air cannot be formed. For example, copper will be diſſolved in ſtrong nitrous acid without producing any nitrous air, juſt as iron may be diſſolved in concentrated vitriolic acid without producing inflammable air." He concludes his experiments on this ſubject with a conjecture, that the phlogiſton, and neither the heat nor light of the electric, contributes to the decompoſition of the nitrous air. As his final ſentiments on the matter, however, are merely conjecture, without any certain experiments to confirm them, we ſhall here refer the reader to his Section on Theory, at the end of his ſixth volume of Experiments, &c.

SECT. X. *Of Dephlogiſticated Nitrous Air.*

This ſpecies differs from common nitrous air in being able to ſupport flame, though it ſtill continues fatal to animal life. Common nitrous air may be converted into the dephlogiſticated kind by particular proceſſes; though, when zinc is diſſolved in the nitrous

trous acid, if the air be taken at different times, that which comes about the middle, or rather the latter end of the process, will be of this kind; in which it not only supports the burning of a candle, but the flame is enlarged (sometimes to four or five times its original bulk) by the addition of a weaker and bluish flame round the former; and this burning is sometimes accompanied with a crackling noise, as if the candle was burning in dephlogisticated air. It may also be obtained in some parts of the process of procuring nitrous air from iron, though with this metal the success is uncertain; but tin yields a considerable quantity of it. By exposing iron to nitrous air, it may be so far dephlogisticated as to admit a candle to burn in it.

In that section of his last volume in which the Doctor treats of this kind of air, he observes that water is absolutely necessary to its composition, or rather to the decomposition of the common nitrous air by iron. He had decomposed it before, either by previously filling the vessels that were to contain the nitrous air with water or with mercury; though it had always required a much longer time when the latter was made use of. The reason of its being formed at all in this last way, was a small quantity of moisture adhering to the inside of the vessel containing the mercury. As the process for obtaining dephlogisticated nitrous air by means of iron is very tedious, the Doctor endeavoured to find another which might be attended with less inconvenience. This he accomplished by dissolving turnings of iron in a dilute solution of copper in nitrous acid (the same that remains after the production of nitrous air), mixing it again with an equal quantity of water. Without this precaution, he tells us, that though the iron will at first be acted upon very slowly, yet the mixture will at length grow so hot as actually to boil, and the process will be exceedingly troublesome; however, it will be necessary, previous to any attempt to dissolve the iron, to heat the solution of copper, in order to expel all the nitrous air and superfluous nitrous acid. Without this precaution a quantity of common nitrous air will be produced.

Dephlogisticated nitrous air is absorbed by water almost as readily as fixed-air, and in considerable quantity; the liquid taking up about one half its bulk of air. After being thus saturated, the whole quantity of dephlogisticated nitrous air may be expelled pure by heat, and is easily received in vessels containing mercury. It was likewise observed, that as this kind of air much resembles fixed air in its properties of being imbibed by water, and expelled again by heat, it resembles it also in this farther property, that all the air which has been actually incorporated with the water will not be imbibed by water again. But the proportion of this part is three or four times greater than the corresponding part of fixed air; it is also considerably more phlogisticated. Water impregnated with it very soon parts with it again on being exposed to the atmosphere. It discovers not the smallest trace of containing either acid or alkali. Its specific gravity is less than that of common air. On heating red precipitate in this kind of air, pure dephlogisticated air was produced without affecting, or being affected by, the nitrous air.

SECT. XI. *Of Vitriolic, Nitrous, Marine, and other Acid Airs.*

Vitriolic acid Air. This is always a combination of vitriolic acid with phlogiston, and consequently may be procured from any mixture of that acid in its highly concentrated state with phlogistic matters. Hence it is obtained from all the metals, gold and platina excepted, on boiling them with strong oil of vitriol. It is also procurable from the same acid rendered black by any phlogistic matter. No greater heat is required to expel this kind of air than that produced by the flame of a candle. It is the heaviest of all aerial fluids, next to fluor acid air, being to common air as 2265 to 1000. Dr. Priestley informs us, that a quantity of vitriolic acid thus impregnated with phlogiston, will yield many times more air than an equal quantity of the strongest spirit of salt. When the vitriolic acid air is produced in great plenty, the top of the phial in which it is generated is commonly filled with white vapours. The air has also the same appearance as it is transmitted through the glass tube; and it is sometimes discoverable in the recipient.

Nitrous Acid Air. This is the pure nitrous acid by itself, without any addition of phlogiston. It is procured by heating the strong spirit of nitre in a phial, and then receiving the vapour in glass vessels filled with quicksilver. It is, however, extremely difficult, or rather impossible, to preserve it for a length of time by means of any fluid hitherto known. Water absorbs it immediately, and quicksilver is corroded, and produces nitrous air. "But (says Dr. Priestley) though the acid vapour very soon unites with the quicksilver, yet, the jar in which it was received being narrow, the saline crust which was formed on the surface of the quicksilver, impeded the action of the acid upon it till I had an opportunity of admitting water to the air I had produced, and of satisfying myself, by its absorption, of its being a real acid air, having an affinity with water similar to other acid airs."

Marine Acid Air. The marine acid, by heat, may be resolved into a permanently elastic and transparent invisible vapour, which, however, is more easily preserved in its aerial state than nitrous acid air, as the former has no effect upon quicksilver. An easy and cheap method of obtaining this kind of air is by filling a phial, fitted with a glass tube and stopper, with common salt, and then pouring a small quantity of oil of vitriol upon it; which, by the assistance of heat, will disengage the acid principle, or the marine acid air, from the salt. "A phial (says Dr. Priestley) prepared in this manner will suffice, for common experiments, many weeks; especially if some more oil of vitriol be occasionally put to it. It only requires a little more heat at the last than at the first. Indeed, at first, the heat of a person's hand will often be sufficient to make it throw out the vapour. In warm weather it will even keep smoking many days without the application of any other heat. On this account it should be placed where there are no metallic utensils which it can corrode; and it may easily be perceived when the phial is throwing out this acid vapour, as it always appears in the open air in form of a light white cloud."

After the marine acid has yielded all the air that can be expelled from it, it is extremely weak, so that it can but barely corrode iron. The gas itself is considerably heavier than common air, the specific gravity of the two being in the proportion of five to three; a cubic inch weighing 0.654 grains. It is very fatal to animal life, but less so than pure nitrous air; for flies and spiders live longer in marine acid than in nitrous air. In dipping a candle into a jar of this air, the flame is extinguished; but the moment before it goes out, and also when it is afterwards first lighted again, it burns with a green or light blue flame, like that of common salt thrown into a fire. Its diminution by the electric spark is barely perceptible. Ice is dissolved by it as fast as if it touched a red hot iron. It is partly absorbed by almost every substance containing phlogiston, and the remaining part becomes inflammable. Oil of olives absorbs it very slowly, and oil of turpentine very fast; by which they both become almost black, and the remainder of the air is inflammable. Essential oil of mint absorbs marine air pretty fast, becoming brown, consistent, and so heavy as to sink in water; and its scent is in a great measure altered. Ether absorbs it very fast, and has its colour altered by the impregnation, becoming first turbid, then yellow, and at last brown. The air over the ether is strongly inflammable. A small bit of phosphorus smoked and gave light in this acid air; and the elastic fluid was but little diminished in twelve hours. On the admission of water, about four fifths of the gas were absorbed, and the rest was inflammable. This change was also effected by a great number of other substances: some of which, however, required a considerable time to produce their effect; such as crusts of bread not burned, dry wood, dry flesh, roasted pieces of beef, ivory, and even flints.

Of Fluor Acid Air. The discovery of fluor acid air was made by Mr. Scheele, who obtained it by distilling the spar called fluor with vitriolic acid. Its most remarkable property is the great attraction it has for siliceous earth, so that it even corrodes and makes holes in the retorts in which it is distilled.

Of the Vegetable and another Acid Air. By means of heat alone, the concentrated vegetable acid emits a permanently elastic and aerial fluid. This has the properties of the acid of vinegar; but, like it, is weaker than the rest of the mineral acid airs, though it agrees with them in its general characters.

An acid air, somewhat different from any hitherto described, was obtained by Dr. Priestley from the vapour arising on distilling to dryness a solution of gold in marine acid impregnated with nitrous acid vapour, which makes the best kind of aqua regia. "The produce (says he) was an acid air of a very peculiar kind, partaking both of the nature of the nitrous and marine acids, but more of the latter than of the former, as it extinguished a candle; but it was both extinguished and lighted again with a most beautiful deep blue flame. A candle dipped into the same jar with this kind of air went out more than 20 times successively, making a very pleasing experiment. The quantity of this acid air is very great; and the residuum I have sometimes found to be dephlogisticated, sometimes phlogisticated, and at other times nitrous, air."

SECT. XII. *Of Hepatic Air.*

This species of air was first particularly taken notice of by Mr. Bergman, who obtained it from an ore of zinc called *Pseudogalena nigra Dannemorensis*, and which was found to contain 29 parts of sulphur, one of regulus of arsenic, six of water, six of lead, nine of iron, 45 of zinc, and four of siliceous earth. The hepatic air was produced but in small quantity by pouring oil of vitriol on this mineral; spirit of salt produced it in much larger quantity; but nitrous acid produced only nitrous air. The most proper method of obtaining this air is by pouring marine acid on hepar sulphuris, which extricates it in vast quantity. The scent of the pure gas is intolerable; and the vapour has a disagreeable effect on many metallic substances, particularly silver, lead, copper, &c. destroying their colour, and rendering them quite black. It is suddenly fatal to animal life.

SECT. XIII. *Of Atmospherical Air.*

The two component parts of our atmosphere, viz. dephlogisticated and phlogisticated air, have been so fully treated of under their respective sections, that little remains to be said in this place, excepting to determine the proportion in which they are usually met with in the common air. The only regular set of experiments

ments which have been made on this subject are those of Mr. Scheele. He constructed an eudiometer, consisting of a glass receiver, which could contain 34 ounces of water, and a glass cup containing a mixture of one pound of iron filings, and an equal weight of flowers of sulphur moistened; which cup standing upon a glass supporter, was inserted in the former receiver, which, when this was in it, could contain 33 ounces of water. To the outside of the glass tube or receiver, was affixed a slip of paper, to the height of a third of the tube, containing 11 divisions, each corresponding to one ounce of water. This paper was varnished over with oil varnish, to prevent its being spoiled by water. The whole was then placed in water, which gradually rose as the air was diminished. This mixture would serve four times before the power of diminishing air was lost. He carefully compared the height of the air therein with the barometer and thermometer, both before and after the experiment; in eight hours the experiment was completed. With this instrument he examined the goodness of the common air in Stockholm every day for a whole year, and found the diminution never to exceed $\frac{1}{15}$, nor to fall short of $\frac{1}{17}$; so that upon a medium it may be estimated at $\frac{1}{16}$. During the months of January and February it was $\frac{1}{16}$. The 23d of March it was $\frac{1}{17}$, though the cold increased, and the barometer stood higher than before. The 19th of April it was $\frac{1}{15}$, though the barometer and thermometer did not vary, and so stood till the 21st. In May and June it stood between $\frac{1}{15}$ and $\frac{1}{16}$. The 30th of July it stood at $\frac{1}{15}$. From the 3d to the 15th of September at $\frac{1}{17}$. The 6th of October at $\frac{1}{15}$, during a high storm; but after it stood between $\frac{1}{17}$ and $\frac{1}{16}$, till the fourth of November, when it fell to $\frac{1}{15}$, and continued between $\frac{1}{15}$ and $\frac{1}{16}$ to the 20th, when it rose to $\frac{1}{16}$. The 21st it fell to 8, and stood between $\frac{1}{17}$ and $\frac{1}{16}$ till the 8th of December, when it rose to $\frac{1}{15}$; and from thence to the 31st it stood between $\frac{1}{15}$ and $\frac{1}{16}$.

As it has already been shown that the pure dephlogisticated part of the atmosphere is entirely consumed by phlogistic processes, such as that of fermenting brimstone and iron filings, this eudiometer must be considered as an exact test of the proportion of dephlogisticated air contained in the atmosphere. The small variation in the quantity shows, that the processes in nature which destroy this air, are nearly balanced by those which produce it; though it must appear surprising, that both these fluids, so extremely different, should be produced at all seasons of the year in a proportion nearly equal; nor is it less surprising that two fluids of equal specific gravity should remain incorporated together without any tendency to separate, which it is certain they never do, either in the atmosphere itself, or when confined in vessels in any quantity whatever. As phlogisticated air is somewhat lighter than dephlogisticated, it might be supposed that the former would occupy the higher regions of the atmosphere in such a manner as to render them considerably more unwholesome than the lower parts; but this seems not to be the case: On the contrary, it appears by experiments with the eudiometer, that the upper parts of the air contain a greater proportion of dephlogisticated air than those near the earth.

SECT. XIII. *Of the artificial Production of Airs of different Kinds.*

Fixed Air, or *Aerial Acid*. The artificial methods of producing this are principally three, viz. by fermentation, by heat, and by acids.

1. *By Fermentation.* When vegetable or animal substances, especially the former, are fermented, they yield a great quantity of fixed air. In breweries, on the surface of the fermenting liquors, there is always a stratum of fixed air reaching as high as the edge of the vats; so that if these vessels are deep, and the fermenting liquor much below their edges, the abovementioned stratum may be some feet in thickness. The same phenomenon is observable in the fermentation of wines in general; and it is owing to the production and elasticity of fixed air, that fermenting liquors, when put into close vessels, often burst them with great violence. The case is the same whatever substance it is that undergoes the vinous fermentation, though the quantity of fixed air produced is not the same in all substances, nor even in the same substance at different times. From 42 cubic inches of beer Dr. Hales obtained 639 cubic inches of air in 13 day. From a quantity of sugar undergoing the vinous fermentation, Mr. Cavendish obtained so much fixed air, that out of 100 parts of the former 57 appeared to have been volatilized and converted into fixed air. But though a vast quantity of fixed air escapes during this process of fermentation, a very considerable portion still remains united with the fermented liquor, and to this it owes all its briskness and agreeable pungent acidulous taste; for when the fixed air is totally evaporated, the liquor becomes entirely vapid and flat. Hence also we are furnished with a method of restoring the briskness to these liquors after they have lost it in consequence of being exposed to the atmosphere, viz. by impregnating them again with fixed air, either naturally or artificially produced.

2. *By Heat.* In every combustion, except that of sulphur or of metals, a quantity of fixed air is generated. This may be observed by fixing a lighted candle in an inverted receiver over a bason of lime water, for a precipitation of the lime will presently ensue; and the same precipitation (which is one of the characteristics of fixed air) will always ensue, whether a candle, a burning piece of wood, or in short, any other combustible substance, except sulphur or metals, be made use of.

Most minerals contain fixed air, which may be extracted to a certain degree by means of heat. Mr. Krenger, distilling a greenish fusible spar, which was luminous in the dark, obtained from it some permanently elastic fluid, which, like fixed air, crystallized a solution of fixed alkali. Mr. Fontana, in his analysis of the Malachite, finds that that mineral contains a vast quantity of fixed air, as pure as that which is extracted from chalk by means of vitriolic acid. From almost every metallic ore and earthy mineral some fixed air may be obtained, as well as from chalk, lime-stone, marble, marine shells, fixed and volatile alkali, and from magnesia alba, by means of a violent fire, or of acids.

3. *By Acids.* Calcareous substances in general produce abundance of fixed air when acted upon by any acid, only the strongest acids will expel from them more fixed air than the weakest; and it happens to be peculiarly advantageous for those who want to produce a great quantity of fixed air, that the vitriolic acid is both the cheapest and strongest acid, and, upon the whole, the fittest for this purpose. The phenomena attending the production of fixed air from calcareous substances, &c. are themselves very remarkable, and furnish the subject of much speculation in philosophy.

It is for its great property of hindering putrefaction, that fixed air by itself, or incorporated with various fluids, especially with water; and that vegetables, sugar, and other substances which abound with fixed air, are very powerful remedies in putrid diseases. Sir John Pringle supposes, with great probability, that the frequent use of sugar and fresh vegetables, which at this time make up a considerable part of the diet of the European nations, prevents those putrid diseases and plagues which formerly were rather frequent. Dr. Macbride, shewing experimentally, that fixed air is discharged by such substances as form our common food, ascribes the preservation of the body from putrefaction in great measure to the fixed air, which, in the ordinary process of digestion, is disengaged from the aliment, and incorporates with the fluids of the body.

From the same property it may be also usefully applied to several œconomical purposes. Mr. Henry found, that fixed air can preserve fruit for a considerable time. He tried a bunch of Italian grapes, which being suspended in the middle part of Dr. Nooth's apparatus, and being supplied with plentiful streams of fixed air every day, was preserved without any signs of decay for about one month longer than a similar bunch suspended in a decanter containing common air. Strawberries and cherries he also found to be preserved without decay some days longer in fixed than in common air. Indeed, fixed air preserves not only fruit, but resists putrefaction in general. Dr. Macbride, in his elegant Essays on Medical and Philosophical subjects, has published various experiments which demonstrate this property of fixed air. He found, that not only good meat was preserved incorrupt for a considerable time, when exposed to fixed air; but that the putrefaction of substances actually putrid was impeded by this means, and even that those substances were restored from the putrescent to a sound state. That putrefaction was checked by fermentation, was discovered by Sir John Pringle; and Dr. Macbride observed, that this effect was owing to the fixed air produced in the act of fermentation.

Sir William Lee, baronet, in two of his letters to Dr. Priestley, informs him of his having found, that fresh meat, even in the hot season, could be preserved wholesome for several days, by only washing it two or three times a day in water impregnated with fixed air. "We have been enabled," says he, to "preserve meat as perfectly sweet and good to the extent of ten days, as at the first killing; and there seems no doubt it might be preserved much longer." He has even recovered some meat that had begun to change. This useful discovery, Sir William justly observes, may be very beneficial to the public, especially to butchers. "Particularly a butcher," says he, "who deals pretty largely, assures me he found the greatest success from it, and only objects that the veal was a little discoloured, though kept perfectly sweet."

Fixed air, as it combines with water, so it may be combined with other liquors. Beer, wine, and other fermented liquors, may be impregnated with fixed air, and by this means their sharpness may be restored, when they are become vapid, or, as it is commonly said, *dead*. The acidulous taste communicated by the impregnation of fixed air, cannot be discovered in beer, wines, and, in short, in such liquors which have much taste of their own. Milk acquires an acidulous taste by being impregnated with fixed air: and is thereby preserved incorrupt for some days; which affords a very easy expedient of preserving milk in those places where it cannot be had new very often.

To produce inflammable Air. The process for making this sort of gas is the same as that for making fixed air; one of the materials only must be different, viz. iron filings, or grossly powdered zinc, must be used instead of chalk; to which filings some oil of vitriol and water must be added, in the same proportion as in the fixed air, or rather a little more of oil of vitriol.

N. B. Instead of the filings of iron, small nails or small bits of iron wire, answer equally well.

When a ſlender pipe is tied to the neck of a bladder, and the bladder is filled with inflammable air, two very pleaſing experiments may be performed with it. Firſt, the inflammable gas may be inflamed by applying the flame of the candle to the extremity of the pipe; and ſqueezing at the ſame time the bladder, a ſtream of fire will be formed in the air, which will laſt as long as the bladder contains any inflammable air; for this gas coming out of the pipe with violence, will continue inflamed for a conſiderable way in the air. Secondly, the extremity of the pipe may be dipped into a ſolution of ſoap, then removing it from the ſolution, and ſqueezing the bladder very gently, a ball of ſoap water may be formed, including inflammable air; which ball, on account of the inflammable gas being much lighter than common air, as ſoon as it is detached from the pipe will aſcend upwards, and will break by daſhing againſt the cieling, contrary to thoſe commonly made by children, which in ſtill air go downwards. Whilſt the ball is aſcending, if the flame of the candle be approached to it, the film of ſoap water will be inſtantly broke, and the inflammable air will take fire. Thus a flame may be ſhown to be ſeemingly produced from a ſoap ball.

Zinc, treated after the ſame manner, produces the like effects, except that it gives more elaſtic fluid, without the application of heat, than iron does; and the greateſt part of the produced elaſtic fluid is inflammable. In order to obtain the greateſt quantity of inflammable air from iron zinc, the vitriolic acid muſt be diluted with much water, as about one part of the ſtrong oil of vitriol to five or ſix parts of water. Dr. Prieſtley found, that 11 grains of iron yielded 8¼ ounce meaſures of inflammable air. According to Mr. Cavendiſh, one ounce of zinc, diſſolved either in the vitriolic or marine acid, yields a quantity of inflammable air equal to the bulk of 356 ounces of water; one ounce of iron, diſſolved by means of vitriolic acid, yields a quantity of inflammable air equal to the bulk of 412 ounces of water; and one ounce of tin yields half as much inflammable air as iron does.

The ſolutions of iron, tin, copper, lead, and zinc, in the marine acid, produce marine acid air, and inflammable air, but in various quantities. The proportion of the former to the latter is as one to eight in iron, as one to ſix in tin, as three to one in copper and lead, and as one to ten in zinc. Regulus of antimony, diſſolved in marine acid, with the application of heat, yields a ſmall quantity of elaſtic fluid, which is weakly inflammable. For other methods of producing this kind of air, ſee the ſyſtem of AEROLOGY.

To produce Nitrous Air. This permanently elaſtic fluid is never found naturally, like fixed or inflammable air, but is entirely artificial.

Either ſilver, copper, braſs, iron, mercury, biſmuth, or nickel, when mixed with nitrous acid, yields nitrous air in great quantities. Some of them, eſpecially mercury, require the aid of heat in order to produce the elaſtic fluid; the flame of a candle applied to the phial is ſufficient: but others, eſpecially copper and iron, do not want the application of any heat. Gold, platina, and the regulus of antimony, when put in aqua regia, yield nitrous air pretty readily. Among the metals, lead yields nitrous air in the ſmalleſt quantity. Among the ſemi-metals, zinc gives the weakeſt nitrous air, when diſſolved in nitrous acid. The elaſtic fluid produced from it is moſtly phlogiſticated air. From four penny weights and 17 grains of zinc, diſſolved in ſpirit of nitre diluted with an equal quantity of water, Dr. Prieſtley obtained about 12 ounce meaſures of very weak nitrous air. It occaſioned a very ſlight effervеſcence when mixed with common air. The Doctor obtained nitrous air even from ſome flowers of zinc. The quantity of nitrous air that may be obtained from various metals, is difficult to be aſcertained, on account of the diverſity occaſioned by the ſtrength of the acid, the various nature of the metallic ſubſtance, and the method of performing the experiments.

As the nitrous air is moſtly neceſſary to try the goodneſs of reſpirable air, it is of great conſequence to make it always of one conſtant degree of goodneſs; but this object is anſwered by diſſolving ſubſtances of a very homologous nature in the nitrous acid; therefore it is plain, that the metals whoſe nature is more uniform muſt be preferred for this purpoſe. Accordingly, braſs yields nitrous air of a more uniform nature than iron: copper is ſuperior to braſs; but pure mercury is ſtill ſuperior to copper: and indeed this is the metal which, conſidering its nature, uniformity of ſubſtance, and eaſy ſolution, is upon the whole the moſt uſeful for this purpoſe.

To procure Dephlogiſticated Air. This is no other than exceedingly pure atmoſpherical air, entirely free from thoſe heterogeneous vapours which contaminate the air we commonly breathe. The eaſieſt method of procuring this air is to put ſome red lead into a bottle, together with ſome good ſtrong oil of vitriol, but without any water. Let the red lead fill about a quarter of the bottle, and the vitriolic acid be about the ſame quantity, or very little leſs; then apply the bent tube to the bottle, and proceed in the ſame manner as above. But it muſt be remarked, that without heat this mixture of red lead and vitriolic acid will not give any dephlogiſticated air, or it yields an inconſiderable quantity of it; for which reaſon the flame of a candle (that of a wax taper is ſufficient) muſt be applied under the bottom of the bottle; which for this purpoſe muſt be rather thin, otherwiſe it will be eaſily cracked.

In this manner the red lead will yield a good quantity of elaſtic fluid, the greateſt part of which is dephlogiſticated air; but not the whole quantity of it, for a good portion of fixed air comes out with it. In order to ſeparate the fixed from the dephlogiſticated air, the inverted bottle, when filled with the compound of both, as it is emitted from the red lead, muſt be ſhook in the baſin for impregnating water with fixed air; by which means the water will abſorb the whole quantity of fixed air, and leave the dephlogiſticated air by itſelf.

From every experiment it appears, that dephlogiſticated air, if it could be readily obtained, and at a cheap rate, would be a moſt valuable manufacture. The heat communicated by means of it to burning fuel is incredible.

Theſe are not the only advantages which might be expected from dephlogiſticated air. It has been found by experience, that animals will live longer in this kind of air than in an equal quantity of common air; whence it is ſuppoſed, that the breathing of it muſt be much more healthy, and contribute to longevity much more than the common atmoſphere. Nay, there are not wanting ſome who attribute the longevity of the Antediluvians to the great purity of the atmoſphere at that time; the whole maſs being afterwards tainted by the deluge, in ſuch a manner that it could never regain its former purity and ſalubrity. But all this as yet is mere conjecture; and excepting the ſingle fact, that animals live much longer in a quantity of dephlogiſticated than of common air, there is no evidence that the former contributes more to longevity than the latter. Dr. Prieſtley even throws out a conjecture, that the uſe of dephlogiſticated air might perhaps wear out the ſyſtem much ſooner than common air, in the ſame manner as it conſumes fuel much faſter than common air. The great quantity, however, even of the pureſt air, which is requiſite to ſupport animal life, and the expence and trouble of the moſt ready methods of procuring it, have hitherto prevented any fair trial from being made. Yet philoſophers, conſidering the probability there is of this kind of air being ſalutary in many diſeaſes, have beſtowed ſome pains in attempting to find out methods of procuring it eaſily, and in large quantities.

To procure Vitriolic Acid Air. This conſiſts of the vitriolic acid, united with ſome phlogiſton, which volatilizes and renders it capable of aſſuming the form of a permanently elaſtic fluid. To obtain it, ſome ſtrong concentrated vitriolic acid muſt be put into the uſual bottle, together with ſome ſubſtance capable of furniſhing phlogiſton. Olive oil anſwers very well. The oil of vitriol ſhould be about three or four times as much as the ſweet oil, and both together ſhould fill about one third or half the bottle. A gentle degree of heat is then required, in order to let theſe materials yield any elaſtic fluid; which may be done by applying the flame of a wax-taper, as before directed for the production of dephlogiſticated air.

To procure Marine Acid Air, which is no other than the marine acid itſelf, and which with out any addition becomes a permanently elaſtic fluid; put ſome ſea-ſalt, or common kitchen ſalt, into the uſual bottle in which the materials for producing elaſtic fluids are generally put, ſo as to fill about a fourth part of it, and upon this ſalt pour a ſmall quantity of good concentrated vitriolic acid; then apply the bent tube to the bottle, and introduce it through the quickſilver into the receiver, filled with and inverted in quickſilver after the uſual method, and the elaſtic fluid is copiouſly produced.

To procure Nitrous Acid Air. This may be obtained from heated nitrous acid, the vapour of which acquires a permanent elaſticity, and it has been found to remain uncondenſed into a viſible fluid by any cold to which it has been hitherto expoſed. The great difficulty is to find a fluid capable of confining this acid air; becauſe it is eaſily and abundantly abſorbed by water, which is one of its properties by which it differs from nitrous air. It acts upon quickſilver, and alſo upon oils: hence its examination cannot be made but very imperfectly; for ſubſtances muſt be expoſed to it, or mixed with it, whilſt it is actually changing its nature by acting on the mercury or other fluid that confines it. When water has abſorbed a good quantity of this elaſtic fluid, it acquires the properties of nitrous acid; and when heated, it yields a large quantity of nitrous air, viz. a quantity many times greater than that which water is wont to imbibe of it by agitation, or by any known means. When the nitrous acid air is combined with eſſential oils, a conſiderable effervеſcence and heat are produced, nearly in the ſame manner as when the nitrous acid itſelf is poured upon thoſe oils.

Fluor Acid Air. Put ſome of thoſe minerals called *fluors*, or *fuſible ſpars*, pulverized, into the uſual bottle, and upon it pour ſome concentrated oil of vitriol; then adapt the bent tube, &c. The fluor acid air is at firſt produced without the help of heat; but in a ſhort time it will be neceſſary to apply the flame of a candle to the bottle, by which means a conſiderable quantity of this elaſtic fluid is obtained.

Alkaline Air. Let the uſual bottle be about half filled with volatile ſpirit of ſal-ammoniac; and after applying the bent tube, &c. let the flame of a candle be brought under the bottle, by which means the alkaline air will be copiouſly produced.

SYSTEM OF AEROSTATION.

THE word, in its primitive ſenſe, denotes the ſcience of ſuſpending weights in the air; but, in its modern acceptation, it ſignifies *aerial navigation*, or the art of navigating through the atmoſphere. Hence alſo the machines which are employed for this purpoſe are called *aeroſtats*, or *aeroſtatic* machines; and, from their globular ſhape, *air balloons*.

The romances of almoſt every nation have recorded inſtances of perſons being carried through the air, both by the agency of ſpirits and by mechanical inventions; but till the time of the celebrated Lord Bacon, no rational principle appears ever to have been thought of by which this might be accompliſhed. Before that time, indeed, Friar Bacon had written upon the ſubject; and many had been of opinion, that, by means of artificial wings, fixed to the arms or legs, a man might fly as well as a bird; but theſe opinions were thoroughly refuted by Borelli in his treatiſe *De Motu Animalium*; where, from a compariſon between the power of the muſcles which move the wings of a bird, and thoſe which move the arms of a man, he demonſtrates that the latter are utterly inſufficient to ſtrike the air with ſuch force as to raiſe him from the ground. It cannot be denied, however, that wings of this kind, if properly conſtructed, and dexterouſly managed, might be ſufficient to break the fall of a human body from an high place, ſo that ſome adventurers in this way might poſſibly come off with ſafety; though by far the greateſt number of thoſe who have raſhly adopted ſuch ſchemes, have either loſt their lives or limbs in the attempt.

Mr. Henry Cavendiſh firſt aſcertained the weight and other properties of inflammable air, determining it to be at leaſt ſeven times lighter than common air. Soon after which, it occurred to Dr. Black, that perhaps a thin bag filled with inflammable air might be buoyed up by the common atmoſphere; and he thought of having the allantois of a calf prepared for this purpoſe: but his other avocations prevented him from proſecuting the experiment. The ſame thought occurred ſome years afterwards to Mr. Cavallo; and he has the honour of being the firſt who made experiments on the ſubject. He firſt tried bladders; but the thinneſt of theſe, however well ſcraped and prepared, were found too heavy. He then tried Chineſe paper; but that proved ſo permeable, that the vapour paſſed through it like water through a ſieve. His experiments, therefore, made in the year 1782, proceeded no farther than blowing up ſoap-bubbles with inflammable air, which aſcended rapidly to the cieling, and broke againſt it.

But while the diſcovery of the art of aeroſtation ſeemed thus on the point of being made in Britain, it was all at once announced in France, and that from a quarter whence nothing of the kind was to have been expected. Two brothers, Stephen and John Montgolfier, natives of Annonay, and maſters of a conſiderable paper-manufactory there, had turned their thoughts towards this project as early as the middle of the year 1782. The idea was firſt ſuggeſted by the natural aſcent of the ſmoke and clouds in the atmoſphere; and their deſign was to form an artificial cloud, by cloſing the ſmoke in a bag, and making it carry up the covering along with it. Towards the middle of November that year, the experiment was made at Avignon with a fine ſilk bag of a parallelopiped ſhape. By applying burning paper to the lower aperture, the air was rarefied, and the bag aſcended in the atmoſphere, and ſtruck rapidly againſt the cieling. On repeating the experiment in the open air, it roſe to the height of about 70 feet. An experiment on a more enlarged ſcale was now projected; and a new machine, containing about 650 cubic feet, was made, which broke the cords that confined it, and roſe to the height of about 600 feet. Another of 35 ſeet in diameter roſe about 1000 feet high, and fell to the ground three quarters of a mile from the place where it aſcended.

A public exhibition was next made on the 5th of June 1783, at Annonay, where a vaſt number of ſpectators aſſembled. An immenſe bag of linen, lined with paper, and containing upwards of 23,000 cubic feet, was found to have a power of lifting about 500 pounds, including its own weight. The operation was begun by burning chopped ſtraw and wool under the aperture of the machine, which immediately began to ſwell; and, after being ſet at liberty, aſcended into the atmoſphere. In ten minutes it had aſcended 6000 feet; and when its force was exhauſted, it fell to the ground at the diſtance of 7668 feet from the place from whence it ſet out.

Some time after this experiment had been made, one of the brothers arrived at Paris, where he was invited by the Academy of Sciences to repeat his experiments at their expence. In conſequence of this invitation he conſtructed, in a garden in the Fauxbourg of St. Germain, a large balloon of an elliptical form. In a preliminary experiment this machine lifted up from the ground eight perſons who held it, and would have carried them all off if more had not quickly come to their aſſiſtance. Next day the experiment was repeated in preſence of the members of the academy; the machine was filled by the combuſtion of 50 pounds of ſtraw made up in ſmall bundles, upon which about 12 pounds of chopped wool were thrown at intervals. The uſual ſucceſs attended this exhibition: the machine ſoon ſwelled; endeavoured to aſcend; and immediately after ſuſtained itſelf in the air, together with the charge of between 4 and 500 pounds weight. It was evident that it would have aſcended to a great height; but as it was deſigned to repeat the experiment before the king and royal family at Verſailles, the cords by which it was tied down were not cut. But in conſequence of a violent rain and wind which happened at this time, the machine was ſo far damaged, that it became neceſſary to prepare a new one for the time that it had been determined to honour the experiment with the royal preſence; and ſuch expedition was uſed, that this vaſt machine, of near 60 feet in height and 43 in diameter, was made, painted with water-colours both within and without, and finely decorated, in no more than four days and four nights. With this machine was ſent up a wicker cage, containing a ſheep, a cock, and a duck, which were the firſt animals ever ſent through the atmoſphere. The full ſucceſs of the experiment was prevented by a violent guſt of wind, which tore the cloth in two places, near the top, before it aſcended: however, it roſe to the height of 1440 feet; and, after remaining in the air about eight minutes, fell to the ground at the diſtance of 10,200 feet from the place of its ſetting out. The animals contained in it did not receive the leaſt injury.

From the great power of theſe aeroſtatic machines, and their very gradual deſcent in falling to the ground, it was reaſonably ſuppoſed that they were capable of conveying people through the air with all imaginable ſafety; and this was further confirmed by the experiment already mentioned.

Encouraged by the ſucceſs of theſe experiments, M. Montgolfier propoſed to make a new aeroſtatic machine of a firmer and better conſtruction than the former: and M. Pilatre de Rozier offered himſelf to be the firſt aerial adventurer.

This new machine was conſtructed in a garden in the Fauxbourg of St. Antoine. It was of an oval ſhape, about 48 feet in diameter and 74 in height; elegantly painted on the outſide with the ſigns of the zodiac, cyphers of the king's name, and other ornaments. A proper gallery, grate, &c. were appended; ſo that it was eaſy for the perſon who aſcended to ſupply the fire with fuel, and thus keep up the machine as long as he pleaſed. The weight of the whole apparatus was upwards of 1600 pounds.

The experiment was performed on the 15th of October 1783. M. Pilatre having placed himſelf in the gallery, the machine was inflated, and permitted to aſcend to the height of 84 feet, where he kept it afloat for about four minutes and a half; after which it deſcended very gently: and ſuch was its tendency to aſcend, that it rebounded to a conſiderable height after toucing the ground.

Two days after, he repeated the experiment with ths ſame ſucceſs as before; but, the wind being ſtrong, the machine did not ſuſtain itſelf ſo well as formerly. However, on repeating the experiment in calmer weather, he aſcended to the height of 210 feet. His next aſcent was 262 feet; and in the deſcent a guſt of wind having blown the machine over ſome large trees of an adjoining garden, M. Pilatre ſuddenly extricated himſelf from ſo dangerous a ſituation, by throwing ſome ſtraw and chopped wool on the fire, which raiſed him at once to a ſufficient height. On deſcending again, he once more raiſed himſelf to a proper height by throwing ſtraw on the fire. Soſhe time after he aſcended in company with M. Girond de Villette to the height of 330 feet; hovering over Paris at leaſt nine minutes in ſight of all the inhabitants, the machine, during the time, keeping quite ſtationary.

From theſe experiments it was evident, that the aeroſtatic machines might be raiſed or lowered at the pleaſure of the perſons who aſcended: they had likewiſe diſcovered, that keeping them faſt with ropes was no advantage; but, on the contrary, that this was attended with inconvenience and hazard.

On the 21ſt of November 1783, M. Pilatre determined to undertake an aerial voyage in which the machine ſhould be ſet at full liberty. Every thing being got in readineſs, the balloon was filled in a few minutes; and M. Pilatre placed himſelf in the gallery, counterpoiſed by the Marquis d'Arlandes, who occupied the other ſide. It was intended to make ſome preliminary experiments on the aſcending power of the machine: but the violence of the wind prevented this from being done, and even damaged the balloon eſſentially; ſo that it would have been entirely deſtroyed had not timely aſſiſtance been given. The extraordinary exertions of the workmen, however, repaired it again in two hours, and the adventurers ſet out. They met with no inconvenience during their voyage, which laſted about 25 minutes; during which time they had paſſed over a ſpace of above five miles. From the account given by the Marquis d'Arlandes, it appeared that they met with ſeveral different currents of air, the effect of which was, to give a very ſenſible ſhock to the machine, and the direction of the motion ſeemed to be from the upper part downwards. It appeared alſo that they were in ſome danger of having the balloon burnt altogether; as the Marquis obſerved ſeveral round holes made by the fire in the lower part of it, which alarmed him conſiderably, and, indeed, not without reaſon. However, the progreſs of the fire was eaſily ſtopped by the application of a wet ſponge, and, in a ſhort time, all appearance of danger ceaſed.

This voyage of M. Pilatre and the Marquis d'Arlandes may be ſaid to conclude the hiſtory of thoſe aeroſtatic machines which are elevated by means of fire; for though many other attempts have been made upon the ſame principle, moſt of them have either proved unſucceſsful, or of little conſequence. They have therefore

given place to the other kind, filled with inflammable air; which, by reaſon of its ſmaller ſpecific gravity, is both more manageable, and capable of performing voyages of greater length, as it does not require to be ſupplied with fuel like the others. This was invented a very ſhort time after the diſcovery made by M. Montgolfier. This gentleman had, indeed, deſigned to keep his method in ſome degree a ſecret from the world; but as it could not be concealed, that a bag filled with any kind of fluid lighter than the common atmoſphere would riſe in it, inflammable air was naturally thought of as a proper ſuccedaneum for the rarefied air of M. Montgolfier.

The firſt experiment was made by two brothers named Roberts, and M. Charles, a profeſſor of experimental philoſophy. The bag which contained the gas was compoſed of luteſtring, varniſhed over with a ſolution of the elaſtic gum called *caoutchouc*; and that with which they made their firſt eſſay was only about 13 Engliſh feet in diameter. Many difficulties occurred in filling it with the inflammable air, chiefly owing to their ignorance of the proper apparatus; inſomuch, that, after a whole day's labour from nine in the morning, they had got the balloon only one third part full. Next morning, they were ſurpriſed to find that it had fully inflated of itſelf during the night: but, upon inquiry, it was found, that they had inadvertently left open a ſtop-cock connected with the balloon, by which the common air gaining acceſs, had mixed itſelf with the inflammable air; forming a compound ſtill lighter than the common atmoſphere, but not ſufficiently light to anſwer the purpoſes of aeroſtation. Thus they were obliged to renew their operation; and, by ſix o'clock in the evening of the next day, they found the machine conſiderably lighter than the common air; and, in an hour after, it made a ſtrong effort to aſcend. The public exhibition, however, had been announced only for the third day after; ſo that the balloon was allowed to remain in an inflated ſtate for a whole day; during which they found it had loſt a power of aſcent equal to about three pounds, being one ſeventh part of the whole. When it was ſet at liberty, after having been well filled with inflammable air, it was 35 pounds lighter than an equal bulk of common air. It remained in the atmoſphere only three quarters of an hour, during which it had traverſed 15 miles. It deſcended very ſuddenly, which was ſuppoſed to have been owing to a rupture that had taken place in the balloon.

The ſucceſs of this experiment, and the aerial voyage made by Meſſrs. Rozier and Arlandes, naturally ſuggeſted the idea of undertaking ſomething of the ſame kind with a balloon filled with inflammable air. The machine uſed on this occaſion was formed of gores of ſilk, covered over with a varniſh made of *caoutchouc*, of a ſpherical figure, and meaſuring 27½ feet in diameter. A net was ſpread over the upper hemiſphere, and faſtened to an hoop which paſſed round the middle of the balloon. To this a ſort of car, or rather boat, was ſuſpended by ropes, in ſuch a manner as to hang a few feet below the lower part of the balloon; and, in order to prevent the burſting of the machine, a valve was placed in it; by opening of which ſome of the inflammable air might be occaſionally let out. A long ſilken pipe communicated with the balloon, by means of which it was filled. The boat was made of baſket-work, covered with painted linen, and beautifully ornamented; being 8 feet long, 4 broad, and 3½ deep; its weight 130 pounds. At this time, however, as at the former, they met with great difficulties in filling the machine with inflammable air, owing to their ignorance of the moſt proper apparatus. But at laſt, all obſtacles being removed, the two adventurers took their ſeats at three quarters after one in the afternoon of the firſt of December 1783. Perſons ſkilled in mathematics were conveniently ſtationed with proper inſtruments to calculate the height, velocity, &c. of the balloon. The weight of the whole apparatus, including that of the two adventurers, was found to be 604½ pounds, and the power of aſcent, when they ſet out was 20 pounds; ſo that the whole difference betwixt the weight of this balloon and an equal bulk of common air was 624 pounds. But the weight of common atmoſphere diſplaced by the inflammable gas was calculated to be 771 pounds, ſo that there remains 147 for the weight of the latter; and this calculation makes it only 5¼ times lighter than common air.

At the time the balloon left the ground the thermometer ſtood at 9° of Fahrenheit's ſcale, and the quickſilver in the barometer at 30.18 inches; and, by means of the power of aſcent with which they left the ground, the balloon roſe till the mercury fell to 27 inches, from which they calculated their height to be about 600 yards. By throwing out ballaſt occaſionally as they found the machine deſcending by the eſcape of ſome of the inflammable air, they found it practicable to keep at pretty near the ſame diſtance from the earth during the reſt of their voyage; the quickſilver fluctuating between 27 and 27.65 inches, and the thermometer between 53° and 57°, the whole time. They continued in the air for the ſpace of an hour and three quarters, when they alighted at the diſtance of 27 miles from Paris; having ſuffered no inconvenience during their voyage, nor experienced any contrary currents of air, as had been felt by Meſſrs. Pilatre and Arlandes. As the balloon ſtill retained a great quantity of inflammable gas, Mr. Charles determined to take another voyage by himſelf. Mr. Robert accordingly got out of the boat, which was thus lightened by 130 pounds, and of conſequence the aeroſtatic machine now had nearly as much power of aſcent. Thus he was carried up with ſuch velocity, that in twenty minutes he was almoſt 9000 feet high, and entirely out of ſight of terreſtrial objects. At the moment of his parting with the ground, the globe had been rather flaccid; but it ſoon began to ſwell, and the inflammable air eſcaped from it in great quantities through the ſilken tube. He alſo frequently drew the valve that it might be the more freely emitted, and the balloon effectually prevented from burſting. The inflammable gas being conſiderably warmer than the external air, diffuſed itſelf all round, and was felt like a warm atmoſphere; but in ten minutes the thermometer indicated a variation of temperature as great as that between the warmth of ſpring and the ordinary cold of winter. His fingers were benumbed by the cold, and he felt a violent pain in his right ear and jaw, which he aſcribed to the dilatation of the air in theſe organs as well as to the external cold. The beauty of the proſpect which he now enjoyed, however, made amends for theſe inconveniences. At his departure the ſun was ſet on the vallies; but the height to which Mr. Charles was got in the atmoſphere, rendered him again viſible, though only for a ſhort time. He ſaw, for a few ſeconds, vapours riſing from the vallies and rivers. The clouds ſeemed to aſcend from the earth, and collect one upon the other, ſtill preſerving their uſual form; only their colour was grey and monotonous for want of ſufficient light in the atmoſphere. By the light of the moon he perceived that the machine was turning round with him in the air; and he obſerved that there were contrary currents which brought him back again. He obſerved alſo, with ſurpriſe, the effects of the wind, and that the ſtreamers of his banners pointed upwards; which, he ſays, could not be the effect either of his aſcent or deſcent, as he was moving horizontally at the time. At laſt, recollecting his promiſe of returning to his friends in half an hour, he pulled the valve, and accelerated his deſcent. When within 200 feet of the earth, he threw out two or three pounds of ballaſt, which rendered the balloon again ſtationary: but in a little time afterwards, he gently alighted in a field about three miles diſtant from the place whence he ſat out; though by making allowance for all the turnings and windings of the voyage, he ſuppoſes that he had gone through nine miles at leaſt. By the calculations of M. de Maunier, he roſe at this time not leſs than 10,500 feet high; a height ſomewhat greater than that of Mount Ætna. A ſmall balloon, which had been ſent off before the two brothers ſet out on their voyage, took a direction oppoſite to that of the large one, having met with an oppoſite current of air, probably at a much greater height.

The ſubſequent aerial voyages differ ſo little from that juſt now related, that any particular deſcription of them ſeems to be ſuperfluous. It had occurred to Mr. Charles, however, in his laſt flight, that there might be a poſſibility of directing the machine in the atmoſphere; and this was ſoon attempted by M. Jean-Pierre Blanchard, a gentleman who had, for ſeveral years before, amuſed himſelf with endeavours to fly by mechanical means, though he had never ſucceeded in the undertaking. As ſoon as the diſcovery of the aeroſtatic machines was announced, however, he reſolved to add the wings of his former machine to a balloon, and made no doubt that it would then be in his power to direct himſelf through the air at pleaſure. In his firſt attempt he was fruſtrated by the impetuoſity of a young gentleman, who inſiſted, right or wrong, on aſcending along with him. In the ſcuffle which enſued on this occaſion, the wings and other apparatus were entirely deſtroyed; ſo that M. Blanchard was obliged to commit himſelf to the direction of the wind: and in another attempt it was found, that all the ſtrength he could ſupply was ſcarce ſufficient to counteract the impreſſion of the wind in any degree. In his voyage, he found his balloon, at a certain period, acted upon by two contrary winds; but, on throwing out four pounds of ballaſt, he aſcended to a place where he met with the ſame current he had at ſetting out from the earth. His account of the ſenſations he felt during this voyage, was ſomewhat different from that of Mr. Charles; having, in one part of it, found the atmoſphere very warm, in another cold; and having once found himſelf very hungry, and at another time almoſt overcome by a propenſity to ſleep. The height to which he aroſe, as meaſured by ſeveral obſervations with mathematical inſtruments, was thought to be very little leſs than 10,000 feet; and he remained in the atmoſphere an hour and a quarter.

The attempts of M. Blanchard to direct his machine through the atmoſphere were repeated in the month of April 1784. Meſſrs. Morveau and Bertrand at Dijon, who raiſed themſelves with an inflammable air-balloon to the height, as it was thought, of 13,000 feet; paſſing through a ſpace of 18 miles in an hour and 25 minutes. M. Morveau had prepared a kind of oars for directing the machine through the air; but they were damaged by a guſt of wind, ſo that only two of them remained ſerviceable: by working theſe, however, they were able to produce a ſenſible effect on the motion of the machine. In a third aerial voyage performed by M. Blanchard, he ſeemed to produce ſome effect by the agitation of his wings, both in aſcending, deſcending, moving ſidewiſe, and even in ſome meaſure againſt the wind; however, this is ſuppoſed, with ſome probability, to have been a miſtake, as, in all

Representation of Various Baloons, with the methods of constructing and filling them, the Implements necessary for accelerating or retarding their Motion, See System of Aerostation.

The Balloon in which Lunardi ascended a 2d time from the Artillery ground May 15th 1785.

Aerostatic Figure, which was exhibited at the Pantheon, by the Brothers Enslen.

The Balloon in which Mr. Blanchard took his aerial flight from Dover to the Continent.

A view from the Balloon at its greatest elevation above the clouds, seen by Mr. Baldwin as he passed over the city of Queen Sep. 1785.

The Fire Balloon in which M. Montgolfier, ascended from Faubourg St. Antoine in France.

The Balloon in which M. Lunardi first ascended from the Artillery ground September 15th 1784.

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his ſucceeding voyages, the effects of his machinery could not be perceived.

The ſucceſs of Meſſrs. Charles and Roberts in their former experiments encouraged them ſoon to repeat them, with the addition of ſome machinery to direct their courſe. Having enlarged their former balloon to the ſize of an oblong ſpheroid of 46½ feet long and 27½ in diameter, they made it to float with its longeſt parallel to the horizon. The wings were made in the ſhape of an umbrella without the handle, to the top of which a ſtick was faſtened parallel to the aperture of the umbrella. Five of theſe were diſpoſed round the boat, which was near 17 feet in length. The balloon was filled in three hours, and, with the addition of 450 pounds of ballaſt, remained *in æquilibrio* with the atmoſphere. About noon, on the 19th of September 1784, they began to aſcend very gently in conſequence of throwing out 24 pounds of ballaſt, but were ſoon obliged to throw out eight pounds more in order to avoid running againſt ſome trees. Thus they roſe to the height of 1400 feet, when they perceived ſome thunder-clouds near the horizon. On this they aſcended and deſcended, to avoid the danger, as the wind blew directly towards the threatening clouds; but, from the height of 600 feet to that of 4200 above the ſurface of the earth, the current was quite uniform and in one direction. During their voyage they loſt one of their oars; but found, that by means of thoſe which remained, they conſiderably accelerated their courſe. From the account of their voyage, it appeared that they had paſſed ſafely through the thunder-clouds; as we are informed, that, about 40 minutes after three they heard a loud clap of thunder; and, three minutes after, another much louder; at which time the thermometer ſunk from 77 to 59 degrees. This ſudden cold, occaſioned by the approach of the clouds, condenſed the inflammable air, ſo that the balloon deſcended very low, and they were obliged to throw out 40 pounds of ballaſt; yet, on examining the heat of the air within the balloon, they found it to be 104°, when that of the external atmoſphere was only 63. When they had got ſo high that the mercury in the barometer ſtood only at 23,94 inches, they found themſelves becalmed; ſo that the machine did not go even at the rate of two feet in a ſecond, though it had before gone at the rate of 24 feet in a ſecond. On this they determined to try the effect of their oars to the utmoſt; and, by working them for 35 minutes, and marking the ſhadow of the balloon on the ground, they found, in that time, that they had deſcribed the ſegment of an ellipſis whoſe longeſt diameter was 6000 feet. After having travelled about 150 miles, they deſcended, only on account of the approach of night, having ſtill 200 pounds of ballaſt left.

Having thus related all that has been done with regard to the conducting of aeroſtatic machines through the atmoſphere, we ſhall now relate the attempts that have been made to leſſen their expence, by concerting ſome contrivance to aſcend without throwing out ballaſt, and to deſcend without loſing any of the inflammable air.

The firſt attempt of this kind was made by the Duke de Chartres; who, on the 15th of July 1784, aſcended with the two brothers, Charles and Roberts, from the Park of St. Cloud. The balloon was of an oblong form, made to aſcend with its longeſt diameter horizontally, and meaſured 55 feet in length and 24 in breadth. It contained within it a ſmaller balloon filled with common air; by blowing into which with a pair of bellows, and thus throwing in a conſiderable quantity of common air, it was ſuppoſed that the machine would become ſufficiently heavy to deſcend, eſpecially as, by the inflation of the internal bag, the inflammable air in the external one would be condenſed into a ſmaller ſpace, and thus become ſpecifically heavier. The voyage, however, was attended with ſuch circumſtances as rendered it impoſſible to know what would have been the event of the ſcheme. The power of aſcent with which they ſet out ſeems to have been very great; as, in three minutes after parting with the ground, they were loſt in the clouds, and involved in ſuch a denſe vapour, that they could ſee neither the ſky nor the earth. In this ſituation they ſeemed to be attacked by a whirl-wind, which, beſides turning the balloon three times round from right to left, ſhook and beat it ſo about, that they were rendered incapable of uſing any of the means propoſed for directing their courſe, and the ſilk ſtuff of which the helm had been compoſed was even torn away. No ſcene can be conceived more terrible than that in which they were now involved. An immenſe ocean of ſhapeleſs clouds rolled one upon another below them, and ſeemed to prevent any return to the earth, which ſtill continued inviſible, while the agitation of the balloon became greater every moment. In this extremity they cut the cords which held the interior balloon, and of conſequence it fell down upon the aperture of the tube that came from the large balloon into the boat, and ſtopped it up. They were then driven upwards by a guſt of wind from below, which carried them to the top of that ſtormy vapour in which they had been involved. They now ſaw the ſun without a cloud; but the heat of his rays, with the diminiſhed denſity of the atmoſphere, had ſuch an effect on the inflammable air, that the balloon ſeemed every moment ready to burſt. To prevent this they introduced a ſtick through the tube, in order to puſh away the inner balloon from its aperture: but the expanſion of the inflammable air puſhed it ſo cloſe, that all attempts of this kind proved ineffectual. It was now, however, become abſolutely neceſſary to give vent to a very conſiderable quantity of the inflammable air; for which purpoſe the Duke de Chartres himſelf bored two holes in the balloon, which tore open for the length of ſeven or eight feet. On this they deſcended with great rapidity; and would have fallen into a lake, had they not haſtily thrown out 60 pounds of ballaſt, which enabled them juſt to reach the water's edge.

The ſucceſs of the ſcheme for raiſing or lowering aeroſtatic machines by means of bags filled with common air being thus rendered dubious, another method was thought of. This was to put a ſmall aeroſtatic machine with rarefied air under an inflammable air-balloon, but at ſuch a diſtance that the inflammable air of the latter might be perfectly out of the reach of the fire uſed for inflating the former; and thus, by increaſing or diminiſhing the fire in the ſmall machine, the abſolute weight of the whole would be conſiderably diminiſhed or augmented. This ſcheme was unhappily put in execution by the celebrated M. Pilatre de Rozier, and another gentleman named M. Romaine. Their inflammable air-balloon was about 37 feet in diameter, and the power of the rarefied air one was equivalent to about 60 pounds. They aſcended without any appearance of danger or ſiniſter accident; but had not been long in the atmoſphere when the inflammable air-balloon was ſeen to ſwell very conſiderably, at the ſame time that the aeronauts were obſerved, by means of teleſcopes, very anxious to get down, and buſied in pulling the valve and opening the appendages to the balloon, in order to facilitate the eſcape of as much inflammable air as poſſible. A ſhort time after this the whole machine was on fire, when they had then attained the height of about three quarters of a mile from the ground. No exploſion was heard; and the ſilk which compoſed the air-balloon continued expanded, and ſeemed to reſiſt the atmoſphere for about a minute; after which it collapſed, and the remains of the apparatus deſcended along with the two unfortunate travellers ſo rapidly, that both of them were killed. M. Pilatre ſeemed to have been dead before he came to the ground; but M. Romaine was alive when ſome perſons came up to the place where he lay, though he expired immediately after. Theſe are the moſt remarkable attempts that have been made to improve the ſcience of aeroſtation; though a great number of other expeditions through the atmoſphere have taken place.

But of all the voyages which had been hitherto projected or put in execution, the moſt enterpriſing was that of M. Blanchard and Dr. Jeffries acroſs the ſtraits of Dover, which ſeparate Britain from France. This took place on the 7th of January 1785, being a clear froſty morning, with a wind, barely perceptible, at N. N. W. The operation of filling the balloon began at 10 o'clock, and, at three quarters after twelve, every thing was ready for their departure. At one o'clock M. Blanchard deſired the boat to be puſhed off, which now ſtood only two feet diſtant from that precipice ſo finely deſcribed by Shakeſpeare in his tragedy of King Lear. As the balloon was ſcarcely ſufficient to carry two, they were obliged to throw out all their ballaſt except three bags of 10 pounds each; when they at laſt roſe gently, though making very little way on account of there being ſo little wind. At a quarter after one o'clock the barometer, which on the cliff ſtood at 29.7 inches, was now fallen to 27.3, and the weather proved fine and warm. They had now a moſt beautiful proſpect of the ſouth coaſt of England, and were able to count 37 villages upon it. After paſſing over ſeveral veſſels, they found that the balloon, at 50 minutes after one, was deſcending, on which they threw out a ſack and an half of ballaſt; but as they ſaw that it ſtill deſcended, and that with much greater velocity than before, they now threw out all the ballaſt. This ſtill proving ineffectual, they next threw out a parcel of books they carried along with them, which made the balloon aſcend when they were about midway betwixt France and England. At a quarter paſt two, finding themſelves again deſcending, they threw away the remainder of their books, and, ten minutes after, they had a moſt enchanting proſpect of the French coaſt. Still, however, the machine deſcended; and as they had now no more ballaſt, they were obliged to throw away their proviſions for eating, the wings of their boat, and every other moveable they could poſſibly ſpare. "We threw away," ſays Dr. Jeffries, "our only bottle, which, in its deſcent, caſt out a ſteam like ſmoke, with a ruſhing noiſe; and when it ſtruck the water, we heard and felt the ſhock very perceptibly on our ear and balloon." All this proving inſufficient to ſtop the deſcent of the balloon, they next threw out their anchors and chords, and at laſt ſtripped off their clothes, faſtening themſelves to certain ſlings, and intending to cut away the boat as their laſt reſource. They had now the ſatisfaction, however, to find that they were riſing; and as they paſſed over high lands between Cape Blanc and Calis, the machine roſe very faſt, and carried them to a greater height than they had been at any former part of their voyage. In a ſhort time after they deſcended ſafely among ſome trees in the foreſt of Guiennes.

It would be tedious as well as unneceſſary to recount all the other aerial voyages that have been performed in our own or other countries: it appeared ſufficient for the purpoſe of this article to notice thoſe which were moſt remarkable and intereſting; and

therefore an account of the ingenious Mr. Baldwin's excurſion from Cheſter, with the particular circumſtances attending it, ſhall now cloſe our enumeration.

On the 8th of September 1785, at forty minutes paſt one P. M. Mr. Baldwin aſcended from Cheſter in Mr. Lunardi's balloon. After traverſing in a variety of different directions, he firſt alighted, at 28 minutes after three, about twelve miles from Cheſter, in the neighbourhood of Frodſham; then re-aſcending and purſuing his excurſion, he finally landed at Rixton-moſs, five miles N. N. E. of Wavington, and 25 miles from Cheſter. Mr. Baldwin has publiſhed his Obſervations and Remarks made during his voyage, and taken from minutes. Our limits will not admit of relating many of his obſervations; but the few following are ſome of the moſt important and curious. "The ſenſation of aſcending is compared to that of a ſtrong preſſure from the bottom of the car upwards againſt the ſoles of his feet. A few ſeconds of time before the balloon had attained its greateſt height, the ſtriking contraſt and novelty of his ſituation filled him with unuſual and pleaſing ſenſations. The ſky was painted with a purer, and more tranſparent azure. The ſun ſhone hot, and with a brighter luſtre. His beams were white and ſparkling; not ſurrounded with haze or vapour; but too fierce for the human eye to look upon a ſecond time with pleaſure. At the diſtance of what appeared to him ſeven miles from the earth, though by the barometer ſcarcely a mile and a half, he had a grand and moſt enchanting view of the city of Cheſter and its adjacent places below. The river Dee appeared of a red colour, the city very diminutive, and the town entirely blue. The whole appeared a perfect plain, the higheſt building having no apparent height, but reduced all to the ſame level; and the whole terreſtrial proſpect appeared like a coloured map. Juſt after his firſt aſcent, being in a well-watered and maritime part of the country, he obſerved a remarkable and regular tendency of the balloon towards the ſea; but, ſhortly after, riſing into another current of air, he eſcaped the danger. This upper current, he ſays, was viſible to him at the time of his aſcent, by a lofty ſound ſtratum of clouds flying in a ſafe direction. The perſpective appearance of things to him was very remarkable. The loweſt bed of vapour that firſt appeared as a cloud was pure white, in detached fleeces, increaſing as they roſe: they preſently coaleſced, and formed, as he expreſſes it, a ſea of cotton, tufting here and there by the action of the air in the undiſturbed parts of the clouds. The whole became an extended white floor of cloud, the upper ſurface being ſmooth and even. Above this white floor he obſerved, at great and unequal diſtances, a vaſt aſſemblage of thunder-clouds, each parcel conſiſting of whole acres in the denſeſt form: he compares their form and appearance to the ſmoke of pieces of ordnance, which had conſolidated as it were into maſſes of ſnow, and penetrated through the upper ſurface and white floor of common clouds, there remaining viſible and at reſt. Some clouds had motions in ſlow and various directions, forming an appearance truly ſtupendous and majeſtic." He endeavours to convey ſome idea of the ſcene as repreſented in *fig.* 11. *A* repreſents a circular view he had from the car of the balloon, himſelf being over the centre of the view, looking down on the white floor of clouds, and ſeeing the city of Cheſter through an opening, which diſcovered the landſcape below, limited by ſurrounding vapour, to leſs than two miles in diameter. The breadth of the outer margin defines his apparent height in the balloon, viz. four miles above the white floor of clouds. Mr. Baldwin alſo gives a curious deſcription of his tracing the ſhadow of the balloon over tops of volumes of clouds. At firſt it was ſmall, in ſize and ſhape like an egg; but ſoon increaſed to the magnitude of the ſun's diſk, ſtill growing larger, and attended with a moſt captivating appearance of an iris encircling the whole ſhadow at ſome diſtance round it, the colours of which were remarkably brilliant. The regions did not feel colder, but rather warmer, than below. The ſun was hotteſt to him when the balloon was ſtationary. The diſcharge of a cannon when the balloon was at a conſiderable height, was diſtinctly heard by the aeronaut; and a diſcharge from the ſame piece, when at the height of 30 yards, ſo diſturbed him as to oblige him for ſafety to lay hold firmly of the cords of the balloon. At a conſiderable height he poured down a pint bottle full of water; and as the air did not oppoſe a reſiſtance ſufficient to break the ſtream into ſmall drops, it moſtly fell down in large drops. In the courſe of the balloon's track it was found much affected by the water, a circumſtance obſerved in former aerial voyages. At one time the direction of the balloon kept continually over the water, going directly towards the ſea, ſo much as to endanger the aeronaut: the mouth of the balloon was opened, and he in two minutes deſcended into an under current blowing from the ſea: he kept deſcending, and landed at Bellair farm in Rinſley, 12 miles from Cheſter. Here he lightened his car by 31 pounds, and inſtantly re-aſcending, was carried into the interior part of the country, performing a number of different manœuvres. At his greateſt altitude he found his reſpiration free and eaſy. Several bladders which he had along with him crackled and expanded very conſiderably. Clouds and land, as before, appeared on the ſame level. By way of experiment, he tried the upper valve two or three times, the neck of the balloon being cloſe; and remarked, that the eſcape of the gas was attended with a growling noiſe like mill-ſtones, but not near ſo loud. Again, round the ſhadow of the balloon, on the clouds, he obſerved the iris. A variety of other circumſtances and appearances he met with is fancifully deſcribed; and at 53 minutes paſt three he finally landed.

The frequency of aerial voyages, accompanied with particular details of trifling and unintereſting circumſtances, and apparently made with a view to promote the intereſt of particular perſons, regardleſs of any advancement in knowledge, have now ſunk the ſcience of aeroſtation ſo low in the opinion of moſt people, that before giving any account of the moſt proper method of conſtructing theſe machines, it may ſeem neceſſary to premiſe ſomething concerning the uſes to which they may poſſibly be applied. Theſe, according to Mr. Cavallo, are the following:

"The ſmall balloons, eſpecially thoſe made of paper, and raiſed by means of ſpirit of wine, may ſerve to explore the direction of the winds in the upper regions of the atmoſphere, particularly when there is a calm below: they may ſerve for ſignals in various circumſtances, in which no other means can be uſed; and letters or other ſmall things may be eaſily ſent by them, as for inſtance from ſhips that cannot ſafely land on account of ſtorms, from beſieged places, iſlands, or the like. The larger aeroſtatic machines may anſwer all the above mentioned purpoſes in a better manner; and they may, beſides, be uſed as a help to a perſon who wants to aſcend a mountain, a precipice, or to croſs a river; and perhaps one of thoſe machines tied to a boat by a long rope, may be, in ſome caſes, a better ſort of ſail than any that is uſed at preſent. The largeſt ſort of machines, which can take up one or more men, may evidently be ſubſervient to various œconomical and philoſophical purpoſes. Their conveying people from place to place with great ſwiftneſs, and without trouble, may be of eſſential uſe, even if the art of guiding them in a direction different from that of the wind ſhould never be diſcovered. By means of thoſe machines the ſhape of certain ſeas and lands may be better aſcertained; men may aſcend to the tops of mountains they never viſited before; they may be carried over marſhy and dangerous grounds; they may by that means come out of a beſieged place, or an iſland; and they may, in hot climates, aſcend to a cold region of the atmoſphere, either to refreſh themſelves, or to obſerve the ice, which is never ſeen below; and, in ſhort, they may be thus taken to ſeveral places, to which human art hitherto knew of no conveyance.

"The philoſophical uſes, to which theſe machines may be ſubſervient, are numerous indeed; and it may be ſufficient to ſay that hardly any thing which paſſes in the atmoſphere is known with preciſion, and that principally for want of a method of aſcending into it. The formation of rain, of thunder-ſtorms, of vapours, hail, ſnow, and meteors in general require to be attentively examined and aſcertained. The action of the barometer, the refraction and temperature of the air in various regions, the deſcent of bodies, the propagation of ſound, &c. are ſubjects that all require a ſeries of obſervations and experiments, the performance of which could never have been properly expected before the diſcovery of aeroſtatic machines."

To thoſe uſes we may add the gratification of curioſity and pleaſure as very ſtrong inducements to the practice of an art, in which, with any tolerable degree of caution, there appears not to be the ſmalleſt danger. Every one who has tried the experiment teſtifies, that the beauty of the proſpect afforded by an aſcent, or the pleaſure of being conveyed through the atmoſphere, cannot be exceeded. No one has felt the leaſt of that giddineſs conſequent upon looking from the top of a very high building or of a precipice, nor have they any of the ſickneſs ariſing from the motion of a veſſel at ſea. Many have been carried by balloons at the rate of 30, 40, or even 50 miles an hour without feeling the leaſt inconvenience, or even agitation of the wind; the reaſon of which is, that as the machine moves with nearly the velocity of the wind itſelf, they are always in a calm, and without uneaſineſs. Some have apprehended danger from the electricity of the atmoſphere; and have thought that a ſtroke of lightning, or the ſmalleſt electric ſpark, happening near a balloon, might ſet fire to the inflammable air, and deſtroy both the machine and the adventurers.—Mr. Cavallo has ſuggeſted ſeveral conſiderations for diminiſhing apprehenſions of this kind. Balloons have been already raiſed in every ſeaſon of the year, and even when thunder has been heard, without injury. In caſe of danger, the aeronauts may either deſcend to the earth, or aſcend above the region of the clouds and thunder-ſtorms. Beſides, as balloons are formed of materials that are not conductors of electricity, they are not likely to receive ſtrokes, eſpecially as by being encompaſſed with air they ſtand inſulated. Moreover, inflammable air by itſelf, or unmixed with a certain quantity of common air, will not burn; ſo that if an electric ſpark ſhould happen to paſs through the balloon, it would not ſet fire to the inflammable air, unleſs a hole was made in the covering.

The general principles of aeroſtation are ſo little different from thoſe of hydroſtatics, that it may ſeem ſuperfluous to inſiſt much upon them. It is a fact univerſally known, that when a body is immerſed in any fluid, if its weight be leſs than an equal bulk of that fluid, it will riſe to the ſurface; but if heavier, it will ſink; and

and if equal, it will remain in the place where it is left. For this reason smoak ascends into the atmosphere, and heated air in that which is colder. The ascent of the latter is shown in a very easy and satisfactory manner by bringing a red-hot iron under one of the scales of a balance, by which the latter is instantly made to ascend; for, as soon as the red-hot iron is brought under the scale, the hot air being lighter than that which is colder, ascends, and strikes the bottom, which is thus impelled upwards, and the opposite scale descends, as if a weight had been put into it.

Upon this simple principle depends the whole theory of aerostation; for it is the same thing whether we render the air lighter by introducing a quantity of heat into it, or inclosing a quantity of gas specifically lighter than the common atmosphere in a certain space; both will ascend, and for the same reason. A cubic foot of air, by the most accurate experiments, has been found to weigh about 554 grains, and to be expanded by every degree of heat, marked on Fahrenheit's thermometer, about one part in 500 of the whole. By heating a quantity of air, therefore, to 500 degrees of Fahrenheit, we will just double its bulk when the thermometer stands at 54 in the open air, and in the same proportion we will diminish its weight; and if such a quantity of this hot air be inclosed in a bag, that the excess of the weight of an equal bulk of common air weighs more than the bag with the air contained in it, both the bag and the air will rise into the atmosphere, and continue to do so until they arrive at a place where the external air is naturally so much rarefied that the weight becomes equal; and here the whole will float.

The power of hot air in raising weights, or rather that by which it is itself impelled upwards, may be shown in the following manner: Roll up a sheet of paper in a conical form, and, by thrusting a pin into it near the apex, prevent it from unrolling. Fasten it then, by its apex, under one of the scales of a balance by means of a thread, and, having properly counterpoised it by weights, put it into the opposite scale; apply the flame of a candle underneath, you will instantly perceive the cone to arise, and it will not be brought into equilibrium with the other, but by a much greater weight than those who had never seen the experiment would believe. If we try this experiment with more accuracy, by getting proper receptacles made which contain determinate quantities of air, we shall find that the power of the heat depends much more on the capacity of the bag which contains it than could well be supposed. Thus, let a cubical receptacle be made of a small wooden frame, covered with paper, capable of containing one foot of air, and let the power of a candle be tried with this as above directed for the paper cone. It will then be found that a certain weight may be raised; but a much greater one will be raised by having a receptacle of the same kind which contains two cubic feet; a still greater by one of three feet; a yet greater by one of four feet, &c. and this even though the very same candle be made use of; nor is it known to what extent even the power of this small frame might be carried.

From these experiments it appears, that in the aerostatic machines constructed on Montgolfier's plan, it must be an advantage to have them as large as possible; because a smaller quantity of fire will then have a greater effect in raising them, and the danger from that element, which in this kind of machines is chiefly to be dreaded, will be in a great measure avoided. On this subject it may be remarked, that as the cubical contents of a globe, or any other figure of which balloons are made, increase much more rapidly than their surfaces, there must ultimately be a degree of magnitude at which the smallest imaginable heat would raise any weight whatever. Thus, supposing any aerostatic machine capable of containing 500 cubic feet, and the air within it to be only one degree hotter than the external atmosphere; the tendency of this machine to rise, even without the application of artificial heat, would be near an ounce. Let its capacity be increased 16 times; and the tendency to arise will be equivolent to a pound, though this may be done without making the machine 16 times heavier than before. It is certain, however, that all aerostatic machines have a tendency to produce or preserve heat within them, which would by no means be imagined by those who have not made the experiment. When Messrs. Charles and Roberts made their longest aerial voyage of 150 miles, they had the curiosity to try the temperature of the air within their balloon, in comparison with that of the external atmosphere; and at this time they found that, when the external atmosphere was 63°, the thermometer within the balloon stood at 104°. Such a difference of temperature must have given a machine of the magnitude which carried them a considerable ascending power, independent of any other cause, as it amounted to 41 grains on every cubic foot; and therefore, in a machine containing 50,000 such feet, would have been almost 200 pounds. Hence we may easily account for what happened at Dijon, and is recorded by M. Morveau. "A balloon, intended to be filled with inflammable air, being completed, was, by way of trial, filled with common air, and in that state exposed to the atmosphere. Now it was observed, and indeed a similar observation had been made before, that the air within the balloon was much hotter than the circumambient air: the thermometer in the former stood at 120°; whereas, in the latter, even when the sun shone upon it, the thermometer stood at 84°. This showed a considerable degree of rarefaction within the balloon; and consequently it was suspected, that, by means of this rarefaction alone, especially if it were to increase a little, the balloon might ascend. On the 30th of May about noon, the wind being rather strong, agitated the balloon so that two men were employed to take care of it; but, notwithstanding all their endeavours, it escaped from its confinement, and, lifting up about 65 pounds weight of cords, equatorial circle, &c. rose many feet high, and passing over some houses, went to the distance of 250 yards, where at length it was properly secured."

This difference between the external and internal heat being so very considerable, must have a great influence upon aerostatic machines, and will undoubtedly influence those filled with inflammable air as well as the other kind. Nor is it unlikely, that the short time which many aerial voyagers have been able to continue in the atmosphere, may have been owing to the want of a method of preserving this internal heat. It may naturally be supposed, and indeed it has always been found, that balloons, in passing through the higher regions of the atmosphere, acquire a very considerable quantity of moisture, not only from the rain or snow they sometimes meet with, but even from the dew and vapour which condenses upon them. On this an evaporation will instantly take place; and, as it is the property of this operation to produce a very violent cold, the internal heat of the balloon must be soon exhausted in such a manner as to make it become specifically heavier than the common atmosphere, and consequently descend in a much shorter time than it would have done by the mere loss of air. To this, in all probability, we are to ascribe the descent of the balloon which carried Messrs. Blanchard and Jeffries; and which seemed so extraordinary to many people, that they were obliged to have recourse to an imaginary attraction in the waters of the ocean, in order to solve the phenomenon. This supposition is rejected by Mr. Cavallo; who explains the matter, by remarking, that in two former voyages made with the same machine, it could not long support two men in the atmosphere; so that we had no occasion to wonder at its weakness on this occasion. "As for its rising higher, says he, just when it got over the land, that may be easily accounted for. In the first place, the two travellers threw out their clothes just about that time; secondly, in consequence of the wind then increasing, the balloon travelled at a much greater rate than it had done whilst over the sea; which increase of velocity lessened its tendency to descend: besides which, the vicissitudes of heat and cold may produce a very considerable effect; for if we suppose, that the air over the land was colder than that over the sea, the balloon coming into the latter from the former, continued to be hotter than the circumambient air for some time after; and consequently it was comparatively much lighter when in the cold air over the land, than when in the hotter air over the sea; hence it floated easier in the former than in the latter case."

It seems indeed very probable, that there was something uncommon in the case of Mr. Blanchard's balloon while passing over the sea; for, as it rose higher after reaching the land than in any former period of the voyage, and likewise carried them to the distance over land more than half of that which they had passed over water, we can scarce avoid supposing, that it had a tendency to descend when over the water more than when over land, independent of any loss of air. Now, it does not appear that the air over the sea, is at all warmer than that above land; on the contrary, there is every reason to believe, that the superior reflective power of the land renders the atmosphere above it warmer than the sea can do; but it is very natural to suppose, that the air above the sea is more moist than that above land; and consequently, by letting fall its moisture upon the balloon, must have occasioned an evaporation that would deprive the machine of its internal heat, which it would partly recover after it entered the warmer and drier atmosphere over land.

I shall now proceed to the construction of aerostatic machines; of which the smaller are only for amusement, or some slight experiments, and are very easily made. As in all of them, however, it is of the utmost consequence to have the weight as little as possible, the shape becomes an object of great consideration.

For this purpose a spherical figure has been mathematically demonstrated to be the best; as capable of containing a greater quantity under a smaller surface than any other. Thus a perfect sphere contains less surface in proportion to its solidity than a spheriod; a spheriod less than a cylinder; the latter less than a cube; and a cube still less than a parallelopiped.

In all cases, therefore, where we can fill the whole capacity of the balloon with air equally light, the spherical figure is undoubtedly to be preferred; and this holds good with regard to all inflammable air balloons, whether their size be great or small; but in the rarefied air ones, where the under part must necessarily be much colder than the upper, the globular shape seems not so proper. An inverted cone, or truncated pyramid, with the smallest part undermost, seems then to be most proper, as it allows the heated air, which has a great tendency to expand as well as to ascend, to collect in the wide part at the top, while the useless surface in the lower part, and which, in any other figure, would contain only the colder and heavier air, is thus thrown aside.

aſide. In fact, it has been found, that aeroſtatic machines, raiſed by means of rarefied air, when made of the ſhape of a parallelopiped, or even deviating ſtill more from the ſhape of a globe, have anſwered the purpoſe as well as they could have been ſuppoſed to do, had ever ſo much care been taken in forming them exactly to that ſhape.

The very firſt machine made by M. Montgolfier was in form of a parrellelopiped: and though it contained only 40 cubic feet, ſhowed a very conſiderable power of aſcent. A very large one, 74 feet high, which M. Montgolfier had deſigned to exhibit before the royal family, had the middle part of it priſmatic for about the height of 25 feet; its top was a pyramid of 29 feet; and its lower part was a truncated cone of near 20 feet. It weighed 1000 pounds; and, notwithſtanding its ſhape, in a very ſhort time manifeſted a power of aſcent equal to 500 pounds.

Another aeroſtatic machine, of a ſmall ſize, but of the figure of a parallelopiped, being ſuffered to aſcend with thirty ſheets of oiled paper fixed in a wire frame, and ſet on fire, roſe to a great height, and in 22 minutes could not be ſeen. It ſeems therefore, that, with regard to the ſhape of theſe machines, it is by no means neceſſary to adhere rigidly to that of a ſphere; but that any oblong form anſwers very well.

For experimental purpoſes, both the inflammable and rarefied air-balloons may be made of paper: the former being made of that kind called thin poſt, varniſhed over with linſeed oil: the latter either of that or any other kind, without varniſh. In order to avoid the danger of burning, however, it has been propoſed to impregnate the paper of which theſe ſmall rarefied air-balloons are made with ſolution of ſal-ammoniac, alum, or ſome other ſalt; but this does not ſeem to be neceſſary. Thoſe filled with inflammable air have been made of gold-beater ſkin or peeled bladders: but the cheaper material of paper is undoubtedly preferable.

For aeroſtatic machines of a larger ſize, the material univerſally employed is varniſhed ſilk; and for thoſe of the rarefied air kind, linen painted over with ſome ſize colour, or lined with paper. The beſt varniſh for an inflammable air-balloon is that made with bird lime, and recommended by M. Faujas de Saint Fond, in a treatiſe publiſhed on the ſubject. The following is his method of preparing it: "Take one pound of bird-lime, put it into a new proper earthen pot that can reſiſt the fire, and let it boil gently for about one hour, viz. till it ceaſes to crackle; or, which is the ſame thing, till it is ſo far boiled, as that a drop of it being let fall upon the fire will burn: then pour upon it a pound of ſpirits of turpentine, ſtirring it at the ſame time with a wooden ſpatula, and keeping the pot at a good diſtance from the flame, leſt the vapour of this eſſential oil ſhould take fire. After this, let it boil about ſix minutes longer, then pour upon the whole three pounds of boiling oil of nuts, linſeed or poppy, rendered drying by means of lithrage; ſtir it well, let it boil for a quarter of an hour longer, and the varniſh is made. After it has reſted for 24 hours, and the ſediment has gone to the bottom, decant it into another pot; and when you want to uſe it, warm, and apply it with a flat brush upon the ſilk ſtuff, whilſt that is kept well ſtretched. One coat of it may be ſufficient; but if two are neceſſary, it will be proper to give one on each ſide of the ſilk, and to let them dry in the open air while the ſilk remains extended."

Mr. Cavallo gives the following method of preparing this varniſh, which he prefers to that of M. de Saint Fond. "In order to render linſeed oil drying, boil it with two ounces of ſaccharum ſaturni and three ounces of lithrage, for every pint of oil, till the oil has diſſolved them, which will be accompliſhed in half an hour; then put a pound of bird lime and half a pint of the drying oil into a pot (iron or copper pots are the ſafeſt for this purpoſe) the capacity of which may be equal to about one gallon, and let it boil very gently over a charcoal fire till the bird lime ceaſes to crackle, which will be about half or three quarters of an hour; then pour upon it two pints and a half more of drying oil, and let it boil for one hour longer, ſtirring it very frequently with an iron or wooden ſpatula. As the varniſh, whilſt boiling, and eſpecially when it is nearly done, ſwells very much, care ſhould be taken to remove, in thoſe caſes, the pot from the fire, and to replace it when the varniſh ſubſides, otherwiſe it will boil over. Whilſt the ſtuff is boiling, the operator ſhould, from time to time, examine whether the varniſh is boiled enough; which is thus known. Take ſome of it upon the blade of a knife, and then, after rubbing the blade of another knife upon it, ſeparate the knives; and when, on this ſeparation, the varniſh begins to form threads between the two, you may conclude that it is done; and, without loſing time, it muſt be removed from the fire. When it is almoſt, though not quite, cold, add about an equal quantity of ſpirit of turpentine; mix it well together, and let it remain till the next day; when, having warmed it a little, ſtrain and bottle it. If it is too thick, add ſome more ſpirit of turpentine. When this varniſh is laid upon the ſilk, the ſtuff ſhould be made perfectly dry, and ſtretched; ſo that the varniſh, which ought to be uſed lukewarm, may fill up the pores of the ſtuff. The varniſh ſhould be laid once very thin upon one ſide of the ſtuff; and, about 12 hours after, two other coats ſhould be laid on, one on each ſide; and, 24 hours after, the ſilk may be uſed, though, in cold weather, it may be left to dry ſome time longer."

Much has been ſaid in France of their elaſtic gum-varniſh, and its compoſition kept a ſecret; but Mr. Baldwin, after many expenſive trials, declares to the world what he conſiders as the ſecret; and it is merely this: "Take any quantity of caoutchouc, as two ounces averdupois; cut it into ſmall bits with a pair of ſciſſars; put a ſtrong iron ladle, like that uſed by plumbers, over a common pitcoal or other fire. The fire muſt be gentle, glowing, and without ſmoke. When the ladle is hot, much below a red heat, put a ſingle bit into the ladle. If *black* ſmoke iſſues, it will preſently flame and diſappear, or it will evaporate without flame: the ladle is then too hot. When the ladle is leſs hot, put in a ſecond bit, which will produce a *white* ſmoke. This *white* ſmoke will continue during the operation, and evaporate the caoutchouc; therefore no time is to be loſt; but little bits are to be put in, a few at a time, till the whole are melted. It ſhould be continually and gently ſtirred with an iron or braſs ſpoon. Two pounds or one quart of the beſt drying oil, or of raw linſeed-oil, which, together with a few drops of neats-foot oil, has ſtood a month, or not ſo long, on a lump of quicklime, to make it more or leſs drying, is to be put into the melted caoutchouc, and ſtirred till hot, and the whole poured into a glazed veſſel, through a coarſe gauze or fine ſieve. When ſettled and clear, which will be in a few minutes, it will be fit for uſe either hot or cold." Mr. Baldwin is not at liberty, he obſerves, to publiſh the art of laying on the varniſh; but ſays, that it conſiſts in making no *inteſtine motion* in the varniſh, which would create minute bubbles; that therefore bruſhes are improper. M. Blanchard's method of making elaſtic gum varniſh for the ſilk of a balloon is the following: "Diſſolve elaſtic gum, caoutchouc, cut ſmall, in five times its weight of ſpirit of turpentine, by keeping them ſome days together; then boil one ounce of this ſolution in eight ounces of drying linſeed-oil for a few minutes; laſtly, ſtrain it. It muſt be uſed warm." The pieces of ſilk for the balloon muſt be cut out of a proper ſize, according to the dimenſions, after the varniſh is ſufficiently dry. They may be joined by laying about half an inch of the edge of one piece over the edge of the other, and ſewing them by a double ſtitching. M. Blanchard uſes expeditiouſly the following method. He lays about half an inch of the edge of one piece flat over the edge of the other, and paſſes a hot iron over it; in doing which a piece of paper ought to be laid both under and over the ſilk. The joining may be rendered more ſecure by running it with a ſilk thread, and ſticking a ribband over it. The ribbands laid over ſeams may be ſtuck with common glue, provided the varniſh of the ſilk is properly dried. When the glue is quite dry, the ribbands ſhould be varniſhed over, to prevent their being unglued by the rain.

To the upper part of the balloon there ſhould be adapted, and well fitted in, a valve opening inwards; to which ſhould be faſtened a ſtring paſſing through a hole made in a ſmall piece of round wood fixed in the loweſt part of the balloon oppoſite to the valve, the end of this ſtring faſtened in the car below, ſo that the aeronaut may open the valve when occaſion requires. The action of this valve may be underſtood from *fig.* 2. A round braſs plate AB has a round hole CD, about two or three inches diameter, covered on both ſides with ſtrong ſmooth leather. On the inſide there is a ſhutter I, alſo of braſs, covered with leather, which is to cloſe the hole CD, being about two inches larger in diameter than the hole. It is faſtened to the leather of the plate AB, and by a ſpring, which need not be very ſtrong, it is kept againſt the hole. The elaſticity of the gas itſelf will help to keep it ſhut. To this ſhutter the ſtring is faſtened, by which it is occaſionally opened for the eſcape of gas. A ſmall ſtring or other ſecurity ſhould be fixed to the ſhutter and the plate, ſo as not to admit the ſhutter to be opened beyond a certain ſafe diſtance. To the lower part of the balloon two pipes ſhould be fixed, made of the ſame ſtuff as the envelope; 6 inches diameter for a balloon of 30 feet, and proportionably larger for balloons of greater capacity. They muſt be long enough for the car. For balloons of 18 feet and leſs diameter, one neck or pipe will be ſufficient. Theſe pipes are the apertures through which the inflammable gas is introduced into the balloon.

The car or boat is beſt made of wicker-work, covered with leather, and well painted or varniſhed over; and the proper method of ſuſpending it, is by ropes proceeding from the net which goes over the balloon. This net ſhould be formed to the ſhape of the balloon, and fall down to the middle of it, with various cords proceeding from it to the circumference of a circle about two feet below the balloon; and from that circle other ropes ſhould go to the edge of the boat. This circle may be made of wood, or of ſeveral pieces of ſlender cane bound together. The meſhes of the net may be ſmall at top, againſt which part of the balloon the inflammable air exerts the greateſt force; and increaſe in ſize as they recede from the top. A hoop has ſometimes been applied round the middle of the balloon to faſten the net. This, though not abſolutely neceſſary, is beſt made of pieces of cane bound together, and covered with leather.

With regard to the rarefied air machines, Mr. Cavallo recommends firſt to ſoak the cloth in a ſolution of ſal-ammoniac and

and common ſize, uſing one pound of each to every gallon of water, and when the cloth is quite dry, to paint it over in the inſide with ſome earthy colour, and ſtrong ſize, or glue. When this paint has dried perfectly, it will then be proper to varniſh it with oily varniſh, which might dry before it could penetrate quite through the cloth. Simple drying linſeed oil will anſwer the purpoſe as well as any, provided it be not very fluid.

The beſt method of cutting the pieces of ſilk that are to form a balloon, is to deſcribe a pattern of wood, or ſtiff card-paper, and then to cut the ſilk upon it. As the edges of ſuch a pattern are not perfect circles, they cannot be deſcribed by a pair of compaſſes: but the beſt method of drawing them is as follows. Firſt, draw on a flat ſurface two right lines, AE, *fig.* 1. and BC, perpendicular to each other. Secondly, find the circumference anſwering to the given diameter of the balloon in feet, and decimals of a foot, and make AD and DE each equal to a quarter of the circumference, ſo that the whole length, AE, of the pattern may be equal to half the circumference. Thirdly, divide AD into 18 equal parts; and to the points of diviſion apply the lines *fg*, *hi*, *kl*, &c. parallel to each other, and perpendicular to AD. Fourthly, divide the whole circumference into twice the given number of pieces, and make DC and BD each equal to the quotient of this diviſion, ſo that the whole, BC, is equal to the greateſt breadth of one of theſe pieces. Fifthly, multiply the above mentioned quotient by the decimals annexed to *fg*, viz. 0.99619, and then the product expreſſes the length of *fg*, again multiply the ſame length of DE by the decimals annexed to *hi*, and the product expreſſes the length of *hi*; and, in ſhort, the product ariſing from the multiplication of the length of DC, by the decimals annexed to each of the parallel lines, gives the length of that line. Laſtly, having found the lengths of all theſe lines, draw, by hand, a curve-line, paſſing through all the extremities of the ſaid lines, and that is the edge of one quarter of the pattern. The other quarters may be eaſily deſcribed, by applying to them a piece of paper cut according to that already found. Suppoſe, for example, that the diameter of the balloon to be conſtructed is 20 feet, and that it is required to make it of 12 pieces, then, in order to draw the pattern for thoſe pieces, find the circumference of the balloon, which is 62.83 feet, and dividing it by four, the quotient is 15.7 feet: make, therefore, AD equal to 15.7 feet, and DE likewiſe of the ſame length. Divide the circumference 62.83 by 24, which is double the number of pieces that are to form the balloon, and the quotient, 2.618 feet, is the length of DC, and likewiſe of BD; ſo that BC is equal to 5.236 feet. Then, having divided the line AD into 18 equal parts, and having drawn the parallel lines from thoſe points of diviſion, find the length of each of theſe lines, by multiplying 2.618 by the decimals annexed to that line. Thus, 2.618, multiplied by 0.99619, gives 2.608 feet for the length of *fg*: and again, multiplying 2.618 by 0.98481, gives 2.578 feet for the length of *hi*; and ſo of the reſt. In cutting the pieces after ſuch a pattern, care ſhould be taken to leave them about three quarters of an inch all round larger than the pattern, which will be taken up by the ſeams.

It now only remains to give ſome account of the method by which aeroſtatic machines may be filled with their proper gas, in order to give them their power of aſcending into the atmoſphere; and here we are enabled to determine with much greater preciſion concerning the inflammable air balloons than the others. With regard to them, a primary conſideration is the moſt proper method of procuring the inflammable air. It may be obtained in various ways, as has been ſhewn in the Syſtem of Aerology. But the moſt advantageous methods are, by applying acids to certain metals; by expoſing animal, vegetable, and ſome mineral ſubſtances, in a cloſe veſſel, to a ſtrong fire; or by tranſmuting the vapour of certain fluids through red-hot tubes.

1. In the firſt of theſe methods, iron, zinc, and vitriolic acid, are the materials moſt generally uſed. The vitriolic acid muſt be diluted by five or ſix parts of water. Iron may be expected to yield in the common way 1700 times its own bulk of gas; or one cubic foot of inflammable air to be produced by 4½ ounces of iron, the like weight of oil of vitriol, and 22½ ounces of water. Six ounces of zinc, an equal weight of oil of vitriol, and 30 ounces of water, are neceſſary for producing the ſame quantity of gas. It is more proper to uſe the turnings or chippings of great pieces of iron, as of cannon, &c. than the filings of that metal, becauſe the heat attending the effervеſcence will be diminiſhed; and the diluted acid will paſs more readily through the interſtices of the turnings, when they are heaped together, than through the filings, which ſtick cloſer to one another. The weight of the inflammable air thus obtained by means of acid of vitriol, is, in the common way of procuring it, generally one ſeventh part of the weight of common air; but, with the neceſſary precautions for philoſophical experiments, leſs than one-tenth of the weight of common air. Two other ſorts of elaſtic fluids are ſometimes generated with the inflammable air. Theſe may be ſeparated from it, by paſſing the inflammable air through water in which quick-lime has been diſſolved. The water will abſorb theſe fluids, cool the inflammable air, and prevent its over heating the balloon when introduced into it.

Fig. 3. repreſents an apparatus, deſcribed by Mr. Cavallo, as proper for filling balloons, of the ſize of two or three feet in diameter, with inflammable air, after paſſing it through water. A is the bottle with the ingredients; BCD a tube faſtened in the neck at B, and paſſing through C, the cork of the other bottle, in which there is another hole made to receive the tube on which the balloon is tied. Thus it is plain that the inflammable air, coming out of the tube D, will paſs firſt through the water of the bottle E, and then into the balloon. Two ſmall caſks may be uſed inſtead of the bottles A and E.

2. Inflammable air may be obtained at a much cheaper rate by the action of fire on various ſubſtances; but the gas which theſe yield is not ſo light as that produced by the effervеſcence of acids and metals. The ſubſtances proper to be uſed in this way, are, pit-coal, aſphaltum, amber, rock-oil, and other minerals; wood, and eſpecially oak, camphor-oil, ſpirits of wine, æther, and animal ſubſtances, which yield air in different degrees, and of various ſpecific gravities: but pit-coal is the preferable ſubſtance. A pound of this, expoſed to a red heat, yields about three cubic feet of inflammable air, which, whether it be paſſed through water or not, weighs about one-fourth of the weight of common air. Dr. Prieſtley found, as we have elſewhere noticed, that animal or vegetable ſubſtances will yield ſix or ſeven times more inflammable air when the fire is ſuddenly increaſed, than when it is gently raiſed, though it be afterwards made very ſtrong. Mr. Cavallo obſerves, that the various ſubſtances above enumerated, generally yield all their inflammable air in about one hour's time. The general method is, to encloſe the ſubſtances in iron or earthen veſſels, and thus expoſe them to a ſtrong fire, ſufficient to make the veſſels red hot: the inflammable air proceeding from the aperture of the veſſel, is received into a tube or refrigeratory, and paſſing through the tube or worm, is at laſt collected in a balloon, or other veſſel. A gun-barrel has been often uſed for eſſays of this kind. The ſubſtance is put into it ſo as to fill ſix or eight inches of its loweſt part, the remainder filled with dry ſand: a tube, adapted to the mouth of the barrel, is brought into a baſon of water under an inverted receiver; and the part of the barrel containing the ſubſtance being put into the fire, and made red hot, the inflammable air is collected in the inverted receiver. As the gun-barrel cannot ſerve for producing a large quantity of inflammable air, Mr. Cavallo recommends, as the moſt advantageous ſhape, the following contrivance: let the veſſel be made of clay, or rather of iron, in the ſhape of a Florence flaſk, ſomewhat larger, and whoſe neck is longer and larger, (as ABC, *fig.* 4.) Put the ſubſtance to be uſed into this veſſel, ſo as to fill about four fifths, or leſs, of its cavity, AB. If the ſubſtance is of ſuch a nature as to ſwell much by the action of the fire, lute a tube of braſs, or firſt a braſs and then a leaden tube, to the neck C of the veſſel; and let the end D of the tube be ſhaped as in the figure, ſo that going into the water of a tub HI, it may terminate under a fun of inverted veſſel EF, to the upper aperture of which the balloon G is adapted. Things thus prepared, if the part AB of the veſſel is put into the fire, and made red hot, the inflammable air produced will come out of the tube CD, and paſſing through the water, will at laſt enter into the balloon G. Previous to the operation, as a conſiderable quantity of common air remains in the inverted veſſel EF, which it is proper to expel, the veſſel EF ſhould have a ſtop-cock, K, through which the common air may be ſucked out, and the water aſcend as high as the ſtop-cock. The dimenſions of ſuch an apparatus Mr Cavallo gives thus: Diameter of the largeſt part of the veſſel, ABC, ſeven inches; length of the whole veſſel, 16 inches; diameter of its aperture one inch; diameter of the cavity of the tube CD three fourths of an inch; lower aperture of the veſſel, EF, ſix inches; leaſt height of the veſſel EF, 24 inches; its aperture F about two inches. The aperture of the veſſel EF ſhould be at leaſt one foot below the ſurface of the water in the tub HI. Care muſt be taken that the fire uſed be kept at a proper diſtance, otherwiſe it may fire the inflammable air which may eſcape out of the veſſel EF.

3. The laſt method of obtaining inflammable air was lately diſcovered by Mr. Lavoiſier, and alſo by Dr. Prieſtley. Mr. Lavoiſier made the ſteam of boiling water paſs through the barrel of a gun, kept red hot by burning coals. Dr Prieſtley uſes, inſtead of the gun barrel, a tube of red hot braſs, upon which the ſteam of water has no effect, and which he fills with the pieces of iron which are ſeparated in the boring of cannon. By this method he obtains an inflammable air, the ſpecific gravity of which is to that of common air as 1 to 13. In this method, not yet indeed reduced to general practice, a tube, about three quarters of an inch in diameter, and about three feet long, is filled with iron turnings; then the neck of a retort, or a cloſe boiler, is luted to one of its ends, and the worm of a refrigeratory is adapted to its other extremity. The middle part of the tube is then ſurrounded with burning coals, ſo as to keep about one foot in length of it red hot; and a fire is always made under the retort, or boiler, ſufficient to make the water boil with vehemence. In this proceſs a conſiderable quantity of inflammable air comes out of the worm of the refrigeratory. It is ſaid that iron yields one half more air by this means than by the action of vitriolic acid.

The Binder is deſired to place this Sheet, Q—2, after Sheet Q given in the preceding Number.

AEROSTATION.

For filling large balloons, a greater apparatus is neceſſary; and the only materials that can, with any certainty of ſucceſs, be employed for producing the proper gas, are, oil of vitriol, and iron filings or turnings.

It has, indeed, been recommended to uſe zinc inſtead of iron filings, becauſe white vitriol, the ſalt produced by the union of the vitriolic acid and zinc, is much more valuable than the green ſort, produced by the union of the ſame acid with iron. But though this is undoubtedly the caſe, it will as certainly be found upon trial, that the ſuperior price of the zinc, will be more than an equivalent for all the advantage that can be derived from the additional price of the white vitriol. For a balloon of 30 feet diameter, Mr. Cavallo recommends 3900 pounds of iron turnings, as much oil of vitriol, and 19,500 pounds of water. Theſe proportions, however, appear too great with reſpect to the acid and metal, and too little with reſpect to the water. Oil of vitriol will not exert its power upon iron, unleſs it be diluted with five or ſix times its quantity of water; in which caſe a much ſmaller quantity of both acid and metal will ſerve. Mr. Lunardi, who, from the number of his voyages, had certainly much practical knowledge in aeroſtation, filled his balloon at Edinburgh and Glaſgow with about 200 pounds of iron, as much vitriolic acid, and 12,000 pounds of water. The iron was placed in his veſſels in layers, with ſtraw between them, in order to increaſe the ſurface. His apparatus was not materially different from that of Mr. Cavallo, repreſented by *fig.* 5. where AA are two tubs, about three feet in diameter, and nearly two feet deep, inverted in large tubs, BB, filled with water. In the bottom of each of the inverted tubs a hole is made, and a tube, E, of tin, adapted, which is about ſeven inches in diameter, and ſeven or eight long. To theſe tubes the ſilken ones of the balloon are to be tied. Round each of the tubs, B, five, ſix, or more ſtrong caſks are placed: in the top of each two holes are made, and to one of theſe holes a tin tube is adapted, and ſo ſhaped, that, paſſing over the edge of the tub, B, and through the water, it may terminate with its aperture under the inverted tub A. The other hole of theſe caſks ſerves for the introduction of materials, and is ſtopped with a wooden plug. When the balloon is to be filled, put the net over it, and let it be ſuſpended, as ſhown by CDF; and having expelled all the common air from it, let the ſilken tubes be faſtened round the tin ones EE; and the materials being put into the caſks, the inflammable air, paſſing into the balloon, will ſoon diſtend, and render it capable of ſupporting itſelf; after which the rope GH may be ſlipped off. As the balloon continues to be filled, the net is adjuſted properly round it: the cords that ſurround it are faſtened to the hoop MN: then the boat IK, being placed between the two ſets of caſks, is faſtened to the hoop MN; and every thing that is required to be ſent up, as ballaſt, inſtruments, &c. is placed in it. At laſt, when the balloon is little more than three quarters full, the ſilken tubes are ſeparated from the tin ones of the inverted tubs, and their extremities being tied up, are placed in the boat. Laſtly, the aeronauts being ſeated in the boat, the lateral ropes are ſlipped off, and the machine is abandoned to the air. This apparatus was at laſt reduced by Mr. Lunardi to its utmoſt ſimplicity, by uſing only two caſks, and ſuffering the vapour to go into the balloon without paſſing through water. Thus his balloon was filled in leſs than half an hour, when, before, it had required two hours at leaſt. The ſinking of his caſks in the ground was alſo an additional convenience, as it created no confuſion, and the materials were much more eaſily conveyed into them.

With regard to the rarefied air balloons, the method of filling them is as follows: A ſcaffold, ABCD, *fig.* 6. the breadth of which is at leaſt two-thirds of the diameter of the machine, is elevated about ſix or eight feet above the ground. From the middle of it deſcends a well, E, riſing about two or three feet above it, and reaching to the ground, furniſhed with a door or two, through which the fire in the well is ſupplied with fuel. The well ſhould be conſtructed of brick or of plaſtered wood, and its diameter ſhould be ſomewhat leſs than that of the machine. On each ſide of the ſcaffold are erected two maſts, HI, KL, each of which has a pulley at the top, and rendered firm by means of ropes, KG, KP, HP, HG. The machine to be filled is to be placed on the ſcaffold, with its neck round the aperture of the well. The rope paſſing over the pullies of the two maſts, ſerves, by pulling its two ends, to lift the balloon about 45 feet or more above the ſcaffold; and the reſt of the machine is repreſented by the dotted lines in the figure MNO. The machine is kept ſteady, and held down, whilſt filling, by ropes paſſing through loops or holes about its equator; and theſe ropes may eaſily be diſengaged from the machine, by ſlipping them through the loops when it is able to ſuſtain itſelf. The proper combuſtibles to be lighted in the well, are thoſe which burn quick and clear, rather than ſuch as produce much ſmoak; becauſe it is hot air, and not ſmoak, that is required to be introduced into the machine. Small wood and ſtraw have been found to be very fit for this purpoſe. Mr. Cavallo obſerves, as the reſult of many experiments with ſmall machines, that ſpirits of wine are, upon the whole, the beſt combuſtible; but its price may prevent its being uſed for large machines. As the current of hot air aſcends, the machine will ſoon dilate, and lift itſelf above the ſcaffold and gallery which was covered by it. The paſſengers, fuel, inſtruments, &c. are then placed in the gallery. When the machine makes efforts to aſcend, its aperture muſt be brought, by means of the ropes annexed to it, towards the ſide of the well a little above the ſcaffold; the fire-place is then ſuſpended in it, the fire lighted in the grate, and the lateral ropes being ſlipped off, the machine is abandoned to the air. It has been determined, by accurate experiments, that only one third of the common air can be expelled from theſe large machines; and therefore the aſcending power of the rarefied air in them can be eſtimated as only equal to half an ounce averdupoiſe for every cubic foot.

The conduct of balloons, when conſtructed, filled, and actually aſcending in the atmoſphere, is an object of great importance in the practice of aeroſtation. The method generally uſed for elevating or lowering the balloons with rarefied air, has been the increaſe or diminution of the fire; and this is entirely at the command of the aeronaut, as long as he has any fuel in the gallery. The inflammable-air balloons have been generally raiſed or lowered by diminiſhing the weight in the boat, or by letting out ſome of the gas through the valve: but the alternate eſcape in the air in deſcending, and diſcharge of the ballaſt for aſcending, will by degrees render the machine incapable of floating; for in the air it is impoſſible to ſupply the loſs of ballaſt, and very difficult to ſupply that of inflammable air. Theſe balloons will alſo riſe or fall by means of the rarefaction or condenſation of the incloſed air, occaſioned by heat and cold. It has been propoſed to aid a balloon, in its alternate motion of aſcent and deſcent, by annexing to it a veſſel of common air, which might be condenſed for lowering the machine, and rarefied again, by expelling part of it for raiſing the machine: but a veſſel adapted to this purpoſe muſt be very ſtrong; and, after all, the aſſiſtance afforded by it would not be very conſiderable. M. Meunier, in order to attain this end, propoſes to incloſe one balloon, filled with common air, in another, filled with inflammable air: as the balloon aſcends, the inflammable air is dilated, and of courſe compreſſes the internal balloon, containing the common air; and by diminiſhing its quantity, leſſens its weight. If it ſhould be neceſſary to ſupply this loſs, he ſays it may be eaſily done, by a pair of bellows fixed in the gallery. Others have propoſed to annex a ſmall machine, with rarefied air, to an inflammable-air balloon, by ropes, at ſuch a diſtance that the fire of the former might not affect the inflammable air of the latter: the whole apparatus, thus combined, of balloons formed on the two principles of heated and inflammable air, might be raiſed or lowered by merely increaſing or diminiſhing the fire in the lower balloon.

Wings or oars are the only means of this ſort that have been uſed with ſome ſucceſs; and, as Mr. Cavallo obſerves, they ſeem to be capable of conſiderable improvement. Although great effects are not to be expected from them, when the machine goes at a great rate, the beſt method of moving thoſe wings are by the human ſtrength, applied ſimilarly to the oars of a waterman. They may be made, in general, of ſilk, ſtretched between the tubes or ſticks; and when uſed, muſt be turned edgewiſe, when they are moved in the direction in which the machine is intended to be impelled, but flat in the oppoſite direction. *Fig.* 7. is the repreſentation of one of M. Blanchard's wings. *Fig.* 8. is one of thoſe by M. Lunardi, which conſiſts of many ſilk ſhutters or valves, ABCD, DECF, &c. every one of which opens on one ſide only; viz. ADBC opens upon the line AB, DECF opens upon the line DC, &c. In conſequence of this conſtruction, this ſort of oars do not need being turned edgewiſe. *Fig.* 9. repreſents one of the wings uſed by the brothers Roberts in the aerial voyage of the 19th September, 1784; and *fig.* 10. repreſents one of the wings conſtructed by Count Zambeccari, which conſiſts of a piece of ſilk, ſtretched between two tin tubes, ſet at an angle; but theſe wings are ſo contrived as to turn edgewiſe by themſelves when they go on one direction. Other contrivances have been made to direct aeroſtatic machines, but they have moſtly been invented to effect power upon them as upon a ſhip. It appears, however, that they can have no effect when a machine is only moved by the wind alone, becauſe the circumambient air is at reſt in reſpect to the machine. The caſe is quite different with a veſſel at ſea, becauſe the water on which it floats ſtands ſtill whilſt the veſſel goes on; but it muſt be time and experience that can realize the expectations ſuggeſted by theſe contrivances.

In the Plate repreſenting the various Balloons, we have introduced the figures of M. Lunardi's two balloons, that of M. Blanchard, and the fire balloon of M. Montgolfier; alſo an aeroſtatic figure, exhibited at the Pantheon, by the brothers Enfien. We have not given a deſcription of theſe balloons, deeming them ſufficiently explanatory of themſelves. The aeroſtatic figure was charged with gas, and proper weights were added to keep it in equilibrium, ſo that it floated in the air, and exhibited a very pleaſing ſpectacle.

We ſhall conclude our ſyſtem of Aeroſtation with remarking, that the ſcenes preſented to the views of aeronauts, in their excurſions, conſtitute the true ſublime and beautiful, inſpire ideas of rational humiliation to a thinking mind, and raiſe the moſt careleſs mortal to an unknown degree of enthuſiaſtic rapture and pleaſure. Every beholder is a judge of the ſcenery around him; and no one, it is preſumed, ever aſcended into the atmoſphere on a mild day, with a ſound and well-ballaſted balloon, that did not wiſh to taſte the luxury of a ſecond voyage.

ÆRUGO, in natural history, properly ſignifies the ruſt of copper, whether natural or artificial: The former is found about copper mines; and the latter, called *verdegris*, made by corroding copper-plates with acids. See VERDEGRIS.

Æs ustum, a chymical preparation, made of thin leaves of copper, ſulphur, and nitre, placed *ſtratum ſuper ſtratum* in a crucible, and ſet in a charcoal fire till all the ſulphur is conſumed; after which, the copper is taken out of the crucible, and reduced to powder. Some quench the leaves of copper in vinegar, and repeat the calcination. Its principal uſe is in colouring glaſs, to which it gives a beautiful tincture. The ſurgeons uſe it as a deterſive, and ſome have given it internally; but it is certainly a very dangerous medicine, and ſhould be avoided.

ÆSCULUS, in Botany, the HORSE-CHESNUT: A genus of the Monogynia order, belonging to the Heptandria claſs of plants. The characters are; The calyx is a ſmall, ſingle leaved, bellied perianthium, divided into five ſegments. The corolla (except in the pavia, where it is four petal'd, and cloſe) conſiſts of five roundiſh, flat, expanding petals, unequally coloured, and with narrow claws inſerted into the calyx. The ſtamina have ſeven ſubulated declining filaments, the length of the corolla: the anthera aſcending. The piſtillum is a roundiſh germen, ending in a ſubulated ſtylus; the ſtygma pointed. The pericarpium is a leathery, roundiſh, trilocular, three-valved capſule. The ſeeds are two and ſubglobular. For repreſentation, See Plate IV. Claſs VII. In this genus Van Rozen and Miller obſerved both male and hermaphrodite flowers. There are two ſpecies. 1. The *hippocaſtanum*, or common horſe-cheſnut. It was brought from the northern parts of Aſia about the year of 1550, and ſent to Vienna about 1558. This tree makes a noble appearance all the month of May, the extremities of the branches being terminated by fine ſpikes of flowers, ſpotted with roſe colours, ſo that the whole tree ſeems covered with them. It is quick in its growth; ſo that in a few years it arrives at a ſize large enough to afford a good ſhade in ſummer, as alſo to produce plenty of flowers. They have, however, this great inconvenience, that their wood is of no uſe, being unfit even for burning; and their leaves beginning to fall in July, ſoon deprive the trees of their beauty. There is ſomething very ſingular in the growth of theſe trees, which is, that the whole ſhoot is performed in leſs than three weeks after the buds are opened. The nuts are reckoned good food for horſes. In Turkey, they are ground, and mixed with the provender of theſe animals, eſpecially thoſe which are troubled with coughs, or broken winded. Deer are alſo fond of the fruit, and at the time of their ripening keep much about the trees, but eſpecially in ſtrong winds, when the nuts are blown down, which they carefully watch, and greedily devour as they fall. 2. The *pavia*, or ſcarlet flowering horſe-cheſnut, is a native of Carolina, the Braſils, and the Eaſt. It grows to about fifteen or ſixteen feet high; and there is a delicacy in this tree that makes it deſirable. The flowers come out from the ends of the branches. The firſt appearance of the buds is in May; though they will not be in full blow till the middle of June. They are of a bright red colour, and conſequently have a pleaſing effect among the vaſt tribe of yellow flowering ſhrubs which ſhew themſelves in bloom at that ſeaſon. They continue in ſucceſſion for upwards of ſix weeks; and ſometimes are ſucceeded by ripe ſeeds in our gardens.

ÆSTIVAL, or ESTIVAL, of or belonging to ſummer. Thus, we ſay, the *æſtival ſolſtice*, &c. in oppoſition to the *brumal*. *Æſtival Point*, is that whereby the ſun's aſcent above the equator is determined. *Æſtival Signs* are thoſe extended from the ſummer ſolſtitial point, i. e. the ſun's greateſt declination northward, to the interſection of the ecliptic and equinoctial ſouthward, including Cancer, Leo, and Virgo. See the Syſtem of ASTRONOMY, Sect. IX.

ÆTHER is uſually underſtood of a thin, ſubtile matter, or medium, much finer and rarer than air; which commencing from the limits of our atmoſphere, poſſeſſes the whole heavenly ſpace. The word is ſuppoſed to be formed from the verb αἴθω *to burn, to flame*; ſome of the ancients, particularly Anaxagoras, ſuppoſing it of the nature of fire. See FIRE.

The philoſophers cannot conceive that the largeſt part of the creation ſhould be perfectly void, and therefore fill it with a ſpecies of matter under the denomination of *æther*. But they vary extremely as to the nature and character of this æther. Some conceive it as a body *ſui generis*, appointed only to fill up the vacuities between the heavenly bodies, and therefore confined to the regions above our atmoſphere. Others ſuppoſe it of ſo ſubtle and penetrating a nature, as to pervade the air, and other bodies, and poſſeſs the pores and intervals thereof. Others deny the exiſtence of any ſuch ſpecific matter, and think the air itſelf, by that immenſe tenuity and expanſion it is found capable of, may diffuſe itſelf through the interſtellar ſpaces, and be the only matter found in them. In effect, æther being no object of our ſenſe, but the mere work of imagination, introduced only for the ſake of hypotheſis, or to ſolve ſome phenomenon, real or imaginary, authors take the liberty to modify it how they pleaſe. Some ſuppoſe it of an elementary nature, like other bodies, and only diſtinguiſhed by its tenuity, and the other affections reſulting from it; which is the *philoſophical æther*. Others will have it of another ſpecies, and not elementary, but rather a fluid of fifth element, of a pure, more refined, and ſubtileous nature than the ſubſtances about our earth, and void of the common properties of matter, as *gravity*, &c. Such is the ancient idea of *æther*, or *ethereal matter*. The term *æther* being thus embarraſſed with a variety of ideas, and arbitrarily applied to ſo many different things, the later philoſophers chooſe to ſet it aſide; and accordingly the Carteſians uſe the term *materia ſubtilis*, which is their *æther*; and Sir Iſaac Newton ſometimes a *ſubtile ſpirit*, as in the cloſe of his Principia; and ſometimes a *ſubtile* or *ethereal medium*, as in his Optics. The truth is, there are abundance of conſiderations, which ſeem to evince the exiſtence of ſome matter in the air, much finer than the air itſelf. There is an unknown ſomething, that remains behind, when the air is taken away, as appears from certain effects which we ſee produced in *vacuo*. Heat, Sir Iſaac Newton obſerves, is communicated through a vacuum almoſt as readily as through air; but ſuch communication cannot be without ſome interjacent body, to act as a medium; and ſuch body muſt be ſubtile enough to penetrate the pores of glaſs, and may be very well concluded to penetrate thoſe of all other bodies; and conſequently be diffuſed through all the parts of ſpace; and anſwers to the full character of an æther. See HEAT. The exiſtence of ſuch an ætherial medium being ſettled, that author proceeds to its properties; inferring it to be not only rarer and more fluid than air, but exceedingly more elaſtic and active: in virtue of which properties, he ſhews, that a great part of the phenomena of nature may be produced by it. To the weight, e. gr. of this medium he attributes gravitation, or the weight of all other bodies; and to its elaſticity, the elaſtic force of the air, and of nervous fibres; and the emiſſion, refraction, reflection, and other phenomena of light; as alſo ſenſation, muſcular motion, &c. In fine, this ſame matter ſeems the *primum mobile*, the firſt ſource or ſpring of phyſical action in the modern ſyſtem.

The Carteſian *æther* is ſuppoſed not only to pervade, but adequately to fill all the vacuities of bodies; and thus to make an abſolute *plenum* in the univerſe. But Sir Iſaac Newton overturns this opinion, from divers conſiderations, by ſhewing that the celeſtial ſpaces are void of all ſenſible reſiſtance: for, hence it follows, that the matter contained in them muſt be immenſely rare, becauſe the reſiſtance of bodies is chiefly as their denſity; ſo that if the heavens were thus adequately filled with a medium or matter, how ſubtle ſoever, they would reſiſt the motion of the planets and comets much more than quickſilver or gold. Some repreſent the æther as 7200 times more rare than air. Others make it more denſe than gold itſelf. The late diſcoveries in electricity have thrown great light upon this ſubject, and rendered it extremely probable that the æther ſo often talked of, is no other than the electric fluid, or ſolar light, which diffuſes itſelf throughout the whole ſyſtem of nature. See farther concerning the exiſtence of æther, Boyl. Philoſ. Works abr. tom. ii. p. 504. Vater, Phyſ. Exper. cap. 2. p. 72, ſeq. Its fluidity, circulation, elaſticity, &c. Vater, ib. 75, ſeq. Verdries, p. 2. cap. 3. § 1. p. 293. Hook, Poſth. Works, p. 171. Its being the *primum mobile*, or ſource of all motion, Verdries, p. 6. 63, & 167. Its influence on the air, Hook, ib. p. 380. Impediment to the moon's motion, Id. ib. p. 191. Its being the cauſe of the planetary motions, Giorn. de Letter. d'ital. tom. x. p. 6, ſeq. Of colours and refrangibility, &c. ib. tom. xxiii. p. 132. Of ſound, ib. tom. ix. p. 315, and Mem. Acad. Selene. Ann. 1720. p. 50. Philoſ. Tranſ. No. 100, p. 15. See alſo the Articles ELECTRICITY, FIRE, HEAT, LIGHT, &c.

ÆTHER, in chymiſtry, called alſo *thereal ſpirit*, of Frobenius, *dulcified ſpirit of vitriol*, *acidum vitrioli vinoſum*, by Pott, and *liquor anodynus mineralis*, by Huffman, is a very ſubtile and penetrating fluid, produced by diſtillation, from a mixture of rectified ſpirit of wine and the vitriolic acid. Mr. Macquer ſuppoſes, that, as ſpirit of wine conſiſts chiefly of an oil, exquiſitely attenuated by fermentation, and intimately combined with water, æther is no other than this ſubtilized oil, extricated by the vitriolic acid; which acid, having a ſtrong affinity or attraction to water, abſorbs the watery element of the ſpirit, and thus ſets the oily one at liberty. Æther is the lighteſt, moſt volatile, and moſt inflammable of all known liquors; it ſwims upon the moſt highly rectified ſpirit of wine, as oil does upon water; and if dropped on a warm hand, it inſtantly exhales, diffuſing a penetrating fragrance, and leaving no moiſture behind. It takes fire on the approach of a candle, and goes off in a flaſh like lightning. As it is the moſt volatile and evaporable of all known liquors, it produces a proportionable degree of cold, inſomuch that M. Beaumé has made the mercury of Reamur's thermometer ſink to 40 degrees below the freezing point, by applying linen wetted in æther to the ball containing the mercury. Æther does not eaſily mix with water, ten parts of water being neceſſary to diſſolve one part of æther. It diſcovers a remarkable attraction to gold, though it has no effect on other metals. Æther, mixed with a ſolution of gold made in acids, imbibes the gold from the acid, keeps it perfectly diſſolved and ſuſpended, and becomes of a yellow colour. This property renders it of great uſe in extracting gold from other metals, and in aſcertaining the ſmalleſt portions

of

of it in liquids. Thus we may likewiſe very expeditiouſly obtain a tincture of gold, or *aurum potabile*. Æther has been ſucceſsfully employed in medicine. Dr. Morris recites ſeveral inſtances, in which he has applied it externally as a remedy for head-achs, the tooth-ach, and rheumatic complaints; and he has likewiſe preſcribed it internally for the hooping-cough, and in hyſterical caſes; and he apprehends that it may be adminiſtered in large quantities with ſafety, and prove a uſeful medicine, in a *ſyncope*, or lethargy. Take of rectified ſpirit of wine three pounds; put it into a two-gallon ſtone bottle; add to it, by two ounces at a time, allowing the interval of a quarter of an hour between each addition, three pounds and ſix ounces of the ſtrong vitriolic acid; let the mixture digeſt without heat for the ſpace of a night: in the morning, decant it from one veſſel to another three or four times; convey it through a glaſs funnel, and long tube, into a retort, capable of containing three times the quantity; place it in an iron pot, with an inch of ſand at bottom; add more ſand round the retort, to the height of the mixture; ſet it over a quick fire; lute a large receiver to the retort, leaving a pin-hole in the luting, unleſs the receiver is perforated; continue the fire till an ebullition, accompanied with large bubbles, is obſerved in the mixture; then remove the fire entirely: the heat of the ſand will be ſufficient to complete the diſtillation of the æther. The diſtilled liquor muſt then be put into a clean retort, with two or three ounces of fixed alkaline ſalt: about half the liquor ſhould be drawn off, by a very gentle heat, into a large receiver; and this being ſhaken with an equal quantity of pump-water, the pure æther will riſe immediately to the top. See Med. Obſ. and Inq. vol. ii. p. 177.

The nature and uſe of æther were very little known to the ancient chymiſts. Mr. Boyle, and Sir Iſaac Newton, indeed, were not entirely unacquainted with it; but it firſt began to excite general attention, in conſequence of ſome experiments of Frobenius, the feigned name of a German chymiſt, publiſhed in the Philoſophical Tranſactions for the year 1730; and it was by him denominated æther. See Phil. Tranſ. abr. vol. viii. p. 744. vol. ix. p. 372, 379.

Æther, though originally obtained from ſpirit of wine, by means of the vitriolic acid, has ſince been produced by means of the other acids; and it has been found, that the acid of vinegar is eſſentially fitter to produce æther than the vitriolic acid. The firſt diſcovery of this kind of æther was made by the Count de Laurguais.

The marine acid unites with vinous ſpirits very ſlowly, and with great difficulty. Proceſſes for this purpoſe have been diſcovered by the Marquis de Courtanvaux, M. Beaumé, and M. le Baron de Bormes. The Marquis employed the *ſmoaking ſpirit* of Libavius; but M. de Bormes made uſe of zinc, as a medium of concentrating the marine acid. M. Navier, in a proceſs communicated to the Academy of Sciences in 1742, ſhews how to procure æther by means of ſpirit of nitre and ſpirit of wine, without diſtillation. He directs to mix them together in a bottle, which is to be exactly cloſed, and left at reſt, till the æther is formed, and collected like an oil upon the ſurface of the liquor. See the Syſtem of CHYMISTRY, Part I. Chap. V. Sect. IV.

ÆTHERIAL, ſomething that belongs to, or partakes of, the nature of æther: thus we ſay, the *ætherial ſpace*, *ætherial regions*, &c. Some of the ancients divided the univerſe, with reſpect to the matter contained in it, into *elementary* and *ætherial*. Under *æther*, or the *ætherial world*, was included all that ſpace above the uppermoſt element, viz. fire. This they ſuppoſed to be perfectly homogeneous, incorruptible, unchangeable, &c. The Chaldees placed an ætherial world between the *empyreum* and the region of the fixed ſtars. Beſide which, they ſometimes alſo ſpeak of a ſecond ætherial world, meaning by it the ſtarry orb; and a third ætherial world, by which is meant the planetary region. Stanley Hiſt. Phil. p. 1040.

ÆTHERIAL *oil* is a fine, ſubtle, eſſential oil, approaching nearly to the nature of a ſpirit. Thus, the pure liquor riſing next after the ſpirit, in diſtillation of turpentine, is called the *ætherial oil of turpentine*. Some chymiſts diſtinguiſh two principles of *urine*; the one a volatile urinous ſalt, reſembling ſpirit of nitre; the other, an *ætherial oil*, or ſulphur, partaking of the nature of ſpirit of wine. See the Syſtem of CHYMISTRY, Part IV. Chap. I. Sect. II.

ÆTHIOPS *mineral*, a preparation of mercury, uſually made by grinding equal quantities of crude quickſilver and flower of ſulphur, in a ſtone or iron mortar, till they become incorporated into a black powder. It is preſcribed for the worms, and all crudities and acrimony of the humours; and is reputed infallible againſt the itch, and other cutaneous diſeaſes. Authors are not agreed as to the merits of *æthiops mineral*. Cheyne, and many more, commended it highly. Boerhaave, on the contrary, and ſome others, reject it as uſeleſs. See the Syſtem of CHYMISTRY, Part III. Chap. II. Sect. V.

ÆTHIOPS *antimonialis* is prepared by fluxing equal parts of antimony and ſea ſalt in a crucible, for an hour: the matter is then left to cool, and the *ſcoriæ* are obtained by breaking the crucible. Equal parts of the regulus thus made, and of mercury, rubbed together, till they are incorporated, will give the compoſition of this name. Different preparations of the ſame kind have been preſcribed, by ſome phyſicians, in venereal and ſcrophulous diſorders. See the Article ANTIMONY.

ÆTHIOPS *martialis*, is a preparation firſt introduced into medicine by M. Lemery, junior, and is made in the following manner. Put filings of ſteel into an unglazed earthen veſſel, with water enough to riſe four inches above the filings: ſtir it every day, and ſupply water as it exhales, ſo as to keep the filing always covered; and continue to do this till a powder of an inky blackneſs be produced, which is called *martial æthiops*.

ÆTHIOPS *vegetabilis*. The ſea-weed, burnt in the open air, and reduced into a black powder, is called *vegetable æthiops*. It is ſometimes uſed to remove ſcrophulous ſwellings.

AFFECTION, in a general ſenſe, implies an attribute inſeparable from its ſubject. Thus magnitude, figure, weight, &c. are affections of all bodies; and love, fear, hatred, &c. are affections of the mind. The word is formed from *afficere*, to affect; the ſubject being here ſuppoſed in ſome meaſure affected, or acted on, by the thing attributed to it. Affection (ſignifying a fettled bent of mind toward a particular being or thing) occupies a middle ſpace, between *diſpoſition* on the one hand, and *paſſion* on the other. It is diſtinguiſhable from *diſpoſition*, which being a branch of one's nature originally, muſt exiſt before there can be an opportunity to exert it upon any particular object; whereas affection can never be original; becauſe, having a ſpecial relation to a particular object, it cannot exiſt till the object has once at leaſt been preſented. It is alſo diſtinguiſhable from *paſſion*, which, depending on the real or ideal preſence of its object, vaniſhes with its object; whereas affection is a laſting connection; and, like other connections, ſubſiſts even when we do not think of the perſon. A familiar example will illuſtrate this. There may be in one perſon's mind a diſpoſition to gratitude, which, through want of an object, happens never to be exerted; and which therefore is never diſcovered even by the perſon himſelf. Another, who has the ſame diſpoſition, meets with a kindly office, that makes him grateful to his benefactor: an intimate connection is formed between them, termed affection; which, like other connections, has a permanent exiſtence, though not always in view. The affection, for the moſt part, lies dormant, till an opportunity offers for exerting it: in that circumſtance, it is converted into paſſion of gratitude; and the opportunity is eagerly ſeized of teſtifying gratitude in the warmeſt manner.

Affection is more peculiarly uſed in medicine for a morbid, or preternatural, ſtate of the body, or ſome of its parts. Thus we ſay, an hypochondriacal, an hyſterical *affection*. And in like manner, ſuch a part of the body is affected, i. e. indiſpoſed, or ſeized with a diſeaſe. The ſick are frequently miſtaken as to the place affected, by reaſon of the conſent between the ſeveral parts, which often makes a diſorder in one part to be felt in another.

AFFINITY, in chymiſtry, is a term which correſponds to *attraction* in the mechanical philoſophy, and denotes the tendency which the conſtituent parts of bodies have to unite, and the power by which they adhere when united. It is ſometimes called *elective attraction*, or the *power of attraction*. For Dr. Black's Table of Affinities, or Elective Attractions, ſee Syſtem of CHYMISTRY.

AFFIRMATION, in logic, a poſitive propoſition, alledging the truth or reality of ſomething. Affirmation is defined, by *Logicians*, an act whereby we attribute one idea to another, as ſuppoſing it to belong, or agree thereto: as when conceiving perfection to agree to the Deity, we ſay, *God is perfect*. This, on other occaſions, is called, *enunciation*, *propoſition*, *compoſition*, and *judging*. See the Syſtem of LOGIC, Part II. Section IV.

AFFIRMATION, in law, ſignifies the ratifying or confirming a former law or judgment. We ſay to *affirm a judgment*: the houſe of lords, on an appeal, *affirmed the lord chancellor's decree*.

Affirmation is alſo uſed in grammar, by ſome refiners upon that art, for what is uſually called a *verb*; becauſe the office of that part of ſpeech is to expreſs what we affirm or attribute to any ſubject. See the SYSTEM, Part I. Chap. II. Sect. I.

Affirmation denotes an indulgence allowed to the people called Quakers, who, in caſes where an oath is required from others, may make a ſolemn affirmation that what they ſay is true; and if they make a falſe affirmation, they are ſubject to the penalties of perjury. But this relates only to oaths taken to the government, and on civil occaſions; for Quakers are not permitted to give their teſtimony in any criminal caſe, &c.

AFFIRMATIVE, in logic. There are univerſal affirmative propoſitions; and ſuch uſually are the firſt of *ſyllogiſms*. See the Syſtem of LOGIC, Sect. IV. In algebra we have alſo affirmative or poſitive quantities, which have their appropriated characters.

AFFIRMATIVE, in grammar. Authors diſtinguiſh affirmative particles; ſuch is, *yes*. The term affirmative is ſometimes alſo uſed ſubſtantively. Thus we ſay, the affirmative is the more probable ſide of the queſtion: there were ſo many votes, or voices, for the affirmative.

AFFIX, in grammar, a particle added at the cloſe of a word, either to diverſify its form, or alter its ſignification. We meet with affixes in the Saxon, the German, and other northern languages; but more eſpecially in the Hebrew, and other oriental tongues. The Hebrew affixes are ſingle ſyllables, frequently ſingle letters, ſubjoined to nouns and verbs; and contribute not a little to the brevity of that language. The oriental

languages

languages are much the ſame as to the radicals, and differ chiefly from each other as to affixes and prefixes. Mem. Acad. Inſcrip. tom. ix. p. 334.

AFFLATUS literally denotes a blaſt of wind, breath, or vapour, ſtriking with force againſt another body. The word is Latin, formed from *ad*, to, and *flare*, to blow. Naturaliſts ſometimes ſpeak of the afflatus of ſerpents.

AFFLICTION is not in itſelf, in propriety of medical ſpeech, a diſeaſe, but it produces many; for whatever excites envy, anger, or hatred, produces diſeaſes from tenſe fibres: as whatever excites fear, grief, joy, or delight, begets diſeaſes from relaxation. Many chronical diſeaſes, particularly the phthiſis, ſpring from affliction. For a very remarkable hiſtory of the effect of affliction, ſee Hiſt. de l'Acad. Roy. des Sciene, an. 1733.

AFFRONTÉ, in heraldry, is underſtood of animals borne in an eſcutcheon as facing, or with their heads turned towards each other. This is otherwiſe called *confronte*, and ſtands oppoſed to *adoſſé*. See the SYSTEM, Plate V.

AFRICAN COMPANY, a ſociety of merchants eſtabliſhed by King Charles II. for trading to Africa; which trade is now laid open to all his Majeſty's ſubjects, paying ten per. cent. for maintaining the forts.

AFTER-BIRTH, among midwives, the coat or membranes wherein the *fœtus* is incloſed *in utero*. It is thus called, becauſe it comes away ſome time after the *fœtus*, by way of a ſecond birth, or delivery. Phyſicians uſually call it the *ſecundine*. It alſo includes the *placenta uterina*, popularly called the womb-cake. In brutes it is denominated the *beam*, or cleaning. See Collect. Acad. P. E. tom. iii. p. 464. Authors ſpeak of a ſtrange kind of after-birth, of the mole-kind, frequent among Dutch women, where it is called *fanger*, q. d. leech; by naturaliſts, *mola volatilis*. The ſkeleton of one of theſe is deſcribed and repreſented by Thomas Bartholine, Ephem. Germ. dec. 1. ann. 2. obſ. 168. p. 255. The after-births of ripe children are brought away more eaſily than thoſe of abortions. See Medic. Eſſ. Edinb. vol. ii. p. 412. For the moſt approved methods of practice relative to this branch of Midwifery, ſee the SYSTEM, Part VIII. Sect. III.

AFTER-*pains*, are pains felt in the loins, the groin, &c. after the birth is brought away. They ſeem to ariſe from a diſtention of the ligaments of the *uterus* in time of delivery, and are ſeldom dangerous, unleſs aggravated by a detention of the *lochia*. For the method of treatment in that caſe, ſee the Syſtem of MIDWIFERY, Part X. Sect. IV.

AGARICUS, or MUSHROOM, a genus of the order of fungi, belonging to the cryptogamia claſs of plants. Botanical writers enumerate 55 ſpecies belonging to this genus; of which the moſt remarkable are the following.

1. The *campeſtris*, or common muſhroom, has the top or cap firſt of a dirty cream colour, convex, and if but juſt expanding, the under part, or what is called the gills, is of a bright fleſh red: this colour laſts but a little time before it turns darker; and when the plant is old, or has been ſome time expanded, the gills become of a dark brown, the cap almoſt flat, of a dirty colour, and often a little ſcaly. It differs much in ſize in different plants, being from an inch to ſeven inches broad. The general uſe of it is well known. It is found in woods, old paſtures, and by road ſides; and is in the greateſt perfection in September. There is a variety of this with a yelloviſh white cap, and white gills; this is very firm, but ſeldom expands ſo freely as the true ſort, and when broiled will exude a yelloviſh juice. It is probable this ſort is not pernicious, though it is always rejected by ſuch as can diſtinguiſh it.

2. The *pratenſis*, or *champignion*, is very common upon heaths and dry paſtures. A number of them generally come up in a place, ranged in curved lines or circles. The cap is ſmall, almoſt flat, from one to two or three inches diameter, of a pale buff colour, often crimpled at the edges, and, when dry, tough, like leather, or a thin piece of fine cork. The gills are of the colour of the cap, are thinly placed, with a ſhort one, and ſometimes two, coming from the edge of the cap between each. The ſtalk, or pillar, is alſo of the colour of the cap: it is long, ſlender, and all the way of a thickneſs. This plant has but little ſmell, and is rather dry. When broiled or ſtewed, it communicates a good flavour. It is in perfection at the ſame time with the former.

3. The *chantarellus*, or *chantarelle agarie*, is rather a ſmaller fungus than the former. The cap is yellow, of different hues in different plants, ſome being of a pale yellow, and others of an orange colour. It is generally ſunk in the middle, ſomewhat reſembling a tunnel; and its edges are often twiſted and contorted, ſo as to form ſinuſes, or angles. The gills are of a deeper colour than the outſide, are very fine, even, numerous, and beautifully branched. The ramifications begin at the ſtalk, and are variouſly extended towards the edge of the cap. The pillar is of the ſame colour as the cap, and ſeldom inſerted in the centre, but rather ſideways: it is ſhort, thickiſh at the root, and the gills moſtly run down the top, which make it appear ſmalleſt in the middle. This plant broiled, with ſalt and pepper, has much the flavour of a roaſted cockle; and is eſteemed a delicacy by the French, as is the former. It is found in woods and high paſtures, and is in perfection about the end of September.

4. The *deliciоſus*, or orange agaric. The general ſize of the cap of this ſpecies is from two to four inches broad. Its form is circular, with the edges bent inwards; convex on the upper ſurface, except in the centre, where it is a little depreſſed, ſo as nearly to reſemble the apex of a ſmooth apple. The colour is a ſordid yellow, ſtreaked with aſh and yelloviſh brown, from the centre to the edge; and when it is broken, it emits a gold colour juice. The gills are of a deep yellow, and a few of them come out by pairs at the ſtalk, but divide immediately, and run ſtraight to the edge of the cap. The ſtalk, or pillar, is thinneſt near the middle, thickeſt at the root; and, when cut tranſverſely, it is quite white in the centre, with a fine yellow ring that goes to the edge. This fungus, well ſeaſoned, and then broiled, has the exact flavour of a roaſted muſcle. Its prime time is September, and is to be found in high dry woods.

5. The *cinnamomeus*, or brown muſhroom, has a cap the colour of freſh tanned hides. At firſt it is hemiſpherical, firm, even, and fleſhy, with moſtly a ſmall riſing in the centre; but when old it is quite flat. The gills are of a yelloviſh brown, not very diſtant from each other, bent like a knee at the pillar, and have a ſhort one or two run from the edge of the cap between each. The pillar is near the length of a finger, firm, rather thick, brown at the baſe, of a ſordid yellow upward, and, when cut tranſverſely, of a fine white grain. The cap in different plants is from two to five inches broad. The whole plant has a pleaſant ſmell, and, when broiled, gives a good flavour. It is found in woods in September and October.

6. The *violaceus*, or violet muſhroom. Its cap, when firſt expanded, is ſmooth, hemiſpherical, the main ſurface of a livid colour, but towards the margin it is of a better blue. When full grown or old, it becomes corrugated, and of a ruſty brown. The gills of a young plant are of a beautiful violet colour, and regularly placed. The pillar is of the colour of the gills, ſhort, of a conical form, but ſwelled at the baſe into a ſort of bulb. Its upper part is ſurrounded with an iron-coloured wool, which, in a plant juſt expanding, ſtretches croſs to the edge of the cap like a web. This ſpecies requires much broiling; but when ſufficiently done, and ſeaſoned, it is as delicious as an oyſter. It is found in woods in October. Hudſon's *bulbоſus* is only a variety of this plant.

The above are the only ſpecies that can be ſafely recommended as edible; though there are ſome other ſorts which are frequently eaten by the country people; and it is probable the greateſt part of thoſe with firm, fleſhy caps might be eaten with ſafety, provided they were choſen from dry grounds. It is well known that ſoil and ſituation have a great influence upon the properties of plants; and theſe being of a ſimilar nature, and abſolutely between that of an animal and vegetable, may be more powerfully affected than a complete ſpecies of either, by reaſon they have neither leaves nor branches to carry off the noxious damps and vapours of a ſtagnant ſoil, as a perfect vegetable has; nor have they any groſs excremental diſcharges, like thoſe of a living animal. The gills, no doubt, do exhale ſome of their ſuperfluous moiſture; but their ſituation is ſuch, that any thick ſteam from the earth may lodge in them, and, by clogging their excretory ducts, render the plants morbid. Thus they ſoon run into a ſtate of putrefaction, and become a prey to worms, flies, and other inſects. The common muſhroom which is in general eſteem (though we have ſeveral others better) is not ſafely eaten when produced upon a moiſt ſoil. Thoſe who gather muſhrooms for ſale, ſhould therefore have particular regard to the lands they collect them from, eſpecially if they know they are to be broiled; but if they are intended for catchup, perhaps they may be leſs cautious, as the ſalt and ſpices with which the juice is boiled may correct any evil diſpoſition in the plants. But, even in this caſe, catchup made of muſhrooms taken from a dry ſoil, has a more aromatic and pleaſant flavour than that which is made of thoſe taken from a moiſt one, and it will always keep a great deal better.

Of the poiſonous ſorts, the two following are the moſt ſingular:

7. The *muſtarius*, or reddiſh muſhroom, has a large hat, almoſt flat, either white, red, or crimſon, ſometimes beſet with angular red warts; the gills are white, flat, and inverſely ſpear-ſhaped; the pillar is hollow; the cap fixed to the middle of the pillar, limber, and hanging down. This ſpecies grows in paſtures, and is ſaid to deſtroy bugs effectually, if the juice is rubbed upon the walls and bed-poſts. The inhabitants of the north of Europe, whoſe houſes are greatly infeſted with flies at the decline of ſummer, infuſe it in milk, and ſet it in their windows; and the flies, upon taſting the leaſt drop, are inſtantly poiſoned. An infuſion of common pepper in milk anſwers the ſame purpoſe: but the flies, through time, become wiſe enough not to taſte it; and though vaſt numbers are at firſt deſtroyed, it is impoſſible to clear a houſe of theſe inſects by this means. This is the *muſcho-more* of the Ruſſians, Kamtſchadales, and Koriacs, who uſe it as an inſtrument of intoxication. They ſometimes eat it dry; ſometimes immerſed in a fermented liquor, made with the epilobium, which they drink, notwithſtanding the dreadful effects. They are firſt ſeized with convulſions in all their limbs, then with a raving, ſuch as attends a burning fever.

A thouſand phantoms, gay or gloomy (according to their conſtitutions) preſent themſelves to their imaginations; ſome dance; others are ſeized with unſpeakable horrors. They perſonify this muſhroom; and if its effects urge them to ſuicide, or any dreadful crime, they ſay they obey its commands. To fit themſelves for premeditated aſſaſſinations, they take the moucho-more. Such is the faſcination of drunkenneſs among theſe people, that nothing can induce them to forbear this dreadful potion!

8. The *clypeatus*, or long-ſtalked muſhroom, has an hemiſpherical hat, tapering to a point, and clammy; the pillar is long, cylindrical, and white; the gills are white, and not concave, duſted with a fine powdery ſubſtance on each ſide: the root is bulbous, long, and hooked at the end. It is found in September, in woodlands and paſtures. This ſpecies is thought to be poiſonous; and we have the following account of the ſymptoms produced by eating it, in Dr. Percival's Eſſays. "Robert Uſherwood, of Middleton, near Mancheſter, a ſtrong healthy man, aged fifty years, early in the morning gathered and eat what he ſuppoſed to be a muſhroom. He felt no ſymptoms of indiſpoſition till five o'clock in the evening; when, being very thirſty, he drank near a quart of table beer. Soon afterwards he became univerſally ſwoln, was ſick, and in great agonies. A ſevere vomiting and purging ſucceeded, with violent cramps in his legs and thighs. He diſcharged ſeveral pieces of the fungus, but with little or no relief. His pains and evacuations continued, almoſt without intermiſſion, till the next night; when he fell into a ſound ſleep, and awaked in the morning perfectly eaſy, and free from complaint." Many of the different ſpecies of this genus grow on cows or horſes dung, on dunghills, on rotten wood, in cellars, or on the trunks of trees.—Only the eſculent muſhrooms are cultivated. For a complete practical method of rearing them, ſee the Treatiſe on GARDENING. Article KITCHEN GARDEN. Month of SEPTEMBER.

Phyſicians have diſputed much about the qualities of muſhrooms; ſome conſidering them as a rich nouriſhment, and perfectly innocent, when properly choſen; and others aſſerting them to be extremely deleterious. Moſt of the fungi are, indeed, of a hurtful quality; and, with reſpect to the whole tribe, the eſculent are very few. Eſculent muſhrooms are very nutritive, very readily alkaleſcent, and more ſo without intermediate aceſcency than any other vegetable: they are therefore, a rich nouriſhment, and much a-kin to animal food; on which account they may be indulged in conſiderable quantity to ſtrong perſons. It requires, however, ſkill to diſtinguiſh this eſculent kind; and very few, eſpecially of thoſe who are commonly employed to gather them, viz. the ſervants, have ſtudied Cluſius, or other authors, who have been at the pains to diſtinguiſh them. Perhaps our eſculent muſhrooms, if old, acquire a dangerous acrimony; and for theſe reaſons Dr. Cullen is of opinion, that it is for the moſt part prudent to avoid them. In the warmer climates they may be uſed as light food; but here it is not prudent to uſe them with animal food. For a repreſentation, and further illuſtration of the Muſhroom, ſee the Syſtem of BOTANY. Sect. III. Claſs 24. Order IV. Plate VI. with the deſcription and claſſification.

AGATE, or ACHAT, (among the Greeks and Latins, from a river in Sicily, on the banks of which it was firſt found) a very extenſive genus of the ſemipellucid gems. Theſe ſtones are variegated with veins and clouds, but have no zones, like thoſe of the onyx. They are compoſed of chryſtal, debaſed by a large quantity of earth, and not formed either by repeated inſruſtations, round a central nucleus, or made up of plates laid evenly on one another, but are merely the effect of one ſimple concretion, and variegated only by the diſpoſition given, by the fluid they were formed in, to their differently coloured veins or matters.

AGAVE, the common American aloe: a ſpecies of a genus of the Monogynia order, belonging to the Hexandria claſs of plants. For a ſcientific and characteriſtic deſcription of this plant, with its properties, uſes, &c. ſee the Article ALOE. Of this genus, botanical writers enumerate eight ſpecies. The ſtems of the *Americana*, or great American aloe, generally riſe upwards of twenty feet high, and branch out on every ſide towards the top, ſo as to form a kind of pyramid; the ſlender ſhoots being garniſhed with greeniſh yellow flowers; which ſtand erect, and come out in thick cluſters at every joint: theſe make a fine appearance, and continue long in beauty; a ſucceſſion of new flowers being produced for near three months in favourable ſeaſons, if the plant is protected from the autumnal cold. The ſeeds do not ripen in England. It has been generally thought, that theſe plants do not flower till they are one hundred years old, but this is a miſtake, for the time of their flowering depends on their growth; ſo that in hot countries, where they grow faſt, and expand many leaves every ſeaſon, they will flower in a few years; but in colder climates, where their growth is ſlow, it will be much longer before they ſhoot up their ſtem. There is a variety of this ſpecies with ſtriped leaves, which are pretty common in the Engliſh gardens. The other ſorts are ſo tender, that they muſt conſtantly remain in the ſtove.

AGE, in the moſt general ſenſe of the word, ſignifies the duration of any being, from its firſt coming into exiſtence to the time of ſpeaking of it, if it ſtill continues; or to its deſtruction, if it has ceaſed to exiſt ſome time before we happen to mention it. Among the ancient poets, this word was uſed for the ſpace of thirty years; in which ſenſe *age* amounts to much the ſame with *generation*. Thus, Neſtor is ſaid to have lived *three ages* when he was ninety years old. By ancient Greek hiſtorians, the time elapſed ſince the beginning of the world is divided into three periods, which they called *ages*. The firſt reaches from the creation to the deluge, which happened in Greece during the reign of Ogyges: this they call the *obſcure* or *uncertain* age, becauſe the hiſtory of mankind is altogether uncertain during that period. The ſecond they call the *fabulous* or *heroic* age, becauſe it is the period in which the fabulous exploits of their gods and heroes are ſaid to have been performed. It began with the Ogygian deluge, and continued to the firſt Olympiad, where the third, or *hiſtorical*, age commenced. This diviſion, however, it muſt be obſerved, holds good only with regard to the Greeks and Romans, who had no hiſtories earlier than the firſt Olympiad. The Jews, Egyptians, Phenecians, and Chaldees, not to mention the Indians and Chineſe, who pretend to much higher antiquity, are not included in it. The interval ſince the firſt formation of man, has been divided, by the poets, into *four ages*, diſtinguiſhed by the epithets of *golden*, *ſilver*, *brazen*, and *iron*. During the golden age, Saturn reigned in heaven, and juſtice and innocence in this lower world. The earth then yielded her productions without culture; men held all things in common, and lived in perfect friendſhip. This period is ſuppoſed to have laſted till the expulſion of Saturn from his kingdom. The ſilver age commenced when men began to deviate from the paths of virtue; and in conſequence of this deviation, their lives became leſs happy. The brazen age commenced on a farther deviation, and the iron age took place in conſequence of one ſtill greater. A late author, however, reflecting on the barbariſm of the firſt ages, will have the order which the poets aſſign to the four ages inverted; the firſt being a time of rudeneſs and ignorance, more properly denominated an iron than a golden age. When cities and ſtates were founded, the ſilver age commenced; and ſince arts and ſciences, navigation and commerce, have been cultivated, the golden age has taken place. Among the Jews, the duration of the world is alſo divided into three ages. 1. The *ſeculum inane*, or *void age*, was the ſpace of time from the creation to Moſes. 2. The *preſent age* denotes all the ſpace of time from Moſes to the coming of the Meſſiah; and, 3. The *age to come*, denotes the time from the coming of the Meſſiah to the end of the world. Various other diviſions of the duration of the world into ages have been made by hiſtorians. The Sibylline oracles, wrote, according to ſome, by Jews acquainted with the prophecies of the Old Teſtament, divide the duration of the world into *ten ages*; and, according to Joſephus, each age contained ſix hundred years. It appears, by Virgil's fourth Eclogue, and other teſtimonies, that the age of Auguſtus was reputed the end of thoſe ten ages, conſequently as the period of the world's duration. The ſeveral ages of the world may be reduced to three grand epochas; viz. the age of the law of nature, called by the Jews the *void age*, from Adam to Moſes; the age of the Jewiſh law, from Moſes to Chriſt; and the age of grace, from Chriſt to the preſent year. Age is alſo frequently uſed in the ſame ſenſe with *century*, to denominate a duration of one hundred years. Age likewiſe ſignifies a certain period of the duration of human life, by ſome divided into four ſtages, namely, infancy, youth, manhood, and old age; the firſt extending to the fourteenth year, the ſecond to the 25th, the third to the 50th, and the 4th to the end of life: by others divided into infancy, childhood, youth, manhood, and old age.

AGE, in horſemanſhip, makes a conſiderable point of knowledge; the horſe being an animal that remarkably ſhews the progreſs of his years, by correſpondent alterations in his body. We have characteriſtics from his teeth, hoofs, coat, tail, and eyes. The firſt year he has his foal's teeth, which are only grinders and gatherers: the ſecond, the four foremoſt change, and appear browner and bigger than the reſt: the third, he changes his teeth next to theſe, leaving no apparent foal's teeth, but two on each ſide above, and two below: the fourth year, the teeth next to theſe are changed, and no foal's teeth are left, but one on each ſide, above and below: at five years, his foremoſt teeth are all changed, and the tuſhes on each ſide are all complete: thoſe which come in the places of the laſt foal's teeth, being hollow, and having a little black ſpeck in the midſt, which is called the *mark in a horſe's mouth*: this continues till eight years of age. At ſix years he puts out new tuſhes: near which appears a little circle of young fleſh, at the bottom of the tuſh; the tuſhes, withal, being white, ſmall, round, and ſharp. At ſeven years, their teeth are all at their growth, and the mark in the mouth appears very plain. At eight, all his teeth are full, ſmooth, and plain, and the mark ſcarce diſcernible; the tuſhes looking yelloviſh. At nine, the foremoſt teeth ſhew longer, yellower, and fouler, than before, and the tuſhes become bluntiſh. At ten no holes are left on the inſide of the upper tuſhes, which till then are very ſenſible: add, that the temples begin to be crooked and hollow. At eleven years, his teeth are very long, yellow, black,

and

and foul; but he will cut even, and his teeth ſtand directly oppoſite to one another. At twelve the upper teeth hang over the nether. At thirteen, the tuſhes are worn cloſe to his chops, if he has been much ridden, otherwiſe they will be black, foul, and long.—2. As to the hoof: if it be ſmooth, moiſt, hollow, and well ſounding, it is a ſign of youth: on the contrary, if rugged, and, as it were, ſeamed, one ſeam over another, and withal dry, foul, and ruſty, it is a mark of old age.—3. For the tail: taking him by the ſtern thereof, cloſe at the ſetting on to the buttock, and griping it between the finger and thumb, if a joint he felt to ſtick out more than the reſt, the bigneſs of a nut, the horſe is under ten; but if the joints be all plain, he may be fifteen.—4. The eyes being round, full, and ſtaring, the pits that are over them filled, ſmooth, and even with his temples, and no wrinkles to be ſeen either under or above, are marks of youth.—5. The ſkin being plucked up in any part betwixt the finger and thumb, and let go again, if it return ſuddenly to its place, and remain without wrinkles, he may be believed to be young.—6. A dark coloured horſe, growing griſly above the eye brows, or under the main; or a whitiſh horſe growing meanelled, either with white or black, all over, may be infallibly concluded extremely aged.—Laſtly, a horſe being young, the bars of his mouth are ſoft and ſhallow; otherwiſe they are deep, and feel hard and rough.

AGE, in hunting, is an article of conſequence. Deer, and other beaſts of game, have different denominations according to their age. The age of a hart, &c. is chiefly judged of by the furniture of his head. The firſt head, called in fallow deer *broches*, and in red deer *pricks*, does not come till the ſecond year of their age. The next year they bear four or ſix ſmall branches; the fourth year, eight or ten; the fifth, ten or twelve; the ſixth, fourteen or ſixteen; the ſeventh year they bear their heads beamed, branched, and ſumed, as much as ever they will be. The huntſmen have ſeveral other marks, whereby to know an old hart without ſeeing him, as the ſlot, entries, abatures, ſoils, fewmets, gate, and fraying poſts.

AGE *of the moon*, in aſtronomy, is underſtood of the number of days elapſed ſince the laſt conjunction, or new moon; called alſo her *quarter*. For an explanation of the particulars relative to this planet, ſee the Syſtem, Sect. III. and IX.

AGENDA, in a general ſenſe, denotes things to be done or performed, in conſequence of a man's duty. The word is Latin, formed from *agere*, to do; and divines ſpeak of the agenda of a Chriſtian, meaning the things to be practiſed by way of contradiſtinction from *credenda*, or things to be believed. The former imports the articles of obedience, the latter of faith.

AGENT, in phyſics, that whereby a thing is done, or effected; or that which has a power whereby it acts on another; or, by its action, induces ſome change in it. The word agent is uſed promiſcuouſly with *efficient*, and in contradiſtinction to *patient*. The learned divide agents into *natural and free*.

Natural and Phyſical AGENTS are thoſe immediately determined by the Author of nature to produce one ſort of effect, with an incapacity to produce the contrary.

Natural AGENTS, again, are ſubdivided into *univocal*, which are ſuch as produce effects of the ſame kind and denomination with the agents themſelves; and *equivocal*, whoſe effects are of a different kind, &c. from the *agents*. The ſchoolmen reckon the following circumſtances neceſſary to the being of an agent, viz. that it be contiguous to the object, diſtinct from it, have a power over it, a ſphere of activity, and a proportion, or rate of acting.

Free or voluntary AGENT is that which may equally do any thing, or its oppoſite; as acting, not from any predetermination, but from choice. Such is the mind ſuppoſed to be, which has a ſpontaneous power of chooſing or refuſing. It is a celebrated queſtion among philoſophers and divines, whether man be a free or a neceſſary agent? It may be thus ſtated: man is a neceſſary agent, if all his actions are ſo determined by the cauſe preceding each action, that no one paſt action could poſſibly not have come to paſs, or have been otherwiſe than it was, nor one future action can poſſibly not come to paſs, or be otherwiſe than it ſhall be. On the contrary, man is a free agent, if he be able at any time, in certain circumſtances, to do different things; or, in other words, if he is not ever unavoidably determined in every point of time, by the circumſtances he is in, to do that one thing he does, and not poſſibly to do any other. Which of theſe two definitions agrees to man, is a queſtion of fact to be determined by what we experience in ourſelves, with regard to the operations in our own minds. See LIBERTY, NECESSITY, and WILL. The term agent evidently implies a power of ſelf-determination; and the epithet *neceſſary*, applied to agent, forms a ſoleciſm both in ſenſe and language. Price's Review, p. 315, &c.

AGENT, in chymiſtry, is ſometimes attributed to menſtrua, or ſuch bodies as in mixture have the greateſt ſhare of activity and motion. That internal agent in man, whereby all the vital motions neceſſary to the preſervation and reſtoration of the body are managed, is by ſome called *nature*; by others, *archæus*, *calidum innatum*, *animal ſoul*, *vital ſpirit*, or *principle*, &c.

AGGLUTINANTS, in medicine, a ſpecies of ſtrengthening medicine, whoſe office and effect are to adhere to the ſolid parts of the body, and thus recruit and ſupply the place of what is worn off, and waſted, in the animal actions. Agglutinants are moſt of them of the glutinous kind, or ſuch as eaſily form themſelves into jellies, and gummy conſiſtencies; whence the name, *agglutinant*. The principal ſimples which come under this claſs, found in the ſhops, are iſinglaſs, olibanum, gum Arabic, dragon's blood, caſſia, ſago, vermiceilli, pulſe, comfrey, &c.

AGGLUTINATION, among phyſicians, implies the action of returning the parts of a body, ſeparated by a wound, cut, &c. It is alſo applied to the action of ſuch internal medicines as are of an agglutinating quality, and which, by giving a glutinous conſiſtence to the animal fluids, render them more proper for nouriſhing the body. Some aſſign a difference between *agglutination* and *aſſimilation*. In that ſpecies of leproſy called LEPRA, there is an adheſion, or agglutination of the nutriment, but no aſſimilation. In the anaſarcous dropſy, on the contrary, there is an adjunction, without any agglutination; i. e. there is an afflux of new matter, or nouriſhment; but this is ſo thin and watery, that it wants the due ſtiffneſs and tenacity to make it bind. Some will have agglutination to be effected by a ferment: others aſſert, that, by reaſon of the glutinous quality of the chyle, a mere contract ſuffices to make it adhere to the parts.

AGGREGATE, the ſum, or reſult of ſeveral things aggregated, or added together. Natural bodies are aggregates, or aſſemblages of particles, or corpuſcles, bound together by the principles of attraction. Bodies politic are likewiſe ſaid to be aggregate; ſuch as mayor and commonalty, dean and chapter, &c. in contradiſtinction to corporations *ſole*; ſuch as the king, a biſhop, &c. Aggregate, in general, ſignifies a body reſulting from the union of others which are ſmaller, the whole ſum of which combined is called the aggregate. It is particularly uſed by ſome modern chymiſts and naturaliſts, for a numerous collection of atoms, or minuteſt corpuſcles, whether homogeneous or heterogeneous, joined together by contiguity, without regard to the quality of ſuch atoms. In which ſenſe, aggregate differs from *mixt*, as the former ſuppoſes no particular ſituation or poſition of the corpuſcles, other than what ariſes from their proportion, and the relation they bear to the ambient bodies, among which the coalition is formed. Aggregate alſo differs from mixt, as the latter is formed immediately out of the principles of matter, ſo firmly united, as that it is very difficult, if not impoſſible, to ſeparate them. Aggregate again differs from *compound*, as the latter is formed out of mixts, and is eaſily diſſolvable. Aggregates then are the ultimate compounds, or the laſt effects of compoſition; they reſolve into compounds as their next ingredients, theſe into mixts, and mixts into ſimples, or principles; though, in ſtrictneſs, aggregates may alſo reſolve into mixts, and mixts into ſimples, inaſmuch as they conſiſt of heterogeneous parts. This doctrine and diſtinction of aggregates, mixts, and compounds, is the foundation of the chymical theory of Becher and Stahl; the laſt of whom has traced it with great exactneſs. Hence has ariſen a new doctrine of earths, metals, &c. which has ſince been illuſtrated and extended by the beſt modern chymiſts.

AGGREGATE, in botany, is a term uſed to expreſs thoſe flowers which are compoſed of parts or florets, ſo united by means either of the receptacle or calyx, that no one of them can be taken away without deſtroying the form of the whole. They are oppoſed to ſimple flowers, which have no ſuch common part, and are uſually divided into ſeven kinds, viz. the aggregate, properly ſo called, whoſe receptacle is dilated, and whoſe florets are ſupported by foot-ſtalks; ſuch are the blue daiſy, thrift, or ſea-pink, &c. the *compound*; the *umbellati*; the *cymoſe*; the *amentaceous*; the *glumoſe*; and the *ſpadiceous*. See the Syſtem of BOTANY, Sect I. No. 22. Letter G, and Plate I. No. 372.

AGITATION properly ſignifies *ſhaking*, or reciprocal motion of a body. The quakers, Pythian prieſteſſes, &c. were ſubject to violent agitations of body. Among phyſiologiſts the term is ſometimes appropriated to that ſpecies of earthquake, called tremor, or *arietatio*. Among the philoſophers it is chiefly uſed for an inteſtine commotion of the part of any natural body. Thus, fire is ſaid to agitate the minute particles of bodies. Fermentation and effervescence are attended with a briſk agitation of the particles. Heat is ſuppoſed, by ſome, to conſiſt in the agitation of the parts of the hot body; and ſound is produced by a tremulous agitation, excited firſt in the ſonorous body, and communicated thence to the ambient air. Agitation is likewiſe uſed for a violent hurry or perturbation of ſpirits, occaſioned by ſome predominant paſſion.

AGITATION is alſo uſed in medicine for a ſpecies of exerciſe, popularly called ſwinging; and, in general, for any exerciſe which ſhakes the body. Bartholine mentions fits of the tooth-ach, deafneſs, &c. removed by vehement agitations of the body; and they have been found of eſpecial uſe for preventing and diſſolving concretions. Dr. Sydenham attributes the great benefits of riding to agitation, which is very efficacious in removing obſtructions of the *viſcera*. Sanguification is in a great meaſure effected by the agitation of the parts of the blood and chyle in their continual circulation. Digeſtion itſelf is only ſuppoſed by ſome to be an inſenſible kind of agitation.

AGITATIVE *force of a pendulum* is that which produces motion in it. The agitative force of the pendulum ariſes from

three

three things. 1. The power of gravity. 2. The weight fastened at the end of the rod. 3. The distance of that weight from the point of suspension; or, which amounts to the same thing, the length of the rod, or pendulum. Hist. Acad. Scien. 1714. For the doctrine of Pendulums, as laid down on Mathematical Principles, see the Article PENDULUM.

AGNUS *Dei*, in the Romish Church, denotes a cake of wax, stamped with the figure of a lamb, supporting the banner of the cross, consecrated in due form by the pope, to be distributed in presents among the people, and supposed to have great virtues annexed to it. The name literally signifies *Lamb of God*; this being supposed an image or representation of the Lamb of God, who took away the sins of the world. They cover it up with a piece of stuff, cut in form of a heart, and carry it very devoutly in their processions. The Romish priests, and religious, derive pecuniary advantage from selling these Agnus Dei's to some, and presenting them to others. The pope provides a regular supply, by consecrating once in seven years: they are distributed by the master of the wardrobe, and received by the cardinals, and other prelates, with great reverence, in their caps and mitres. This ceremony they pretend to derive from an ancient custom of the church, wherein part of the paschal taper, consecrated on Holy Thursday, was distributed among the people, to perfume their houses, fields, &c. in order to drive away devils, and to preserve them from storms and tempests. Other imaginary virtues are likewise attributed to them. The Agnus Dei is forbidden to be brought into England, under pain of incurring the *præmunire*. 13 Eliz. cap. 2.

AGONY, *Agonia*, denotes the extremity of pain, or a disease, when nature makes her last effort, or struggle, to throw off the evil that oppresses her. The word is formed from the Greek ἀγων, *certamen*, combat, this being a kind of strife between life and death. Much of the terror of death consists in the pangs and convulsions wherewith the agony seems attended; though we have reason to believe, that the pain, in such cases, is, ordinarily, not extremely acute; a course of pain and sickness having usually stupified and indisposed the nerves for any quick sensations. However, various means have been thought of for mitigating the agony of death. Lord Bacon considers this as part of the province of the physician, and that not only when such a mitigation may tend to a recovery, but also when, there being no farther hopes of a recovery, it can only tend to make the passage out of life more calm and easy. Accordingly, he ranks *euthanasia*, or the art of dying easily, among the *desiderata* of science; and does not even seem to disapprove of the course Epicurus took for that end. De Augm. Sc. lib. iv. c. 4. Opium has been applied for this purpose, with the approbation of some, but the condemnation of more. Baglivi published a treatise expres, *De Medicina Agonizantium*, or the method of treating those in the agonies of death. But perhaps one of the best *recipes* for this end, is that of Mr. Patin, viz. *abstinence from all medicines*.

AGRARIAN LAWS, among the Romans, those relating to the division and distribution of lands, of which there were a great number; but that called the *Agrarian Law*, by way of eminence, was published by Spurius Cassius, about the year of Rome 268, for dividing the conquered lands equally among all the citizens, and limiting the number of acres which each citizen might enjoy. The Roman lands were of several kinds; some conquered from the enemies, and not yet brought to the public account; others brought indeed to the public, but clandestinely usurped by private great men; lastly, others purchased with the public money, in order to be divided. Agrarian laws, for dividing lands taken from the enemy, or the public lands, or those purchased with the public money, were easily passed without disturbance; but those whereby private rich men were to be deprived of their lands, and the common people put in possession of what had been held by the nobility, were never attempted without great disturbances.

Several have pleaded for the necessity of agrarian laws in England. William Spriggs, or, as some say, Fr. Osborne, has written expressly on this subject. See also the Supplement to Dr. Price's Observations on Reversionary Payments, &c. p. 381. But the author who seems to have entered deepest into the nature and use of agrarian laws, is Harrington. He shews, that the balance of property in a state cannot be fixed but by laws, and the laws whereby such provision is made are agrarian laws. Now these are necessary to the stability of government, because governments will, according to the diverse balance of property, be of diverse or contrary natures; that is, monarchical, or popular. Thus monarchy requires of the standard of property, that it be vast or great; and of agrarian laws, that they hinder recess or diminution; at least in so much as is thereby entailed upon honour. But popular government requires, that the standard be moderate, and that its agrarian laws prevent accumulation. This author thinks, that, in a territory not exceeding England in revenue, if the balance be in more hands than three hundred, it is declining from monarchy; and if it be in fewer than five thousand hands, it is swerving from a commonwealth. The same writer defines an equal agrarian, a perpetual law, establishing and preserving the balance of dominion by such a distribution, that no one man, or number of men, within the compass of the few, or aristocracy, can come to overpower the whole people, by their possessions in lands. He also observes, that the people of Rome, by striving for an agrarian, strove to save their liberty; and that that commonwealth, through want of such a law, or the non-observance of it, came to ruin. In the Grecian cities, the defect of an agrarian was supplied by *ostracism*. In Venice, the council of ten, and the officers of pomp, restrain those who might be too powerful; and these two orders in a commonwealth, where the gentry have but small estates in land, are as much as needs be in lieu of an agrarian. Some German republics have no more to supply the place of this law, than that estates descending are divided among the children. And the same law would establish an agrarian in England.

Agrarian laws may be framed different ways, as by entailing the lands upon certain families, without power of alienation in any case, as in Sparta, or Lacedæmon; or, except with leave of the magistrate, as in Spain. But this, by making some families too secure, as those in possession, and others too despairing, as those not in possession, may make the whole people less industrious. Therefore Harrington prefers a law regulating estates so that no man shall have above two thousand pounds a year in land; and that the estates of those who exceed this proportion shall be divided, in descending to their children, till the greatest share do not exceed two thousand pounds per annum. This is the rule he lays down for his commonwealth of Oceana, by which he means his scheme for the government of England. By this law Harrington intended, that the property of land in England should never fall into fewer hands than five thousand; as he computes the rents of this country to be ten millions. But if these rents, as is probable, amount now to twenty millions, it would follow that, by our author's rule, the land could never be in less than ten thousand hands, which, according to his system, must effectually secure the liberties of the people. It would exceed the limits of our design to enter into the full detail of all the reasonings of this ingenious author on the subject of agrarian laws; we therefore refer to his works. See also GOVERNMENT, PROPERTY, &c.

AGRICULTURE may be defined, The art of disposing the earth in such a manner as to produce whatever vegetables we desire, in large quantity, and in the greatest perfection of which their natures are capable. But though, by this definition, agriculture, strictly speaking, includes in it the cultivation of every species of vegetable whatever, and consequently comprehends all that is understood of gardening and planting, we mean here to confine ourselves to the cultivation of those species of grain, grass, &c. which in this country are generally necessary as food for men and beasts.

A noble spirit, for making improvements in agriculture, has lately gone through this nation, for which posterity will thank the present age in terms of the highest approbation. The principles on which those improvements have been conducted are as judicious as the subject is important; and it is highly probable, that many good effects will take place in every part of the kingdom.

Agriculture has been considered of national importance by the most discerning part of mankind in all ages. Every civilized nation, at one period or other, has been convinced of its intrinsic excellence; and the wisest men, of every age and country, have unitedly bestowed the highest encomiums on it.

Every one who reflects justly, must be sensible, that it is with agriculture as with physic. While facts and experiments are producing and increasing the best knowledge, it is necessary that those who may hereafter engage in either of the professions, be instructed in the principles of the one, and the practice of the other.

Agriculture is a science as well as an art; and some general scientific knowledge is requisite, before that art can be practised with any rational hope of full success; unless quacks may be allowed to perform perfectly well in agriculture, although they are continually breaking the sixth commandment in physic. Let the spirit which has gone forth continue to prevail; let agriculture be studied by gentlemen of landed property, on philosophic principles; let it be taught to their tenants; and the happy consequence will soon be apparent throughout this island.

The following SYSTEM *of* AGRICULTURE *is the production of a Gentleman Farmer in Oxfordshire. It contains many novel remarks of the author's, resulting from his own practice, as well as extracts from all the most esteemed publications on the subject, including those which have appeared as late as the present year; with observations, comments, and illustrations on the same. It has met with very high encomiums from several agricultural gentlemen, to whose judgment it was submitted previous to insertion, who have pronounced it a System well selected, and free from those redundant and superfluous theories which cannot be reduceable to practice, as well as replete with those judicious discriminations, and practical observations, which are so well calculated to extend the knowledge of an art of such national importance, and so much cultivated by the noble, the wise, and the learned, who have brought it forwards to public view under the sanction of their own practice. It is therefore hoped that such a System, containing all the new discoveries and improvements in this useful art, will be considered as a valuable acquisition to this Work.*

W. H. HALE.

A NEW SYSTEM of AGRICULTURE.

AS we commenced our undertaking with the intention of pruning Art and Science of that burden of uſeleſs theory with which other ſimilar publications have been loaded, we ſhall endeavour to collect, from the beſt information, ſuch theory as is conſiſtent with practice, and ſuch practice as we have known tried and approved.

In the important Art of Agriculture, now before us, moſt writers on the ſubject have been men of independent fortunes, making experiments in gardens, and other ſmall, rich incloſures; and, on a favourable reſult, have committed their thoughts to the public as unerring maxims; not conſidering the expence or practicability of their ſchemes on a larger ſcale, or inferior ſoil.

The more ſimple the plan of huſbandry, the more certain will be the farmer's ſucceſs; it being almoſt without a precedent, that a book-learned farmer ever became wealthy; for which we can aſſign no other reaſon, than that former theories, being compoſed of undigeſted, ſpeculative materials, ſerve only to perplex, inſtead of inſtruct, the practitioner who depends on them for knowledge. Theſe are not the only defects to which lettered huſbandmen have been ſubject; and as the compilers of dictionaries have copied them, every modern treatiſe on the ſubject is rendered unintelligible to the majority of thoſe whom it materially concerns, by being filled with pedantic terms of art, or, on the other hand, with provincial dialect. We ſhall not fill page after page with the errors and inconſiſtencies of other writers, thinking it ſufficient to paſs them over with that diſregard they deſerve. We think our readers are entitled to ſomething of more intrinſic value, than Mr. Young's account of "feeding a lean hog fat in ten days with carrots;" and other miracles ſo frequently to be met with in the works of ſcientific writers. Where we meet with ingenious theory that claſhes with practice, we beg leave, with all ſubmiſſion, to adopt the idea, at the ſame time making due acknowledgment to whom we are indebted; and occaſionally we ſhall take the liberty to expoſe abſurdities, as we think the labours of others, as well as our own, lie open to candid criticiſm.

HISTORY AND PROGRESS OF AGRICULTURE.

Agriculture unqueſtionably has been practiſed in the moſt remote ages of the world. As mankind advanced from a ſtate of nature their neceſſities increaſed, and invention made improvements on ſpontaneous vegetation. The mode of cultivation uſed in the antediluvian world we muſt leave to the inveſtigation of thoſe who are reſolved to ſay ſomething on every ſubject, and, rather than be ſilent, fill up the chaſm with idle conjecture. The works of Heſiod and Virgil can add nothing to a ſyſtem of Britiſh huſbandry, although they abound with fine imagery, and, perhaps, the firſt information the ſubject was capable of receiving, when practiſed in the warm luxuriant climate of Italy, where oil and wine are produced without human aid. Leaving this unintereſting detail to thoſe who endeavour to amuſe, inſtead of inſtruct, we proceed to give a conciſe narrative of the progreſs of agriculture in our own country, where the hand of nature has been very ſparing of her gifts, as few of the neceſſaries of life flouriſh without the moſt unremitted induſtry. *By nature our apples are crabs! and our plumbs, ſloes!* But art and labour have changed the ſcene, and health-giving exerciſe has brought this kingdom to an unequalled ſituation of plenty and ſplendor.

The æra when the yeomanry of England in a great meaſure began to feel the benign effects of freedom, was in the reign of Henry VIII. after the diſſolution of the monaſteries; the heavy yoke of church tyranny being removed, all degrees of people, from the peaſant to the peer, began to ſee the happy effects of cultivation. Several acts of parliament were then paſſed for incloſing of waſte lands, improving the breed of cattle, and other good purpoſes, all which ſhew how highly, and of what importance, the legiſlature thought agriculture. It is evident that at this time tillage was extended as wide as it poſſibly could be; and manures, except the produce of the fold and ſtable, but little known, or, from the badneſs of the roads, were but ſeldom applied. Moſt of the wood lands in the inland parts of the kingdom bear evident traces of the plough, which are now occupied by venerable decaying oaks, in all probability of three or four hundred years ſtanding. There are but few downs or ſheep walks that have not the marks of cultivation; but neither memory or tradition account for the time when they were in that ſtate. The grain produced at that time was the ſame as the preſent, except a much greater portion of rye, then almoſt in general uſe for bread, either alone or mixed with wheat. Sainfoin was introduced into England previous to this period; as alſo clover; but the value of artificial graſſes, or roots, for the ſupport of cattle, and improvement of land, were not in practice.

Dividing and incloſing waſte and commonable lands continued till the reign of Edward VI. when improvement received a very ſevere check; a number of perſons riotouſly aſſembled in various parts of the kingdom, and, by pulling up the fences, laid waſte, and deſpoiled, what induſtry and judicious management had effected. We may, from this circumſtance, infer, that incloſures were not conducted in that equitable and juſt manner as they are at the preſent day. A mob have generally ſome pretence for their conduct; and in the preſent inſtance the lower order of people, finding their property invaded, had recourſe to thoſe violent means for redreſs. This, and the troubled ſtate of the nation, rendered improvements in agriculture very ſlow in their progreſs during the troubleſome reign of Queen Mary, and the former part of that of Elizabeth. Fitzherbert, judge of the Common Pleas in the year 1525, was the firſt perſon who wrote on the ſubject of Agriculture in England, and whoſe familiar ſtyle is a proof that he meant to ſerve the cauſe. His excellent inſtructions reſpecting the management of land and cattle, render him one of the greateſt ornaments of the age in which he lived. For the entertainment and information of our readers, we give them a ſpecimen of his works in their native dreſs.

Directions to be obſerved in the choice of lean cattle for feeding, as well as thoſe which are already fat.

"*Theſe huſbandes and they that wyl thryve they muſt have both kye, "oxen, horſes, mares, and yong cattel, and to reyre and brede every yere "ſome calves and ſolen, or els ſhall he be a lyer. And if thou ſhalt bie "oxen for the plough, ſe that they be yonge and nat gauty, nor broken of "theare nether of tayle, nor of fyſel. And if thou bye kye to the payle, ſe "that they be yong and good to mylke, and ſede her calves wel. And yf "thou bye keye or oxen to fede, the yonger they be the rather they wyl fede, "but ſe wel that the beare ſtare nat, and that he lycke blanketſ, and be "whole mouthed, and want no teth. And though he haue the gaute, and "be broken both of tayle and fyſel, yet wyl he fede. But the gauty oxe "wyl nat be driuen far, and ſe that he haue a brode ribbe and a thicke "hyde, and to be cluſe ſhinned, that it ſticke nat harde nor ſtrait to his "ribbes, for then he will nat fede.*

"*And yf thou ſhalt bye fat oxen or kye, handle them and ſe that they be "ſofte on the fore crop bekynde the ſhulder, and upon the hynder myft ryb "and upon the huckleboue, and the nach by the tayle. And ſe the oxe "haue a great cod and the cowe a great nauyl, for then it ſhulde ſeme that "they ſhulde be wel talowed. And take hede wher thou byeſt any leane "cattel or fat, and of whom, and wher it was bred; for yf thou by out "of a better grounde then thou haſt thy ſelfe, that cattel wyl nat lyke with "the. Alſo take that there be no meuer of ſickneſs among the cattel in that "townſhyp or paſture that thou byeſt thy cattel out of. For if there be "any murren or longſought, it is great ieopardy, for a beaſt may take "ſickneſs ten or twelve dayes or more, or it appere on him.*"

The practical directions given in this ſhort extract are alone ſufficient to prepoſſeſs every huſbandman in this good judge's favour. What grazier would wiſh for more wholeſome advice?

Sir Francis Bacon threw in his mine of philoſophy at this period. What art or ſcience was there this great genius did not illuminate?

A north-countryman, of the name of Lawſon, alſo employed his ruſtic pen; and although his writings contain a number of abſurdities, yet he frequently acquits himſelf like a farmer.

Several tranſlations from the French, and other languages, made their appearance about this time, containing ſo little to the purpoſe, that it is obvious this country poſſeſſed a ſuperiority in agriculture even at this period.

The celebrated botaniſt Gerrard publiſhed his great work about the latter end of the reign of Elizabeth, and was the firſt who taught the culture of potatoes. If we conſider the period at which Gerrard wrote his voluminous publication, with the correctneſs and beauty of his work, we cannot withhold our aſtoniſhment at his unrivalled merits and induſtry.

From the beginning of James I. to the end of Charles I. little reſpecting huſbandry can be collected; every manœuvre was uſed, and every opportunity taken, by thoſe kings, and their adherents, to increaſe the prerogative of the crown. The event that followed need not be mentioned here; but we cannot help remarking, that, when monarchical government ceaſed, art and induſtry rapidly improved, particularly ſcientific and practical agriculture.

The writings of Sir Hugh Platt deſerve every praiſe, and prove him a man actuated by the pureſt of motives, the good of his country. Gabriel Plattes muſt likewiſe have made cultivation his principal ſtudy, as his writings conſiſt of judicious digreſſions, and good practical information.

But of all the writers on huſbandry, Captain Blyth ſtands foremoſt. His works, in 4to, are dedicated to Oliver Cromwell, and furniſh as complete a ſyſtem of practice as ever was produced by an individual. He treats largely on fallows, and their different management; manures, and how to apply them to the beſt advantage. On the culture of various graſſes now in uſe, (which are generally thought to have been unknown at the period he wrote;) alſo on turnips, and other roots, for the uſe of cattle. The improvement of meadow and paſture lands are, with very few exceptions, the beſt committed to print. Under-draining and cleanſing ſwampy grounds were well known to this writer; and, although the great improvement in draining fens has been ſo recently adopted, Captain Blyth gave a plate and accurate deſcription of engines for that purpoſe, nearly the ſame as thoſe now in uſe. He ſtrongly recommends incloſures, and the planting of coppices and timber, and frequently in a manner that proves him a complete maſter of his ſubject.

Samuel Hartlib lived in intimacy, and correſponded with, the writer before-mentioned, as did the immortal Milton.

During the commonwealth agriculture flouriſhed, and the huſbandman met with every encouragement a wiſe government could beſtow: and, however hiſtorians may brand the rulers of

the day with puritanic fanaticism, and other opprobrious epithets, it is certain art and science flourished; and those who directed the helm of state did not number the acquisition of wealth among their ambitious pursuits. But this wise turn was not of long continuance. At the Restoration they generally became infected with that intoxication and love of pleasure which succeeded. All their industry and knowledge were changed for neglect and dissipation; and husbandry descended as rapidly as it had lately improved.

Jethro Tull next followed, and endeavoured to cut up the old system root and branch, and to introduce in its stead drilling and horse-hoeing, without the use of manure. This novel mode has had many advocates, who, with too much credulity, taking Mr. Tull's *ipse dixit* for matter of fact, have always relinquished the plan, and, on consulting their pockets, have found the idea mere quackery. Not that drilling is, in every respect, inconsistent with practical husbandry. In many instances great good may accrue from the practice, when judiciously used, on some kinds of soil; but Mr. Tull, and his disciples, by attempting to make drilling general, have brought it into disgrace with a great majority of those who have given credit to their assertions.

Since the Revolution, agriculture has been materially improved, particularly the culture of grasses and roots for the use of cattle in the winter, and early in the spring. Mr. Bradley, professor of botany in the university of Cambridge, took up the cause of agriculture, and his writings on the subject do him great credit as a scientific and practical author. Mr. William Ellis, of Gadsden, in Hertfordshire, by his writings, displayed considerable knowledge in agriculture; and was the person who first made known, without reward, what Mr. Vagg has lately delivered to the public as his own invention, for the small sum of 2000l.

Without any improper partiality to our own country, we are fully justified in asserting, that Britain alone exceeds all modern nations in husbandry; and, from the spirit which, for the last twenty years, has animated many of our nobility and gentry, to become the liberal patrons of improvement, there is reason to hope that this most useful of arts will, in a few years, be carried to a greater degree of perfection, than it has ever yet attained in any age or country. The Royal Society, the Bath Society, and the Society of Arts, &c. in particular, have been signally useful in this respect; and the other associations which are now established in many parts of the kingdom, co-operated with them in forwarding their laudable design.

Of such importance are the study and practice of agriculture now held in Scotland, that, in the year 1790, they instituted a professorship in one of their universities; and it is much to be lamented that a similar institution has not been introduced in the universities of Oxford and Cambridge; as it would so essentially tend to the promotion of this important department of knowledge, so highly beneficial to mankind.

It is not, however, to the exertions of public societies and institutions, excellent and honourable as they are, that all our modern improvements in agriculture owe their origin. To the natural genius of the people have been added the theory and practice of all nations in ancient and modern times. This accumulated mass of knowledge has been arranged, divided, and subdivided; and after passing the test of practical experiments, the essential and most valuable parts of it have been preserved, improved, and amply diffused in the works of modern authors, whose productions on this important subject have been principally instrumental in rendering the inhabitants of this kingdom happy, wealthy, and powerful. To these respective authors we have had recourse, and presume that we have made such a collection, as will render our System as complete as possible.

Before we enter on the respective heads or sections into which we shall divide the System, we shall introduce a few prefatory remarks.

The right of the clergy to tythes, is, perhaps, more inimical to the progress of agriculture, than that of any other order of society; and nothing but a commutation in lieu of tythes, can secure a farmer from that most unwelcome of all visitants, the tytheman. To toil, invent, and use expensive means to improve land, to improve live stock at a great expence, and your neighbour to come and claim a tenth of your industry, is, of all taxes, the most cruel. Let our readers only weigh the matter one minute. We will suppose a farmer to cultivate his land nine successive years, and to take the produce to his own use and benefit, and on the tenth plough and sow as usual, increase his live stock, make the best of the dairy, reap and mow, pay servants their wages, and every contingent expence whatever, then comes the clergyman, and takes all the produce, leaving neither hay or corn for cattle, nor any thing to make manure for the succeeding years. This is eventually the case, by which the farmer is greatly injured, and the proprietor of tythes not proportionably benefited.

When tythes are commuted, and consumed on the land where they grew, the farmer collects them without an additional expence; and, what is of equal importance, his land is not impoverished, by losing annually one tenth of its produce. The collector of tythes finds himself in quite a different predicament, being obliged to keep a team of horses, and servants, to collect tythes over an extensive parish; and when they are collected, to draw the corn, &c. to market; and, except there are some glebe lands annexed to the living (which is frequently not the case, and the quantity always very small) he has no place, but a fold yard, for the cattle, kept to eat hay and straw, and cannot dispose of the manure to a proper advantage. These are but few of the disagreeable circumstances which attend the collecting of tythes, and which every person acquainted with the business must be sensible of. The great national importance we conceive of agriculture, led us to these concise observations respecting inclosures, and the commutation of tythes; being well convinced, that, was the plan generally adopted, all ranks of people would participate in the advantages; the clergy would become more esteemed and respected; and, instead of being the authors of feuds and law-suits, would have seldom reason to deviate from those fine examples of their master, the "MINISTER OF PEACE!"

Within these few years it has become a very prevailing idea with gentlemen of large landed property, to refuse leases to their tenants, particularly of any long continuance, under the notion that, during the term of a lease, the proprietor is not master of his property. If a landlord will assist his tenants in making improvements, lands may be rendered more fertile, without being let on long leases; but, admitting that to be the case, a farmer cannot exercise his skill and industry with that spirit which is requisite in all important undertakings, without some probable security for the enjoyment of the fruits of his labour. In the instance before us, where can the tenant fix any hopes of reward? Death may perhaps take from him a landlord on whom he could depend, and whose word was equal to his bond, and the estate devolve to another, who, regardless of the promise of his predecessor, gives his tenant notice to quit, or cruelly raises his rent. There are a variety of other causes by which a man may be turned out of his farm, before he has reaped any benefit from expensive improvements. His dog may unfortunately kill a hare which has been bred and nourished on the farm; or the same mastiff may cruelly fall upon and beat a pointer or spaniel, when the gentleman, his keeper, or steward, were sporting on the premises. On such accidents as these, and others of equal consequence, we have known gentlemen discard their tenants. We have likewise known tenants extremely impertinent and overbearing, knowing themselves secure from their landlords' resentment, by having a lease of many years unexpired. On briefly considering and weighing matters between the lessor and lessee, we are well convinced, that a lease of not less than fourteen years will be of mutual benefit to both parties; if, at the commencement of a new inclosure, or where considerable improvements are necessary, such lease should extend to twenty-one years, otherwise the proprietor cannot expect his estate will be properly managed and improved, or the tenant will risque his property and industry, without a hope on which he can depend of making a return. Prescribing a system of management by lease to a tenant, is curbing genius, and tying the hands of industry: the result of various seasons, and local circumstances, often require different modes of cultivation. We are sorry to observe so impolitic a measure so much in vogue amongst landed gentlemen, being convinced that improvements in agriculture are greatly impeded by such means. Some restraints are certainly necessary, particularly the management of fences, not selling manure, or such produce of the land which makes manure, and other similar covenants; but always to enforce one unalterable round of cultivation, is making an attorney the practical husbandman, and the husbandman of no more consequence than a horse in a mill. The three or four last years of a lease, it is necessary for the lessor to bind the tenant in a particular manner, for the benefit of the succeeding tenant, provided he should change; but enforcing a general series of husbandry, will not improve an ignorant and slovenly man, and is sure to injure him who is ingenious and assiduous.

In the choice of a tenant, a gentleman should look for a person of plain unaffected manners; by no means of a whimsical turn of mind; an early riser; persevering, industrious, and honest; bred to, and capable of, performing all parts of the business; and possessed of property equal to the undertaking. Farms should be rented in such a manner, as the cultivator, by hazarding his property, and exercising his industry, should acquire a comfortable subsistence, and something to render the decline of life pleasant and happy. When this is the case, the landlord and tenant are generally pleased to meet each other; whereas, on the contrary, a gentleman reluctantly views his own estate, as it neither yields him his income at the proper season, nor receives that cultivation which he can see with pleasure; for nothing restrains assiduity so much as labouring without a prospect of gain. You will always perceive a farmer, who rents his farm too high, either inert and melancholy, or a careless drunkard.

Mr. Young very justly observes, "that the cultivation of small farms by their owners, is generally productive of the best and most improveable mode of agriculture, as the farmer finds himself doubly encouraged by interest." In this, as in a number of other ideas, we perfectly agree with him; and think ourselves justified on the same principle, to recommend leases to gentlemen, instead of agreements from year to year, as interest will add vigour to improvements in one instance as well as the other.

As Arthur Young, Esq. has been a labourer in the field of agricultural improvements the greatest part of his life, we cannot quit this part of the subject, without taking some notice of such of his works as we have had the pleasure to see. When Mr. Young first

first started as a public man, (whether profit or amusement were his pursuits we know not, or whether he entered himself for the public good,) the high flattering manner in which he speaks of the various noblemen and gentlemen he visited, his inflated and poetic description of their mansions and agriculture, and, above all, his constant advice to them to raise their rents, in order to make their tenants more industrious and thrifty, are maxims which seem to indicate that Mr. Young wanted to curry favour with those who were able to bestow it; for we cannot believe oppression can be exercised with success to stimulate industry. Indeed, the fretful manner in which Mr. Young delivers himself at the conclusion of the first volume of his Annals, and in other places, are plain proofs that he is a disappointed man. We hope experience and extensive travelling have given him a better opinion of English husbandry than he entertained when first they were honoured with his visits, and that he is convinced of the wide difference between speculative theory and rational profitable practice. The variety of academic honours this author is enabled to annex to his name may be food for ambition, and add consequence to a title page; but liberality of sentiment, and a just record of events, are certainly of more value to the community. That the Annals are, in many instances, a candid statement of facts, elucidated with fair and liberal digression, by Mr. Young, the editor, we acknowledge with pleasure, and admire the open manner in which he frequently delivers his sentiments on agricultural improvements. We hope, likewise, Mr. Young has experienced the sweets of his present publication; and could wish him to have some mercy on the purses of his subscribers, and only admit such correspondence as conveys some new idea, or to add to such subjects as have been before slightly touched upon. By this time we should suppose him sufficiently experienced in theory and practice, to be competent to the task of selecting the useful from the useless; as inconsistencies, and tedious repetition, are poor amusement, and convey no instruction, however learned or high in life the author may be. Anonymous correspondence being contrary to Mr. Young's plan, what can be his motive for so frequently admitting such effusions of uncertain experiments from unknown authors? If pecuniary notions are his object, we pity the narrowness of his mind; and if the ambition of having wrote much, in his own words we tell him, "a little business well performed is better than much performed bad."

George Winter, Esq. a gentleman of independent fortune, who cultivates the land for health, amusement, and to serve his unenlightened neighbours, has recently published a *compendious System of Husbandry*, particularly recommending the drilling of grain, and all kind of seeds. Mr. Winter has likewise had the good fortune to invent a new drill plough, for which he has obtained *his Majesty's Letters Patent*. Had the inventor of the machine made the public good his study, we should have given him credit for a share of disinterested patriotism; but to publish information, and to sell such publication for nearly double the price he could have afforded it at, is not accommodating himself to those who are in need of instruction. His compendious system contains some ingenious and learned observations; but at the same time it has many distinguished singularities, in which we cannot agree with the writer, especially in his treatment of pigs; in which he recommends, before they are turned out to grass, the use of spirits of hartshorn, the usual application to those who are troubled with hysterics. We do not wish to depreciate Mr. Winter's very novel improvements, but cannot help suggesting, that beans, peas, or barley meal, will answer the medical purpose, and are articles easier procured, and better adapted to the constitution of the animal. There is very little public spirit in gentlemen procuring patents: such monopolies are, in some instances, excusable in mechanics; but a man who styles himself independent in circumstances and mind, must surely forget himself, when he procures a patent on purpose to enhance the price of a useful machine three times above its real value. Without an intention of giving offence to any individual, we are determined to speak with the same freedom respecting our contemporaries, as we shall of those whose works are only left to answer for themselves; and we are sorry to observe several gentleman, professors of agriculture, have obtained patents for inventions not their own, by which means those who should reap the advantage are precluded from their share, through the enormous price of those experimental machines. This conduct may be consistent with the old adage of "every man for himself;" but there is very little fellow-feeling, or genuine philanthropy, in the measure.

Thus having prefaced our System of Agriculture in as concise a manner as possible, we shall proceed to treat of the theory and practice of the art in the following Sections, under their respective heads.

INDEX TO THE SYSTEM.

1. The various kinds of soils, and observations.
2. Manures, and to what soil best adapted.
3. Wheat, and its cultivation.
4. Barley, ditto.
5. Oats, ditto.
6. Beans and peas, ditto.
7. Vetches or tares, rye, buckwheat, and lentiles or tills, ditto.
8. Clover, rye-grass, and trefoil, ditto.
9. Saintfoin and lucerne, ditto.
10. Other grasses not generally in use, ditto.
11. Cabbage, turnip cabbage, and rape, ditto.
12. Turnips, ditto.
13. Potatoes, ditto.
14. Carrots, ditto.
15. Mangel Wurzel, and other roots and plants not generally in use, ditto.
16. Hops, ditto.
17. Flax and hemp, ditto.
18. Madder, woad, &c. ditto.
19. Meadow and pasture, overflowing, draining, and cleansing, ditto.
20. Hay, and its management.
21. Dividing and inclosing, with the planting and management of fences.
22. Horses and oxen, as used for husbandry.
23. Cows and dairy.
24. Sheep.
25. Pigs.
26. Plowing, harrowing, and cleaning land.
27. Sowing, drilling, and other means of depositing seed in the earth.
28. Implements used in husbandry.

SECTION I. THE VARIOUS KINDS OF SOIL.

Soils are generally distinguished by loam, clay, sand, and chalk, each of which has its respective kinds. As we do not purpose to enter into a chymical analysis of their nature and quality, we mean to give a simple and plain description of them, so far as we think conducive to vegetation. Whether phlogisticated or dephlogisticated air is the food of plants, it is not for the practical farmer to consider: nor has every thing that art and sophistry could invent and say on the subject, had the least tendency to the improvement of agriculture, but has frequently disgusted and tired the reader, and driven him from a pursuit which he had previously followed with pleasure. As it is only the province of the respective editors to offer their opinion, but not to decide on those points, the reader is referred to the philosophical investigations of Priestley, and others, contained in the system of AEROLOGY, Sect. III. and IV. and under the Article FOOD OF PLANTS, in the order of the Alphabet.

The food of plants is earth or soil, which to manure and cultivate should be the farmer's care. Some kinds of soil cannot be ploughed and pulverized too much; others the less they are stirred the better, as frequently ploughing is found by experience to produce thistles, and a variety of other weeds, in much larger quantities than when the plough has been more sparingly used. Soil easily made fine, or reduced, is much improved by a course of drilling occasionally:—But more of this when the subject is before us.

LOAM.

Loam, or native mould, is the soil best adapted for vegetation: this, in its highest or most pure state, is formed from decayed vegetables, and other perishable substances, and, when acted upon by the sun and air, is rendered fertile. All other soils, capable of nourishing plants, are composed more or less of this mould, and other less fertile ingredients, as clay, sand, chalk, stones, and the like; and according to this mixture, the soil is prolific or barren. The soil, thus blended by nature, should be the farmer's first consideration, for on that depends what is called the goodness of the land, or the essential matter to the growth of crops of corn, and other vegetables. This pure mould, being the lightest of those several substances which compose the earth, naturally lies on the surface, or above the others, in various thicknesses, according to the nature of the soil; which, mixed with the under-layer, bed, or, as some term it, the pan (by too deep ploughing) generally injures the fertility of the lands. The loamy soil in the greatest estimation, is known by its tender softness, and blackish colour, being with ease crumbled to-pieces: it is justly called the heart of the land, or principal nourishment to herbage. When the greatest part of the soil is composed of this rich or vegetable mould, it is likewise termed loam, or loamy earth, whether the admixture be clay, sand, or other earthy substances; for this reason loamy soils differ in colour and quality. When a reddish sand makes a part, with, or without, a small portion of clay, it is called a yellow loam; and is land well adapted for all kinds of corn, roots, and most kinds of grasses: it is easily worked; not so liable to couch-grass, and other kinds of running weeds; therefore easily kept clean. There is likewise another kind of soil, generally called a tough, sour, black loam. This is composed of a black or blue clay, and native or vegetable mould, and is fertile in proportion to the quantity of the latter. If this soil is without small stones or gravel, it requires much ploughing, and occasionally to be exposed to winter's frost and summer's sun; for however speculative theorists, and those determined friends to the drilling system, who figure away in Mr. Young's Annals, may argue and attempt to prove to the contrary, we will venture to pronounce, that no person can manage this kind of land, and a stiff clay, to a proper advantage, unless he sometimes turns it up to the frost and sun; but this comes more properly under *the article* FALLOWING. This soil is subject to a variety of weeds, as couch-grass, docks, and others equally difficult to destroy, which renders frequent ploughing, and careful weeding, the more necessary. Wheat, oats, and beans, are the grain best suited to this kind of soil; and turnips, if cattle can eat them off in the winter, without injuring themselves or the land by treading it: or turnips may be drawn, and carted off the land, for cattle in houses or on pasture. This method renders the crop of turnips

very

very useful, but does not enrich the ground on which they grow. Clover and rye-grass, with a small mixture of trefoil, are the best grasses to sow on a strong loam: if it is continued grass no more than one year, clover alone is preferable.

A loamy soil, with a mixture of small round stones, is, beyond a doubt, the most pleasant land a man can cultivate; and, although not possessed of strength equal to the land we have been just taking notice of, it is for general culture superior. All kinds of grain, grasses of all sorts, turnips, and potatoes, may be cultivated with advantage; and if the farmer does not covetously crop it too much, it will prove the most profitable land he can plough. Loam, mixed with pebbles, or flints, is generally called a gravel loam; it works easy, and may be cropped like a stony loam; but requires more manure, and is not so certain.

CLAYS.

Clays are of various colours, as red, blue and white; darker, or lighter, according to the sort which is predominant: they all agree in their general nature, and may properly be treated of together. Clays are cold and tough, and retain a great deal of moisture; or, on the contrary, when completely dried, the surface becomes so very hard, that the rains do not easily penetrate. In proportion as clays are united with natural or vegetable earth, so is their fertility to be estimated: their colour is not to be regarded, but their quality. The sun and frost are friendly to all kinds of clay soil, and lying wet in winter is particularly injurious. The plough should not be sparingly used on clay in dry weather; and the rougher you lay it exposed to the frost or sun the better. Cattle lying on clay in winter materially hurt the land, and it seldom benefits the cattle. Buck-wheat, or vetches, sowed and ploughed in, is a good and cheap improvement, which will be considered under the article MANURES. Wheat, rye, beans, and clover, seem best adapted to grow on clay.

SANDS.

There are several kinds of sand distinguished by their colours, as brown, red, yellow, and white. These sands, without a mixture of earth, or clay, are barren, being only the sport of winds, not sufficiently adhesive to afford any nourishment to the roots of plants. Sand, when it thus forms the covering or surface of the earth, must be called the soil; but being so useless in its nature, is seldom cultivated to any advantage. If clay, or marle, can be easily obtained, it may be improved, but at too great an expence to fall upon a tenant; therefore this kind of soil is not what we would wish the husbandman to understand as a sandy soil; we mean a soil in which sand is predominant, although there are other kinds of earth in the mixture.

Sandy soils, when the sand does not make too great a part, are cultivated with profit and ease, as they are worked in all seasons with less difficulty than any other kind of land. Sandy soils are warm or cold, according to the substances with which they are incorporated: thus, when mixed with pebbles or flint, it yields its produce more early; and is subject, if pasture, to be burned up by a continuance of dry weather; and if arable, is rendered almost barren by what is called a dry summer. This is enriched by turnips, if cattle eat them off in a proper manner. Crops of buck wheat, or other juicy vegetables, ploughed in before they blossom, also add much to its fertility, perhaps more so than on any other kind of soil. Wheat, barley, peas, and all kinds of grasses, are adapted to the gravelly sand; and strong manures will always meet a welcome reception, and quickly lose their virtue.

A sandy soil, with a mixture of red mortary earth, which runs to a considerable depth, is generally backward in yielding its produce, and not subject to burn, or feel the effects of a continuance of dry weather; this, although light in its nature, is superior to the former, and is particularly adapted to oats, rye, and peas, as it seldom produces wheat or barley of a good colour or quality. Turnips, potatoes, and particularly carrots, grow to great advantage on this kind of sandy land: rye-grass, trefoil, and clover, generally give good crops; and it is likewise well suited to natural grass. On this soil the drill, or what the speculists call the new husbandry, will be found a great improvement, as no more ploughing than just to keep it clean is the best management.

CHALK.

Without a mixture of other kinds of earth, chalk is almost barren; but with a due proportion of other earthy substances, it is fertile, requiring little labour, and that performed with ease; except tough clay forms a part, in which case there is no soil more binding.

Chalk is of different kinds, some being hard as a stone, and others soft like marle: this renders a different mode of management necessary. One kind of chalky soil will be little benefited by what would improve the other. It is generally esteemed, that the harder the chalk which makes part of the soil, the less value is the land; and the softer the chalk, of greater value. It is much in favour of chalky soils, that they are the least of any over-run with weeds, except some few of the annual kind, which are kept under with little difficulty. The light, loose, chalky soil requires little ploughing; and too much is sure to be an injury, by rendering it too fine and light to support and nourish the roots of plants.

Folding of sheep on this kind of soil is particularly serviceable, as, besides the benefits which accrue from the manure, the treading of the sheep gives it a firmness, which, by nature, it is much in need of: so saintfoin and rye-grass are useful. The soft kind of chalk requires more ploughing, and is naturally more fertile. Wheat, barley, and peas, are generally produced in good quantities, and of the best quality, on the soft or marly chalk. It sometimes happens unfortunate, when heavy rains immediately succeed the seeding, as by that means the surface is so firmly united that the plants cannot make their passage through the soil, consequently the seed and labour are lost: this may, in some degree, be prevented, at least guarded against, by not harrowing too fine.

OBSERVATIONS.

As we have shortly treated on the kinds of soil which are in general cultivation in this country, if it should be alledged, that there are some sorts which we have not particularly noticed, we acknowledge there are; and at the same time are persuaded, that if those we have omitted are not exactly the same, yet they bear such a similarity in their nature, as their culture and produce will be nearly the same, and, under the articles Manures, or Ploughing, &c. will be mentioned. To give or propose directions to any person for their choice in land, would be arrogantly assuming a province to which we by no means think ourselves intitled, as we hope every farmer, before he changes his situation, will be particular in estimating the goodness of the land, with the price per acre; what situation it has been in, in what manner managed, and the probable improvements that can be made, with the expences that will attend such improvements; and particularly to consider the term of his lease, that he may have it in his power to reap the profits of his industry. Mr. Wishaw, Mr. Black, and several other persons who are employed by gentlemen of landed property, to put a value on their estates, have scientifically obtained the appellation of *land tasters*, by estimating the degrees of fertility which belonged to the soil, and its quality, according to their palate. On what criterion these gentlemen found their skill we cannot determine; but we can inform them, and the public, that many industrious husbandmen think their mouths must have been out of taste, at the time the farms they rented were under their inspection; for industry can seldom meet its reward where those speculative appraisers have made their appearance.

Strange as this may seem, it is really true, that it is at this time a prevailing custom for gentlemen, when they think proper to raise their rents, to apply to an eminent *land taster*, who perhaps resides an hundred miles or upwards from the place where he is employed, and never saw the land before, and whose reputation is in proportion to the oppression he has been the cause of. When this important regulator arrives, his first business is to examine the *rent roll*, and make such minutes as are necessary to prevent his running into error: thus equipped, he takes the field, and sacrifices the success and happiness of those individuals and their families, who are so unfortunate as to have their farms substituted to the test of this pretender's *taste* and judgment.

It may be said, if the tenant does not approve of the alteration, it is at his option to provide for himself in another place: he may so; but let it be recollected, that those advances are generally made at the time when a tenant has made expensive improvements; which, with the difficulty and expence of removing, and the uncertainty attending agricultural concerns, frequently induces a man to endure an evil he knows something of, than hazard his property where he is a stranger: besides, *land tasters*, surveyors, and merciless landlords, are become so numerous, and taxation so high, that a tolerable farm is rare to be met with.

In opposition to those gentlemen, and as friends to humanity and industry, we, with respect, mention the names of Mr. WILLIAM MACRO, of Barrow; R. LEGRAND, Esq. of Guilton House; WILLIAM HALL, Esq. of Elmstone; and some few others who correspond with Mr. Young in his Annals. The writings of these gentlemen are evident proofs that they are friends to their country, to industry, and agriculture; not judging as theorists, but as ingenious and liberal practitioners, who highly deserve the farmer's most cordial thanks for their communications. As a contrast to these characters, we cannot omit the Reverend Mr. FISKE, of Shimpling, near Bury, Suffolk. The following appears in one of his letters to Mr. Young, published in the 5th volume of his Annals: "Small farmers are obliged always to have some crop on their land, or they could not live; therefore, substitute clover, beans, peas, or something instead of fallowing. Here is a striking instance that large rents encourage industry; and, I believe, nine times in ten, advance in rent will be found of service. For no sooner is a farm raised, but the farmer rouses from his lethargy, opens his eyes, and contrives some method to pay the additional sum." True, Reverend Sir! otherwise he must go to gaol, and his family into the work-house; except, indeed, he turns his own executioner, and puts an end to a miserable life; or adopts another expedient—he might "contrive a method" to rob his neighbours, and then the law would find an executioner, and also a parson to take care of his soul. Suppose we ask the Reverend Mr. Fiske, if a poor unfortunate curate, who with the utmost difficulty

difficulty procures a neceſſary ſuſtenance for himſelf and family, is not a greater object of compaſſion than the fat and haughty rector who rolls in plenty, takes his tythes in kind, and tyrannizes in a truly Nabob ſtyle as far as his authority extends? If this is anſwered in the affirmative, ſuppoſe we tranſfer the analogy to a poor hard working tenant, who labours hard, and fares badly; and his wealthy landlord, who knows no want, but that of a good appetite, and who, inſtead of feeling the excruciating pains attendant on a poor *half-ſtarved rheumatiſm*, enjoys himſelf with *a fine luxuriant gout*.

The caſe being thus briefly drawn, do, Mr. Fiska, tell us in what manner this rich man, who lives in plenty and idleneſs, can beſt ſerve the poor man who owes his exiſtence to hard labour and active induſtry? Would it be charitable, or juſt, in either caſe, to rob the indigent man, and give to him that is opulent? This ſeems to be your opinion; as you have already anſwered the queſtion, by aſſerting, that the way to make the farmer thrive, is to raiſe his rent. This, we think, needs no comment, as it ſufficiently ſpeaks for itſelf; we, therefore, take our leave of you for the preſent, in a few words. If thoſe, reverend ſir, are your ideas, as a man and citizen of the world, we deſpiſe your deſpotic notions, and feel for your dependents: if, as a chriſtian and a divine, we are apprehenſive you do not inculcate or practice thoſe fine morals which your religion teaches.

Being led from the obſervations which commenced this ſection, by accidentally meeting with the uncharitable opinion of this reverend gentleman, we return to the ſubject; and, although our opinion is in oppoſition to the whole *land taſting* fraternity, yet we take the liberty to recommend to the gentleman or farmer's notice, the general appearance of herbage and vegetation, in preference to the taſte or colour of the ſoil. If winter happens to be the ſeaſon, the ſtrength and appearance of ſtubbles, with the dry or wet ſituation land appears in, and whether the land will endure treading by cattle or not: and if paſture, whether graſs appears thick or thin, if over-grown with a ſtrong courſe of moſs; or if its general appearance is green, or of a whitiſh caſt; likewiſe what improvement can be made by draining, cleaning, and other operations. In ſummer, if the ſeaſon has been regular and kind, the appearance of land ſpeaks for itſelf, nature has then cloathed it in its beſt garment; whether good, bad, or indifferent, is the queſtion which the enquirer ſhould make himſelf acquainted with. Meadow and paſture are ſometimes very deceiving, when in the moſt luxuriant ſtate, as frequently the white bloſſomed clover and other delicate plants appear, in the greateſt plenty, on account of a friendly ſeaſon to this ſweet herbage, when in other ſeaſons nothing of the kind ſhews itſelf. Theſe circumſtances require a perſon ſhould conſult ſome one acquainted with the land. The beſt arable land may, indeed it does very often, bear an unkind aſpect from bad management, which a perſon with a ſlight knowledge of buſineſs will eaſily diſtinguiſh. For inſtance, if the growth of grain carries with it the appearance of poverty; the nature and ſituation of the weeds are evidences ſufficient with a diſcerning practical farmer; and as every country has ſuch uſeful men, we recommend the young and unſkilful to adviſe with ſome *ſage experienced neighbour*. It is a cuſtom with ſome perſons to take the growth of timber and other trees, and the favourable appearance of hedges, as a never-failing rule to judge of the quality of the land; but this we can, from experience, refute; as very often trees and fences grow in the moſt luxuriant manner, and corn and graſs very indifferently; and, on the contrary, good corn land frequently bears wood very badly. Beſides, one half of the hedges are ſpoiled by bad planting; or, perhaps, worſe management; of courſe, little information can be expected from ſuch a theory. By this we mean to guard the huſbandman againſt a too haſty determination; for deliberation on cauſes and effects, in general, amply pays thoſe who apply with careful caution.

SECT. II. MANURES.

TO WHAT SOIL EACH IS BEST ADAPTED.

AS we have conſidered the nature and cultivation of ſoils, and made ſome obſervations on their uſes; manures, the great ſupport and ſtamina of continued cultivation, come next before us. Pulverizing the land with the plough, and other implements adapted for the purpoſe, and enriching it by natural and artificial compoſts and manures, are circumſtances on which good huſbandry chiefly depends. We purpoſe treating of manures under theſe diſtinct heads: 1. *Animal*, 2. *Artificial*, 3. *Natural Manures*. To ſpeak of the dung of animals, as chymiſts, we do not conceive neceſſary: Why ſhould a farm yard be converted to a laboratory? We cannot help taking notice of the Encyclopædia, publiſhed in Scotland; ſeveral numbers of which are taken up with a ſyſtem of Agriculture. We ſhould have been happy to have improved our reading and experience, by conſulting that voluminous work occaſionally; but, on peruſal, we find a ſelection from Dr. Prieſtley's Philoſophical Labours, the Practice and Theory of Lord Kaimes and Mr. Anderſon, and a few of the Bath Societies papers, make a great part of their ſyſtem. However learned the editors of that great undertaking in other departments; in agriculture they are notoriouſly deficient; ſome few glaring errors we ſhall mention in the courſe of our ſyſtem; for ſhould any perſon be weak enough to follow their directions, in ſome matters, they would be inevitably miſled.

1. *ANIMAL MANURE IN GENERAL.*

As vegetation naturally exhauſts the land, ſo cattle which depaſture, by leaving the dung and urine, ſupply the defect, by returning from whence it came, what they had previouſly taken from the ſoil. If land is mowed and loſes its produce every year, and never receives any aſſiſtance from manures of any kind; ſuch land is greatly injured, and in proceſs of time the beſt ſoil may be reduced low and impoveriſhed. Animal manures ſtand foremoſt, and thoſe animals which feed the higheſt produce manure of the greateſt value; in fact, the virtue of animal manures may be eſtimated by the food which is given to the animal. Cattle of the cow kind, kept in a ſtraw-yard, without any thing but ſtraw for their ſuſtenance, yield a poor light manure, little ſuperior to natural ſoil; when cows or oxen feeding on good hay, aſſiſted by corn, oil cakes, or other invigorating food, yield a manure little inferior to the beſt horſe dung. Thus, the ſtronger the manures are impregnated with animal ſalts, of more value they are; to preſerve ſuch ſalts requires the utmoſt care; and of all careleſs neglects in farmers this is the greateſt, it being deemed an object worth notice with but few.

Every huſbandman will tell you that one load of ſtable dung is worth five of that from the ſtraw-yard, and yet, at the ſame time, permits his yards and dunghills to drain themſelves of their virtue, unnoticed and diſregarded. We will not comment on this miſmanagement, any further than by obſerving, that many gentlemen and experimental farmers have taken this matter into conſideration and practice, much to their credit and judicious diſcernment; while farmers who pay heavy rents, and ſhould let no opportunity of enriching their land eſcape, ſuffer the moſt eſſential part of their manure to paſs away as uſeleſs, and to anſwer no good purpoſe whatever. It is a cuſtom to turn dung and expoſe it to the air and weather in the yard; this is certainly founded in error; by ſuch means all fermentation is ſtopped, and its ſtrength is evaporated by wind and ſun; therefore let it be avoided. Should a leiſure time preſent itſelf, it is by all means to be recommended to the farmer to take the dung from his yard in its crude and undigeſted ſtate, near to the place he intends to uſe it, and mix it with earth taken from waſte roads, or if that is not in his power, from a headland or other part of the field which preſents itſelf. It ſhould be obſerved, that in general the ſoil thrown up, and carted off with the manure, is amply reinſtated by the natural and unavoidable drainings from the compoſt heap. The dung of animals, as we have obſerved before, poſſeſſes a fertilizing quality in proportion to the quantity of animal ſalts it contains: we ſhall rank them according to their quality, and ſpeak of the quantity of each, without entering into an elaborate and uſeleſs detail, as we deem it unneceſſary to deſcribe every minutia of an article, which, from the nature of things, cannot be productive of general uſe. For the phyſical qualities of dung in general, as a manure, ſee the article Dung.

HORSE DUNG.

The Dung of Horſes, which are kept in ſtables on hard meat, is firſt in general utility, and improves all kinds of ſoil. Sir Hugh Platt ſays, that from experience he knows "one load of grain or fruit well conſumed, and laid on a ſpot of ground, will enrich it more than ten loads of common horſe dung." To give implicit credit to this circumſtance is more than we can readily aſſent to, although Sir Hugh's authority is very great; yet this may remove the doubts (if there are any) of thoſe who do not ſufficiently eſteem the dung from animals highly fed. Horſe dung ſhould be well fermented and decayed before it is layed upon the land; otherwiſe mixed in a freſh ſtate, with earth, which ſhould lie together until they are incorporated. This valuable manure laid on land too green or new, beyond a doubt encourages weeds, which we attribute to its ſuperior ſtrength or ſpirit; as what makes weeds grow luxuriant and ſtrong will alſo make more valuable plants flouriſh with greater vigour. As a Horſe chews his food but once, oats are ſeen frequently to paſs through them undigeſted; this often prevents thoſe who are curious in preſerving their corn for ſeed, from manuring their land intended for barley or wheat with the produce of the ſtable; this obſtacle is entirely removed by letting it become rotten before it is uſed. The Dung of Horſes, and all dung of a warm kind, particularly benefit poor barren land; and on theſe we need give no caution reſpecting quantity, as people generally diſtribute their manure according to the land which wants it. But it is certainly much the beſt way to manure land well when it is attempted.

Of good Horſe Dung, twenty cart loads upon an acre is thought a tolerable good dreſſing, each cart load a ſmart draft for three ſtrong horſes on level ground, the load weighing thirty hundred weight. On rich loamy land you may run into an error by profuſion in manuring; ſhould that happen, we know of no better remedy in ſuch caſe, than a crop of flax or hemp, which will ſoon reduce it to the ſtandard for corn. Every horſe dunghill is not of the ſame richneſs, although the horſes may feed the ſame; for there is much to be ſaid reſpecting the quantity of litter that has been uſed.

COW DUNG.

By Cow Dung is meant that of all horned or neat cattle. In treating on Horſe Dung, we have attempted to explain the cauſe of heat and cold in the effects of Dung in general. As the higheſt fed cattle produce the ſtrongeſt manure from the goodneſs of their food, it follows by the ſame rule, that cow dung ſhould be cold and ſpiritleſs in proportion to the virtue of its feed. Cow dung, eſpecially when the animal has good hay given, is an excellent manure, although not ſo ſtimulative as horſe dung; its nature is particularly adapted to promote vegetation. This animal manure deſerves more eſtimation than it really has; particularly that made in yards, and not lying in a ſituation to receive too much rain, nor to drain itſelf dry from urine and other moiſture. The dung of horned cattle does not ferment ſo ſpeedily as that of horſes or pigs, provided the animal feeds equally high; perhaps this may be accounted for by the additional fermentation it receives in the ſtomach, by chewing its food a ſecond time. On cold ſtiff clays, or loams approaching to the ſame nature, cow dung does not ſhew itſelf with equal advantage to thoſe of a warmer kind; but on warm gravel, or ſand, provided it has been carefully preſerved, it will not be found materially inferior. The utmoſt care is neceſſary to keep this manure from being expoſed to the ſun and wind, and (indeed as you ſhould with all others) plough it in immediately as it is laid on the land; mixing it as ſoon as poſſible with earth is good management.

HOGS DUNG.

Some of the old writers on Huſbandry diſcarded the manure made from pigs, which erroneous prejudice has been followed by ſome of a later date; but we will take the liberty to obſerve, that ſuch perſons could only write to increaſe the number of books.

The principal fault they diſcovered in the dung of hogs, were, that it "was poiſon to land, and produced nothing but weeds." Curious as this may appear, it is really a fact, that ſo fooliſh and abſurd a notion is not yet entirely exploded. To any perſon of experience and obſervation, this opinion muſt appear abſurd, for in general that which forwards the growth of one plant will promote that of another. The dung of pigs, particularly thoſe that are feeding, is unqueſtionably of the firſt quality, and laid on ploughed land in too large quantities, freſh from the PIGS COT, will cauſe weeds to grow, but reaſon ſhould direct every perſon in all their purſuits; and an error committed is generally an ample leſſon to a circumſpect man.

To lay experiments before our readers, which have not undergone the teſt of examination, is foreign to our plan, as we derive our information from a truly practical ſource, which we are of opinion, may be depended upon: but as an inſtance lately preſented itſelf much in favour of the manure now under our conſideration, we ſhall preſent it to the public.

Mr. JOHN DAVIS, an ingenious practical farmer of LITTLE ROLLRIGHT, in the county of OXFORD, being led by curioſity to try the effects of pig dung, unmixed with any other, on a light ſtony loam mixed with ſand, manured about an acre with four cart loads of pig dung, not in a rotten and decayed ſtate. The acre on which this manure was laid, run acroſs the middle of a piece of about twenty acres which was under preparation for turnips, according to the uſage of the country; or, more properly ſpeaking, a ſpring fallow, which generally happens in theſe hilly countries on oat ſtubble, after the land has been exhauſted by three preceding crops. The lands on each ſide we are mentioning, which was manured with pig dung, were dreſſed with about twelve or fourteen loads of good horſe dung to an acre, and all received the ſame ploughing, harrowing, and other management. The reſult was, the acre on which the pig dung was laid looked in a more kind and promiſing manner as ſoon as the turnips appeared; they were leſs annoyed by the fly or ſlug; and when at their full growth it produced nearly double the quantity to any other part of the field of the ſame meaſurement. The ſucceeding crop of barley bore a manifeſt ſuperiority to the pig dung manure; and the rye graſs and clover, ſowed among the barley, in order to lay the land down for two years, appears at this time more luxuriant, and of a darker colour than the lands manured with horſe dung on each ſide.

This circumſtance is evidently in favour of the dung made from pigs, as ſuch we think it worthy of notice; but it ſhould be conſidered, that it is the cuſtom in thoſe parts of OXFORDSHIRE, GLOUCESTERSHIRE, and the adjacent country, not to litter their feeding pigs; of courſe the dung is entire, and free from any mixture of ſtraw or other ſubſtance. Neither do we ſuppoſe any fermentation has ever taken place, which renders the ferment more powerful with the ſoil: horſe dung uſed in the ſame manner would in all probability, be equal in virtue; the experiment might be eaſily proved.

Pigs in their nature are a very cleanly animal; this may, perhaps, be objected to by thoſe who are unacquainted with them particularly; although nature has not endowed them with thoſe ſenſitive organs of ſmelling and taſting, correſpondent with other animals, there is not an animal that will keep the place he ſleeps in ſo clean as a pig will, provided the ſtye or cot is conſtructed in a proper manner. The place of reſt or retirement ſhould be covered in, with the bottom paved with ſtone or ſome other materials, and a court adjoining walled in to give them their food. It is uſeleſs to litter the place where they lie, as they enjoy themſelves in a cooler manner on the pavement; and there is not one pig in twenty but what will go into the court where he eats his food, and evacuate. If this court is littered or ſtrewed with ſtraw, or for want of ſtraw, earth or ſand to abſorb the urine, and keep the dung from drying, and frequently cleaned out, a great deal of valuable manure will be procured, and by that means preſerved. Trivial as this obſervation may ſeem, it will be of more real advantage in practice, than will at firſt be imagined. Pig dung on meadow or paſture is of great utility; mixed with ſoil it is uſed to the beſt advantage; and the moſt proper ſeaſon to lay it on is when the graſs begins to grow in the ſpring.

SHEEP DUNG.

Is by experimentaliſts held in great eſtimation as a forcing ſtrong manure; certain it is that the folding of ſheep is much practiſed, and the ſucceſs attending it very great. But we do not believe it equal in virtue to either horſe or pig dung; as Mr. Davis, who made an experiment with the manure from pigs, made alſo the like from ſheep, in a much larger quantity per acre, which by no means anſwered his expectation.

Folding, or penning upon land, is ſufficiently known to need any particular deſcription, and when a large flock are managed carefully, and the fold not hurried too faſt over the land, a good purpoſe is anſwered. Land ſhould be ploughed as ſoon as poſſible after folding, otherwiſe no benefit is to be expected except from the urine, which it is reaſonable to ſuppoſe, is in ſmall quantities, as ſheep ſeldom drink, excepting when they live on dry food. Sheep are often folded on light hollow ſandy lands, and dry hard chalk, after the ſeed is ſown, particularly wheat; this is intended to tread the land, and to improve it by making it more firm, as well as to add ſome benefit by manure: care ſhould be taken and caution uſed in wet weather, alſo when the corn appears. We have known ſheep drove morning and evening over turnips, when the fly or ſlug has been ſuppoſed to be buſy; and doubtleſs to a very good purpoſe, although ſuch exerciſe is by no means ſervieeable to the ſheep, particularly thoſe which bear heavy fleeces.

To houſe ſheep on nights, and litter them with ſtraw or haulm, or for want of thoſe, with ſand or fine gravelly loam, has furniſhed topics for many writers; the PLATTS, and more particularly the celebrated CAPTAIN BLYTHE, recommended the cuſtom very ſtrongly, and with as many pertinent remarks, and as much to the purpoſe as any writer of the preſent day. This method on ſome kinds of ſoil would prove an admirable acquiſition; as a large quantity of excellent manure might by that means be obtained; to be uſed at pleaſure, and on ſtiff cold land, both that and the ſheep would be benefited. Covered houſes, open on both ſides are preferable with a court incloſed around according to the ſize of the flock.

On large paſture fields or downs, which are grazed on every ſummer, (if ſheep are not driven to fold on ploughed or arable land) the upper part of ſuch fields will be rendered very rich and fertile by cattle, (ſheep in particular) lying on thoſe higher parts, As the folding of ſheep on poor moſſy paſture is very improving, it would amply repay the trouble and expence to drive ſtore ſheep to fold to an adjoining paſture, which is occaſionally mowed for hay; it would be the means of helping land which wanted manure, without injuring that which was ſufficiently rich.

According to the preſent management of ſheep, their dung is not an important article in agriculture, any further than as they diſtribute it themſelves. There is not a doubt that care and attention, by houſing them on nights as before deſcribed, with racks to give them hay or other food, as may be thought proper, would be a great advantage, and when put in practice attended with very little trouble. Eating turnips off the land with ſheep, in a proper manner where the ſoil ſuits, is one of the greateſt points in the turnip culture. We ſhall be more particular on this ſubject under the head of turnips.

The obſtacle to new methods are very formidable in imagination, but deliberate perſeverance makes ſmall difficulties light and eaſy. Having deſcanted on the uſe and properties of manure raiſed from thoſe uſeful animals, which are conſidered neceſſary to the purpoſe of huſbandry in our own country, we ſhall proceed to the dung of poultry.

DUNG OF POULTRY.

By poultry we mean hens, ducks, geeſe, pigeons, and whatever birds our readers think proper to rank with them, as no injury can accrue from uſing them as manures indiſcriminately. Theſe contain large quantities of the eſſentials, which conſtitute ſtrong manures; and we believe principally to be attributed to birds not having any evacuation by urine, and their feeding chiefly on corn.

In inland countries, where rich manures are not to be purchaſed, it is an object worthy the farmers notice carefully to preſerve every thing, be the quantity ſmall or large, which can add to the fertility of the land. Prepoſſeſſed highly in favour of this method, we are certain a valuable ſource for manure lies neglected by the multitude with reſpect to the dung of birds. To litter with ſtraw, or lay ſand or dry mould where poultry lie, and clean them out often, and again replenith the litter, would produce more manure, and that of the beſt qualities, than any perſon not maturely

naturely conſidering the ſubject would imagine. We would recommend this manure to be uſed on meadow, paſture, or arable lands, particularly on thoſe of a cold nature, and are well aſſured, all trouble and expence would be fully paid. It is a cuſtom to uſe pigeons dung, by ſowing it in upon young wheat for the rain to waſh it in; ſome advantage may attend ſuch a practice; but ploughing it in on arable land is by far the moſt preferable method.

HUMAN ORDURE.

This ſhall be called, if you pleaſe, animal manure; but reſpect to our ſpecies prevented our connecting it with brute, although the word brute is frequently diſgraced by the compariſon.

An eminent writer on Agriculture ſays, "There is ſomething "diſguſtful in the thought of uſing the excrement of our ſpecies "for the dreſſing of lands, as it is putting it again down our "throats." This gentleman was certainly of a very delicate turn: as the celebrated DEAN SWIFT obſerves, "Nice people have the moſt naſty ideas." The greateſt part of the vegetables and roots uſed near the metropolis and other large places, owe their forwardneſs and luxuriant appearance to the fertilizing manure now under our conſideration. Of all others this makes the moſt exciting compoſt, and ſhould not be uſed until it has lain well mixed with earth, ſand, or clay, a conſiderable time; the mixture to ſuit the huſbandman's convenience, or the kind of ſoil he intends to uſe it upon.

Dr. Prieſtley, Mr. Young, Mr. Winter, and all the tribe of chymical and experimental farmers may diſpute, and try to diſcover the food of plants; but we defy any of them to find a more nutritive and ſubſtantial food for all kinds of plants than we are now ſpeaking of; if properly adminiſtered. This manure, as previouſly obſerved, cannot be obtained, except near large cities or towns; therefore, we adviſe thoſe who have an opportunity of getting it, by no means to let it paſs unnoticed; obſerving to mix it well with earth, and let it lie thick near twelve months.

2. *ARTIFICIAL MANURES.*

We deem thoſe manures artificial which are calcined or have undergone ſome proceſs before they are rendered of uſe as manure, and which we diſtinguiſh by LIME, SOOT, ASHES, RAGS, GYPSUM, &c. and improving land by PARING and BURNING, commonly called breaſt ploughing and burning.

LIME.

Uſing lime as a manure has been practiſed upwards of two hundred years in this country, and continues in uſe to the preſent time, which is certainly much in favour of its utility, and proof poſitive that it is advantageous. In ſome countries, where materials for fire are expenſive, it is uſed on land at the expence of eighteen-pence per buſhel; and perhaps fetched ſeven or eight miles diſtance, which conſiderably enhances the price.

Lime being a ſtrong alkali is ſuppoſed to fertilize land, by correcting and blunting the vitriolic acids with which moſt ſoils abound; when ſuch purpoſe is anſwered by deſtroying the effects of thoſe acids, it is ſuppoſed lime loſes its fertilizing quality and becomes uſeleſs, nay, ſome pronounce it injurious. In ſupport of this, it is generally known that lime is ſeldom uſed to much advantage after the firſt or ſecond dreſſing. In lime it is well known there is nothing of a nutritious or oily property, that can poſſibly be conducive to vegetation; and that mixed with earth in a proper manner, it ſtimulates the growth of corn and moſt other kinds of plants in a very eminent degree.

On ſome kinds of land we find it of no uſe whatever, whether the ſoil be poor or rich, conſequently it requires judgment to diſcern on what ſoil it is beſt to uſe it; and likewiſe the manner to apply it, in order to anſwer the purpoſe. Some account for the good effects of lime, in quite a different manner than that above-mentioned; namely, by attracting and drawing its enriching and fertilizing qualities from the atmoſphere; this opinion has for its advocate the *celebrated georgical* DR. HUNTER, and other ſcientific gentlemen. Such an idea as this deſtroys the common practice of uſing lime, mixed with earth or dung: and likewiſe the cuſtom of ploughing it in, as ſoon as laid on the land, as burying it muſt neceſſarily prevent its atmoſpheric attractions.

When doctors diſagree, how are farmers to determine?

By Mr. Young's leave, we will preſent our readers with a letter from the *Annals of Agriculture, Vol. 4. page 47.*

ADVANTAGE OF MIXING LIME WITH DUNG.

By ROBERT ANDREWS, ESQ. of AUBERIES, near SUDBURY.

"Cart the dung out of the farm yard ſome time in December, "and continue to do it as made in the following months, till the "heap amounts to about 120 loads, each 40 buſhels; if made "larger, the dung does not rot ſo well: when finiſhed, leave it "about two months, and then add 200 buſhels of lime, which is "ſold at the pit at 5d. per buſhel, mix the whole together immediately; but it is to be obſerved, that the dung muſt not be dry, "if it is, it will fire by being mixed with lime; let it lie three "months, and then ſtir it over again; the expence of the firſt "ſtirring is 1d a load, and of the ſecond ½, carry it on to the "pea ſtubble as ſoon as harveſt is over, and plough it in for barley; "if the ſeaſon does not ſuit for carting, take the opportunity of a "froſt; this management has anſwered ſo well, that upon an aver"age of 12 years, my barley crops have amounted to four quar"ters ſix buſhels per acre. I have at different times laid ſome dung "on without lime being mixed, and the difference was very per"ceptible; ſo that from many experiments, I find it neceſſary to "ſpread 12 loads an acre, inſtead of 10, which, with the lime, "is the uſual quantity.

"The benefit reſulting from the lime is to be attributed to two "circumſtances, firſt, it deſtroys the ſeeds of weeds, ſo that I "have always found the land cleaneſt where the lime mixture is "laid; and, ſecond, it brings the dung forwarder, by raiſing "the fermentation higher. The expence of the lime 10s. an acre, "which holds very good for four crops; and I have, in one in"ſtance, ſeen the difference of part of a field being manured with "lime muck, and the other part with muck without lime, four "years after it was ſpread."

This practical information from Mr. Andrews, a gentleman, according to Mr. Young, who ſtands very high in Agricultural experience, is a matter of much importance to thoſe who uſe lime as a manure, or who having it in their power, omit it for want of being informed of its effects. As a further confirmation of its merits and demerits, likewiſe its effects on various ſoils, the methods of uſing it as manure and other matters, eſſential to be known, we take the liberty to tranſcribe another letter from the Fifth Volume of Mr. Young's Annals, page 147.

By R. LEGRAD, ESQ. of GUILTON-HOUSE near SANDWICH.

"In the courſe of my huſbandry, I have frequently uſed lime, "ſometimes upon a large ſcale, and always with ſucceſs upon ara"ble land. General method, one buſhel upon a rod, covered the "ſoil till it is ſlacked, then ſpread abroad, and ploughed in.

"Experience juſtifies a better way, viz. hot as poſſible from the "kiln; ſpread it immediately upon the ſoil; and no more in a "day than can be ploughed in the ſame day. I have uſed it upon "ſandy, loamy, and clayey ſoils; all have been greatly improved, "but moſt ſo the ſandy. Upon paſture land, neither expence nor "expectation have been anſwered.

"I have applied it ſimply, and mixed with mould, making a "compoſt of 40 loads per acre, allowing 5 loads of lime to 35 of "mould. At the ſame time a portion of land in the ſame field, "and contiguous thereto, has been dreſſed with the ſame ſort of "mould well pulverized; the reſult has been, that the compoſt "was much better than the lime alone, and ſuperior to the mould "alone; both the lime and compoſt gave a more early and lively "verdure; but the ſuperiority was of ſhort duration. In the "compariſon of Chalk and Lime, it is neceſſary I ſhould ſay, "my experience is decidedly in favour of chalk upon arable land. "Lime alſo greatly cleans the ſoil from weeds, and eſpecially "deſtroys the wild marygold."

We cannot ſay too much on the diſintereſted and candid manner in which this gentleman acquits himſelf in his correſpondence with Mr. Young; from ſuch a ſource, every part of the community are benefited; and the Annals of Agriculture become reſpectable and inſtructive.

To this experimental information, we add the practice of Mr. Fowler, near Chipping Norton, in the county of Oxon. On paſture, the ſoil, a ſtiff clayey loam, he mixed mould, the ſhovelings of a lime ſtone turnpike road, and lime freſh from the kiln; about one-eight lime. This compoſt was collected and thrown together in the winter, and ſpread on the land early in the ſpring, about 10 cart loads to an acre. The reſult was the herbage which was before benty and thin, with a mixture of rye-graſs; (owing to the land not being laid down paſture more than eight years) entirely changed its nature, growing much thicker, and conſiſted of white clover and other ſweet graſſes. The cattle fed with avidity on the part manured, and while there remained a blade uncropped, would not touch that part of the ground which had not been dreſſed.

Mr. LEGRAND obſerves that lime gave a more early and promiſing verdure, but it was of ſhort duration. The ſame gentleman, a few years ſince, uſed lime on black ſour bad land, at the time it received a ſpring fallow for turnip; but was diſappointed in his expectation, both with the turnip, and the ſucceeding crop of barley. In all probability, in the laſt inſtance, the lime was not applied in a proper manner; in fact, we think it lay on the land a long time before it was ploughed in; a cuſtom certainly founded in error.

Upon the whole, it muſt be acknowledged, lime is a fertilizing uſeful article as a manure, but not of much permanence, or to be too often repeated on the ſame land; and on ſome ſoils not beneficial equal to the expence. Before a farmer runs into an expenſive uſe of lime, prudence ſhould direct him to try the experiment on a narrow ſcale, by ſelecting ſmall pieces in the midſt of fields, uſing different quantities with different mixtures, by which advantages might be anticipated, and loſs and trouble often prevented. The uſe of lime, in Agriculture, only comes under our conſideration in this place; directions for making, and its other uſes, are given under the Article LIME.

SOOT.

Soot, another artificial manure, which is alſo produced by fire, is of different kinds, being made from both wood and coal, uſed as manures: their effects are the ſame on vegetation, although long arguments have been uſed by various writers, as MORTIMER, HALE, and others, to adapt each to particular ſoils to anſwer their reſpective purpoſes.

We

We can, from experimental authority, aſſure thoſe who have an opportunity of uſing ſoot, that each kind anſwers the ſame purpoſe. On ſome kinds of paſture land, ſoot does not ſhew itſelf to the ſame advantage as on others; we have obſerved ſoot uſed at the rate of forty buſhels to the acre on a ſmall part in the middle of a meadow, where drift ſand had proved an excellent manure; the reſult was not viſible, as the ſmalleſt traces of improvement never appeared. We muſt confeſs this circumſtance is quite oppoſite to the general theory reſpecting ſoot, but thought it our duty to record it, as we ſaw the experiment tried. Thoſe who manure with ſoot are in general well ſatisfied with the advantages which ariſe from it; as appears from the following letter of R. LEGRAND, Eſq. extracted from vol. 5. p. 148, of the Annals of Agriculture.

" Soot is moſt evidently an excellent manure for paſture land. " Quantity 40 buſhels per acre. I generally dreſs from 7 to 10 " acres annually with it; and the ſucceſs anſwers every reaſon- " able expectation.

" One acre of lucerne, reſerved for my horſes, receives annu- " ally a dreſſing of 40 buſhels, and I am perfectly ſatisfied with " the reward it gives.

" N. B. One rod of lucerne, cut juſt before flowering, will " weigh upwards of one hundred weight."

This extract from ſo faithful a reporter of cauſes and effects as R. Legrand, Eſq. we look upon as a leſſon, which may guide thoſe who have not uſed ſoot as a manure.

It is frequently ſtrewed on young peas, and other kinds of grain, to deſtroy ſlugs and ſnails, and to a very good purpoſe. The time this ſhould be done is very early in the morning, or late in the evening, when thoſe inſects are out of the earth and feeding; as the eſſential part is loſt when it is uſed in the day time, by the ſun, air, or rain.

Soot is an alkali and oily compoſition, conſequently a ſtimulative and nouriſhing mature; the ſooner it is uſed after it comes from the chimney, the better it will anſwer the purpoſe; as, like other manures, its virtues fly when expoſed to the air. The beſt method of uſing ſoot is by mixing it well with earth, and on paſture ſpread it early in the ſpring; if rain comes ſoon after it is laid on the land it is fortunate, as by that means its virtues are waſhed into the earth. On arable land it ſhould be buried as ſoon as diſtributed, for the ſoil to imbibe its virtues.

Malt kiln duſt; and *malt duſt*, one of theſe is the ſweepings of the kiln, and the other duſt or roots ſereened from the malt. The former is greatly ſuperior in quality; as manure it is much like ſoot in its operation on land, and in general uſed the ſame. The latter is likewiſe uſed on land, but not with equal ſucceſs. They are both excellent to put in the houſes where poultry or pigeons lie, to mix with and abſorb the moiſture of their dung, and are improveable on arable or paſture land, but moſtly uſed on paſture.

COAL AND WOOD ASHES.

Mr. YOUNG has very ingeniouſly made various experiments on manures, and ſeems well ſatisfied of the good effects of wood and coal aſhes, as promoters of vegetation; particularly wood aſhes, when uſed on ſoils that abound with *vitriolic acid*. This language to farmers can only puzzle and make them ſcratch their heads, and ſhould they be promoted to conſult the rector, curate, or an apothecary, it is full twenty to one, they could not be informed whether the land contained *vitriolic* acid or not. As we hope to make ourſelves underſtood by farmers, we would adviſe them, when doubts ariſe, to make experiments on a ſmall ſcale, and then they may go to work leſs expenſively, with courage and ſatisfaction.

Coal aſhes, on rough ſour paſture, are an excellent manure, rendering what cattle would not eat ſweet and palatable to them; in truth, we will pronounce it unequalled in making coarſe paſture land ſweet and fine; and if you give a good dreſſing it will endure; we mean by a good dreſſing, fifty or ſixty buſhels to an acre. We have known wood aſhes uſed to much leſs advantage on paſture, and cannot by any means think them equal in value; they are ſometimes uſed on wheat and other corn in ſpring, but are not equal to ſoot. On all kinds of arable land, aſhes ploughed in with the ſoil are a valuable manure, the land ſhould work fine when manured with aſhes; ſuch kind of manures tend greatly to deſtroy weeds. Before Baſilla was ſo much uſed in making ſoap, wood aſhes were difficult to procure for the purpoſe of manure; but they are of late become more plentiful in ſome countries.

Soapers Aſhes are a powerful manure on arable or paſture land, they being a mixture of lime, wood aſhes or barilla, ſalt, and likewiſe ſtrongly impregnated with animal oil. This manure, judiciouſly uſed, ſweetens herbage, and is in every reſpect valuable. But Mr. WINTER *Author of the Compendious Syſtem of Huſbandry*, could not be ſerious when he recommends " one hundred and ſixty, or two hundred buſhels per acre, on paſture;" if that is his practice, we cannot wonder at his caution; that when " uſed to exceſs he has known it very hurtful, like a man drinking too much brandy."

What we call uſing it judiciouſly is mixing it with earth or dung in compoſt about an eighth or tenth part ſoapers aſhes, and then ſpreading about twenty load of ſuch compoſt to an acre early in the ſpring, if on paſture, and if arable when you plough for ſeeding.

WOOLLEN RAGS AND WOOL CLIPPINGS.

Woollen rags and wool clippings are a good manure for arable lands, on any kind of ſoil; the way they are uſed is by cutting them in ſmall pieces, like taylors ſhreds, ſowing them on the land before it is ploughed, about twenty buſhels to an acre, or more, as no one need fear injuring their land by laying on too much. This manure will endure a long time, and does not yield its virtue the firſt year; but will keep improving ſeveral years.

Dr. POTT, in his Hiſtory of Oxfordſhire, ſays, woollen rags were eſteemed a beneficial manure for land, in that country, at the time he wrote; and that they had been ſo according to tradition in remote ages. Woollen rags are to be purchaſed in large quantities in ſea-port towns, and other large places; and we aſſure the farmer, they are an article well worth his notice. To artificial manures may be added leather parings, horn ſhavings, pulverized brick, old mortar, and other matters from old buildings: theſe are of conſiderable ſervice when laid on coarſe paſture, or ſour arable; and ſhould by no means be neglected; for their uſe is very great, which experience will ſhew. As the benefits which accrue from paring and burning, more commonly called breaſt ploughing and burning, are by means of the aſhes, and the action of fire on the earth; we proceed next to

BREAST PLOUGHING AND BURNING.

This is likewiſe in ſome countries called bumbarting, and in others denſhiring, ſuppoſed to bear an alluſion to Denbyſhire, the county where it was firſt practiſed in this country. The antiquity of this practice is very great, HESIOD, VIRGIL, and COLUMELLA, make mention of it; and it is very probable, the Romans introduced it into Britain.

Matthew of Weſtminſter ſays, it was a practice in Wales to pare the turf from the ſurface, and burn it when dry, by which means the moſt barren land was rendered fertile. From theſe inſtances, it is doubtleſs an ancient cuſtom; and at this time, that large extent of hills called the Cotſwold Hills, in Glouceſterſhire, and Wiltſhire, are kept in cultivation by means of breaſt ploughing and burning.

Some gentlemen of landed property entertain a notion, that repeated ploughing and burning weakens and injures the land; to this we can only obſerve, that in the country we have above noticed, thouſands of acres have been breaſt ploughed, and burned once in ten years, ſometimes oftener; and ſometimes not ſo often for ſixty or ſeventy years paſt, and rents have kept riſing; inſomuch that lands, which let for four or five ſhillings per acre 30 years paſt, let now from ſeven to fifteen ſhillings; and are improved in quality. Although Mr. Young only rode through it, and called it an " ill-cultivated country," we can aſſure him, conſidering the natural poverty of the ſoil, this kingdom does not ſhew ſo large a track of land in better cultivation. It is true, thoſe drilling fancies are not ſo much in vogue as they are in ſome other parts of the kingdom; but ſummer fallows for wheat or barley, have given place to turnips for upwards of 30 years.

Spring ploughings and manure are the preparations for the turnip crop, which is ſucceeded by barley. Rye-graſs, clover, and trefoil, are generally ſowed among the barley. The land being generally broke up for wheat, if a turf of any ſubſtance is formed, it is generally breaſt ploughed and burned. Farmers have commonly a piece or two of ſainfoin, which laſts 12 or 16 years, which when broke up is invariably breaſt ploughed and burned, either for turnips or wheat; but the former is deemed the beſt management, and with juſtice, on the poor land with which the Cotſwold Hills abound. Better crops of turnips are not raiſed in England than in the barren hills of Glouceſterſhire, nor are they any where more carefully hoed; hoeing has been the general practice for more than 20 years; *but more of this, when we ſpeak of turnips.*

Breaſt ploughing and burning is a laborious exerciſe, but thoſe men who are accuſtomed to work at it perform it with as much eaſe and pleaſure as any other of the different branches of huſbandry. Many perſons have endeavoured to invent methods to perform the ploughing or paring, by means of horſes: but as yet every effort has proved ineffectual. It is particularly requiſite to pare the ſurface as thin as poſſible, that the aſhes may be free from the earth which is calcined or burnt, and therefore ſuppoſed of no ſervice to vegetation: it is alſo neceſſary to pare the turf thin, as it burns much the better, particularly in wet and damp weather. On land free from ſtones or gravel, it is probable, paring the turf to burn might be performed with a horſe or horſes; a method that would make the expence much eaſier; but on a ſtoney or gravelly ſoil, we think it impracticable.

Mr. WINLAW, of *Margaret-ſtreet, Cavendiſh Square*, has a paring plough which he made, and has ſold many of them, and of which he has received very favourable accounts; this ſeems the moſt promiſing machine we have ever ſeen of the kind. Breaſt ploughing is generally performed early in the ſpring, and the turf ſeldom burned till well dried by the ſummer's ſun: if it happens to be burnt long before the time of ſeeding, whether turnips or wheat, it is deemed good management to ſpread the aſhes and rib, or reſt balk, the land croſs-ways and very thin.

Ribing

Ribing or reſt balking is performed by ploughing a furrow, and leaving the intermediate ſpace unploughed, by which means the ſurface of the ploughed furrow and that unploughed, lie one upon the other, and incloſe the aſhes between them; this prevents the wind and air from exhaling the virtue of the aſhes, and when ploughed acroſs at ſeed time ſomething deeper, mixes the aſhes and ſoil duly. This method frequently makes, what a farmer calls, rough work; for wheat, we make no doubt, ſuch rough ſituation of the ſoil is preferable. We have known breaſt ploughing and burning performed early in the ſpring, and barley ſowed; but it is ſeldom the weather will permit, and the method is by no means adviſeable. Breaſt ploughing and burning rough grunſward has been uſed advantageouſly, particularly on freſh boggy land full of ruſhes, ſegs, and other plants uſual on wet ground.

Mr. ROBERT LINE, a young enterprizing farmer, of Rendecombe, near Cirenceſter in Glouceſterſhire, breaſt ploughed and burned a conſiderable quantity of newly drained land; and on its not becoming fine the next ſummer, ſerved it the ſame the next ſpring, which made a very valuable, although expenſive improvement. Such exertions as theſe deſerve every encouragement, and a gentleman of diſcernment will always reward a tenant who ſo earneſtly endeavours at improvement.

In burning the turf, care ſhould be taken to attend the heaps while they are on fire, and cover in the ſmoke, when it is ſeen to riſe rapid; this is done with thoſe looſe turfs which fall down on the ſides of the heap, and one perſon will be able to attend an acre: by this care the aſhes are rendered ſuperior in quality. We preſume it will be uſeleſs to give further deſcriptions of paring and burning, as the practice is old and general. If in any country there ſhould be men and their families wanting to perform ſuch labour, in a proper manner, we are well aſſured 50 might be raiſed on the Cotſwold hills in Glouceſterſhire, in a few days, who would go 100 miles, or any diſtance, if they could meet with a ſummer's labour; the price of ploughing, burning and ſpreading the aſhes, is from fourteen to twenty-ſhillings per acre.

As a further confirmation of the great utility of burning and paring in the improvement of waſte land, we ſhall preſent the reader with the following extract of a letter from the 17th Vol. of the Annals of Agriculture, page 356. by ABRAHAM WILKINSON, M. D. of Enfield Chace.

"I am confirmed in my opinion, that nothing is equal to paring and burning for the improvement of waſte lands. My two ſucceſſive crops, peaſe wheat, and oats wheat, have been great. The wheat after the peaſe better than what ſucceeded the oats, beſides eſcaping the inconvenience of the oats ripening among the wheat and injuring the ſample. It has been aſſerted, with confidence, that paring and burning is loſing ſoil in the air. This is an aſſertion plauſible in theory only; experience, I am perſuaded, is againſt it; the bad management of the ſucceeding crops, and the frequent repetition of corn, injure the land, and not the operation of burning. I will venture to aſſert, that I have a greater depth of ſoil where I pared and burnt than I had before. Any perſon following the plough as it breaks up the wheat ſtubble, would agree with me in opinion. It turns up a looſe black garden mould of conſiderable depth.

"This, I apprehend, is eaſily accounted for, by attending to the action of burnt clay, as a mechanical manure, which, when ploughed into ſtiff land, breaks its adheſion, and, aided by the vegetable aſhes, converts it into good loam. I am happy to find my own obſervations confirmed by ſo able and ſpirited a cultivator as Mr. Wilks; his great exertions in agriculture and manufactures challenge the eſteem and applauſe of his country. Fire and water, I conſider with him, as of more conſequence in raiſing manure than farmers in general have as yet viewed them; not being able to procure hands for paring and burning part of my Chace land, I ploughed and croſs-ploughed the turf, and then burnt it for manure with ſucceſs. Burning the turf ſecures the crop from that injury from the worm, to which an freſh land it is ſo much expoſed. With my beſt wiſhes for your continual health, I remain,

"Your obedient humble ſervant,

Dec. 31, 1791. "ABRAHAM WILKINSON."

3. *NATURAL MANURES.*

By natural manures, we mean ſuch as are uſed without any previous preparation, by fire or artificial proceſs, as MARLE, CHALK, LIME STONE pulverized, SEA SHELLS, and the effects of one ſoil upon another. It is proverbial with old farmers, "*that ſomething may be always diſcovered by digging in the earth, which will enrich the ſurface.*" How unfortunate to Agriculture ſuch an idea is not more frequently put in practice! This is a maxim well known, but ſeldom attempted. To account for this remiſs conduct in huſbandmen, we need look no further than the expence attending ſuch improvements.

MARLE,

Wherever it is found, is certainly a great acquiſition, and in thoſe countries where it is not ſought after or regarded, undoubtedly there is a groſs neglect. The criterion by which Marle is known is its fat and ſlippery appearance, when rubbed in the hand; after being wetted, it falls to pieces like dry fuller's earth, or quick lime. If a piece of Marle lies expoſed to the ſun and air, it tumbles to pieces, bearing ſomething of a hoary appearance. If the dry powder is thrown into a briſk fire, it will crack like ſalt when caſt into the fire. Another method, by which Marle is proved, is putting it into water; if it effervesces, or ſparkles in the water, this trial is deemed ſatisfactory Marles are of different colours, as blue, white, red, and yellow; the colour makes little difference, provided the quality is of an enriching nature. Sometimes Marle is diſcovered near the ſurface, but generally deep and below different ſtrata of clay, rock, or mould; and as the quantity neceſſary to render ſervice to land is conſiderable, the expence of marling is very great.

To give a proper idea of marling and claying, we are confident Arthur Young, Eſq. as a friend to improved Agriculture, joins us, in commending the practical and concluſive opinions on the ſubject given by Mr. W. Macro, in the Ninth Volume of the Annals of Agriculture, page 117. As ſuch genuine information cannot be too much diſſeminated, we ſhall give another extract, and although rather too much at large, conſidering our plan, which is to treat of every ſubject, we are well convinced thoſe of our readers whom it concerns will think it much too ſhort.

On the Expence and Profits of Claying and Marling, and how far it anſwers for a common Farmer to be at all the Expence himſelf.

By Mr. W. MACRO.

"I Promiſed to give you my opinion in writing, why I thought Claying and Marling did not anſwer to a common farmer, even on a 21 years leaſe, although he might in that time improve the lands ſo as to be worth two or three ſhillings an acre more to the landlord.

"As a well-wiſher to all improvements in Agriculture, I am ſorry to find, that it is now quite out of faſhion for the proprietors of lands to bear any part of the great expence that attends Claying and Marling, and which, on that account, falls cruelly heavy indeed upon the common farmer, that has a taſte and ſpirit for improvement; and who, too, after ſpending a ſum of money nearly equal to the value of the lands he improves, lies under a certainty, I may ſay, of not enjoying the benefit of them for little more than 15 years, without the ungrateful return for all his labour and induſtry, that of being obliged to pay an advanced rent for his own improvements.

"To begin with the expence: the firſt is the filling, which including ſpreading is 25s. a hundred, or 2d½ a load, with an allowance, by ſome farmers of 2s. 6d. by others of 5s. for opening the pit; and 1s. a load for all the large ſtones they throw out at the time of filling, the farmer to find drifts and ſtakes, for letting down what they call the falls. The team muſt conſiſt of four ſtrong trace horſes, and two ſhaft ditto, which, for ſuch ſtrong work, muſt have very high keeping; I cannot, therefore, lay their labour at leſs than 2s. a day each, and the carter at 1s. 6d. a day, which, ſuppoſing they carry one day with another, (allowing for wet weather, and hindrance by accidents, &c.) 30 loads a day will be about 5d½ per load more, making in the whole 7d½ a load, for filling, carting, and ſpreading. As farmers differ in their opinion about the quantity that ſhould be laid upon an acre, ſome preferring 80 loads, and others 70, I will take the medium, and ſay 75 loads, which at 7d½ a load is

Per Acre	£.	s.	d.
Harrowing and rolling ſeveral times to pulverize and ſpread it equally on the ſurface, per acre	0	1	6
Picking the ſtones up and caſting off, where uſed for the highways	0	0	9
Loſs by the ſtones thrown out by the labourers in the pit, the farmer ſeldom making half the money of them again, about a load to 70 loads of clay	0	0	8
Wear and tear of carts and harneſs, including accidents, at a farthing a load per acre	0	1	6½
Drifts, ſtakes, &c. &c. per acre	0	0	8
Loſs of ſeed, as it ſhould always be laid upon a layer, and lie ſome months before it is ploughed in, per acre	0	1	8
	2	12	6
Intereſt of the above ſum, for two years and a half, as it will be ſo long before the farmer gets any of his money into his pocket again	0	6	6½
	2	19	0½

"The next expence the farmer has to encounter, and which muſt ever be a bar to all improvements in Agriculture in this kingdom, as the laws now ſtand, is the tythes; for no ſooner has he been at the expence of carrying a thouſand or two thouſand loads of clay, or marle, than his good rector comes and demands a larger compoſition.

"The farmer's argument, that he has been at all the expence, and has not yet got his money into his pocket again, is of no avail; for he tells him, that the tenth of all his paſt and future improvements are, by the Engliſh laws, as firmly veſted in him and his ſucceſſors, as if a tenth part of the expence had been taken from his (the rector's) own pocket; therefore, if he will not give him ten or fifteen pounds a year more for the next three years, he muſt draw his tythes. The farmer unwilling to have the tythe cart come and carry away a part of the improvements, ſo recently laid on, ſays, he will agree to the advance, provided it is for the remaining part of his leaſe, if they both live ſo long: No, ſays the rector, as

you are going on with your improvements, at the three years end, my tythes will be worth more, and so on the next, and the next three years; and so it is, I suppose, that some improved farms in Norfolk (as I have been informed) have before the first leafe is expired, paid nearly as much tythes as they did rent.

"Of this, I shall take notice again in another place, and return to the £2. 19s. 0d.½, which sum being money sunk upon another person's estate, the interest of it is not only an additional rent to the farmer of about three shillings an acre, but he is in all fairness in the course of his term, to be reimbursed, the principal likewise; and which sums added together, allowing for the decrease of interest, as the principal is paid off, I calculate to amount to 5s. 6d. an acre per annum; which, supposing the rent to be 5s. an acre when the farmer enters upon his farm, more than doubles it, from the time of improving till the leafe expires.

"I will now calculate the improvements, and compare them; but before I do this, it will be necessary to remind you, that there are many lands where the clay or marle beneath the surface is so intermixed with sand, that there are many hundreds of loads carried that yield no improvement at all; another thing is, that supposing the marle, &c. good, yet if the carriage is long, or it is laid on thirtable fields, which are subjected to two crops, and a fallow, I am of opinion that in this case likewise it never pays half the expence; because, being obliged to plough the clay or marle in directly, it is sunk and lost before it ever incorporates properly with the soil; these failures, therefore, may fairly be laid at one fifth of the lands covered.

"To proceed to the calculation of the profits from the produce, I will throw the lands into the following course. First, pease dibbled, or oats harrowed in, upon the flag with one ploughing; second, turnips; third, barley; fourth and fifth, layer for two years. Now as lands thrown into the above course would, by rest, and taking only two crops of corn, and one of turnips, in five years, be in a state of improvement without clay or marle; I can say the additional produce to each crop, on account of the clay, &c. (supposing it answers the farmers wishes) would only be as follows:

	£.	s.	d.
1. If with pease one comb, or if with oats, six bushels per acre..	0	12	0
2. Turnips per acre	0	4	0
3. Barley per acre, six bushels	0	15	0
4. Layer per acre, first year	0	4	0
5. Ditto second year	0	2	6
	1	17	6
Deduct 1-tenth for tythes	0	3	9
	1	13	9
The 5th of which is	0	6	9
But as 1-fifth of the claying fails of improvement, 1-fifth of this sum must be deducted	0	1	4
Extra profit on account of the clay, &c. per acre	0	5	5

"If I am right in the above calculation, (and if not I wish to be set right) a farmer who has spirit to improve another person's estate, by clay and marle, may, in the course of a 21 years leafe, get nearly all his money into his pocket again: but then you will say, that the great expence being over, he will have the advantage in the next leafe: certainly, as he has had no advantage in the first term, his landlord can and ought to give him some in a second; but there is no tie upon him, but honour and gratitude; and if the tenant is not in better luck than some folks I could name, he will find upon a new agreement, that he will have to pay very dear for improvements made wholly at his expence, or be obliged to turn his back and leave them. Yet far be it from me to suggeft, that there are not some worthy characters, that have nobly and generously said to a tenant at the expiration of a leafe, "I know you have been at a very great expence in improving my estate, therefore, go on and enjoy it at the old rent, so long as we both live." Two or three instances of this sort have come within my own knowledge; I wish for the encouragement of improvements in Agriculture, I could say 20 or 30.

"But suppose there were more instances, and a farmer was lucky enough to begin to improve a large tract of land, under one of those worthy landlords, before a 21 years leafe was expired; it is odd, but he might be dead, and his heir might be quite a different character; or, if as good a one, I am sorry to say it, there are too many fools, nay knaves, they ought to be called, of farmers, that would endeavour to spoil him by going secretly, like a thief in the night, and offering all the rent that his industrious tenant has, with great toil and expence (which he is not again repaid) made it worth, and by so doing, bring it to what I observed above, that he must either pay a full rent for all his own improvements, or leave them to be enjoyed by a villain. From this unfair, unneighbourly behaviour, arises a double expence; for no sooner is it known that A has offered 50l. a year more for B's farm, and the latter unwilling to turn his back upon all his improvements, has given the advance offered, (for his landlord could not refuse him the first offer) than his neighbours in the parish begin with him; first, the overseer puts 4s. and 2d. more into every poor's rate, which supposing them four or five shillings in the pound, as they are in many parishes, and daily increasing, say only 9l. a year for them; then comes the surveyor and calls for six days work more, with another team on the highways, which, if compounded for, is often 11. 16s. more; but say, 11. 7s. which is the least; the 50l. advance is then got to upwards of 60l. to this must be added, the advance of tithes, which 19 times out of 20 is more in proportion than the advance of rent.

"The above, Sir, without dwelling any longer upon the subject, I should think sufficiently explains what I advanced, that there are too many obstacles in the way, to make it prudent for a common farmer to improve by claying or marling, (wholly at his own expence) a large track of light lands on another person's estate, even upon a leafe of 21 years; indeed, it is my opinion, that it seldom answers in the first, and often fails in the second leafe, by a farmer's giving too great an advance of rent, rather than turn his back upon his improvements; for, if he is once led to give a little too much rent, he is next rated higher to the tithes, higher to the poor, higher to the church, and higher to the highways; in short, there is no end that I can see, but utter ruin. I should think, therefore, that it would be only fair and just, for gentlemen, after their tenants have laid out a thousand pounds of upwards, (or less if the occupation is less) in improving their lands, to renew their leafes at the same rent for 21 years, from the time the last years improvement was laid on, provided they went on with spirit, and got through the whole in seven years, from the time of entering upon the farm; this, I must take the liberty to say, is the least a gentleman can, or ought to do, to encourage a tenant, that has a spirit to improve his estate at his own expence.

"I would not have you or your readers think, that I write this paper to discourage improvements in Agriculture; quite the contrary; I believe it is well known, that I contradict such an idea by my practice: all I aim at is, to lay what is termed the *saddle* upon the *right horse*, by cautioning young spirited farmers to consider a little, and have some good grounds to go upon, before they lay out great sums of money upon another person's estate, and I wish at the same time, to give land owners a hint, that it is their duty, as well as interest, to assist their tenants in so expensive an undertaking, as that of improving their light lands by clay and marle."

In addition to this we shall make another short extract from the same gentleman, vol. I. p. 286, Annals, &c.

"From trials and observations I am clearly convinced that 70 cubic yards is the best quantity to be laid upon an acre of land. If more be laid on, the longer it will be before it incorporates with the soil, and of course, the longer before any benefit can be received. I once knew an instance where a farmer laid on 120 yards per acre, and after an expence which would have purchased the fee simple of the land, no benefit could be perceived.

"No pains should be spared to break all the lumps: and get it fine by repeated harrowing and rolling, otherwise claying and marling seldom answer, where you go on with a course of ploughing in the old way. Little need be said about the different quality of clay or marle, as every one must be content to use such as is found on his premises. Clay that is freest from land, and marle that is soft and greasy, are certainly the most valuable. And even blue clay that is condemned by most farmers I have found answer very well on light sand; but they generally lie at too great distance from each other to be prudently got together.

"I have a scheme in agitation, on a small scale, which I mean to execute: and which I expect to be very much condemned for; that is, to sink a pit upon a stiff, clayey soil, and carry it about half a mile to light sandy soil; to keep a standing cart at both places, and take off as many loads from the surface of the latter and bring back: so that when I have clayed a few acres of land, I shall have sanded about the same number of acres of clay land."

We beg pardon of Mr. Macro for the liberty we have taken in abridging his letter, as we do assure him it was a painful task to lop off a syllable from so useful a subject so well treated. Our comments on these extracts would be useless, for they want no elucidation. Did every gentleman feel so justly for that profession to which he so honourably belongs, Agriculture would be considerably improved; as the source of all great and expensive improvements should originate with the proprietor of land, and not with a tenant, who is subject to the caprice of his landlord. Marle is unquestionably the most antient of natural manures, and, well mixed and worked fine with the soil, adds vigour to land of any kind, that has been exhausted by cultivation. On pasture marle is likewise useful, provided it is of a good kind: the only way to ensure success is, to make a small experiment, as precepts cannot be infallible, and examples speak for themselves.

CHALK.

Chalk is beneficial as a manure on stiff clays and sand, as it is likewise on other soils, where it does not compose a part of the soil by nature. Chalk of the soft kind is best suited as manure for gravel or sand, and that of the stony or hard kind will answer best on clay or stiff loam. Hard stony chalk is burnt into lime, similar in quality to lime made from stone.

A gentleman of experience in Kent says, "In comparison of chalk

chalk and lime, it is neceſſary I ſhould ſay my experience is in favour of chalk." As a further inſtance of the great eſtimation in which the Kentiſh farmers hold chalk, Mr. YOUNG informs us "it coſts them 20s. per load by the time they get it home: that they lay from 5 to 8 loads on an acre, either on a clover lay that it may be waſhed into the earth before it is ploughed, or on ſummer fallow; and that the effect is equal to the beſt rotten dung, and laſts 15 or 20 years. On loam it anſwers the beſt: in fact, he ſays it performs wonders. This is certainly valuable information for thoſe who have it in their power to procure chalk, and are ignorant of its value as manure. We are now led to an article little known as a manure; namely,

LIMESTONE PULVERIZED.

Limeſtone broke into ſmall pieces certainly adds fertility to ſeveral kinds of ſoil, as clay loams, which have not previouſly a mixture of ſmall ſtones or pebbles, and alſo a ſandy loam without ſtones. The method of enriching lands by means of ſtone chippings is mentioned by Dr. Plot in his "Hiſtory of Oxfordſhire," as a cuſtom in common uſe in ſome parts of the country; which deſtroys all doubts of its antiquity. The effect of ſtones promoting vegetation on cloſe ſtiff lands may be rationally accounted for, without even admitting they poſſeſs any alkaline quality. In the firſt place, ſoil with a mixture of ſmall round ſtones is preferable to one of the ſame kind without any: this hypotheſis we believe is invariable. The reaſon of ſuch an effect in ſtones we apprehend proceeds from their breaking and dividing cloſe ſoils, thereby giving room for the roots of plants to ſtrike; and as they render the texture of the land more looſe, the ſun and air have an eaſier admiſſion, and conſequently their benign and fertilizing influence have the power of acting with the greater force.

Where coals are expenſive, and other firing ſcarce, lime is a very chargeable manure. We have not the leaſt doubt but lime ſtone beat ſmall would anſwer every purpoſe of lime, particularly on ſtiff, cold land: ſhould this be the caſe, a valuable ſource for manure lies unexplored; as the breaking and preparing ſtones for lime is attended with an heavy expence, breaking them ſtill ſmaller would not be a material addition. But this being ſpeculation, as we have never known it tried, we hope the reader will judge for himſelf, and excuſe the hint we have given; and we will introduce a manure which has been tried with the greateſt ſucceſs; this is LIMESTONE reduced to powder in a turnpike road. This, as a manure, was introduced to practice by Mr. Richard Davis of Kiteborough, near Morton in Gloucesterſhire, between 30 and 40 years ſince. The ſoil of this farm was of a hollow, cold, loamy, nature, ſubject to grow furze and a long coarſe graſs, and very uncertain for corn. Thinking the ſoil wanted ſomething to give it firmneſs, he carted the cleanings from a limeſtone turnpike road (which runs parallel with his farm) upon a ſummer fallow for wheat, about 30 cart loads to an acre. The ſucceſs which attended this firſt effort was beyond his moſt ſanguine expectation, and was a ſufficient ſtimulative for him to proceed. The ſhovelings, or cleanings of the road, which had, from the time of its being firſt made a turnpike, been thrown by the road ſide as uſeleſs, were ſoon conveyed by Mr. Davis upon his farm, and their effect was much greater than the beſt horſe dung. One year in particular he carried ſomething more than 1000 loads on a piece of fallow of about 15 acres, and the reſult was equal to the quantity. Four quarters of oats upon an acre previous to the diſcovery of this improving manure were deemed a good crop, but ſince he has had 8 or 9 quarters upon an acre. Theſe improvements have not been confined to arable lands alone, but have been found equally beneficial to meadow and paſture, as it produces white clover, and other ſweet herbage, where the moſt rough and ſour graſs grew before.

It is neceſſary to remark, that the lime ſtone of which we are ſpeaking is ſoft in its nature, by no means of a proper ſubſtance to make roads; but upon the road we are noticing it is *Hobſon's choice*, that or none. After theſe ſtones are laid and broke upon the road, if rain follows very ſoon, the heavy carriages which paſs quickly reduce them to the conſiſtence of a very ſoft mud, which is raked or ſhovelled off, and is, as a manure, ſuperior to any thing which can be procured. To uſe it generally on all kinds of ſoil, it might not be equally efficacious, as on the hollow wet land we are mentioning; but we have every reaſon to believe it would anſwer a very good purpoſe on any kind of ſoil, as we have known it tried ſucceſsfully on ſeveral. On a rich ſtrong loam in particular it has a very good effect; and with one fourth of good mould it will produce cabbages of a very large ſize; theſe we imagine are proofs of its general utility as an excellent manure.

Mr. Davis, the gentleman who has the credit of firſt uſing the cleanings of a lime ſtone road as a manure, has acquired a very conſiderable fortune, and with pleaſure attributes no ſmall ſhare of his great ſucceſs to the diſcovery; he is now retired from buſineſs, and enjoys the reward of his integrity and induſtry; making himſelf a uſeful member of ſociety, unambitious of any other diſtinction than that of an Engliſh farmer.

As with marle, the ſame care ſhould be taken with lime ſtone road cleanings, to mix it well with the ſoil; for which purpoſe, it is a good method to ſpread it on clover, or other graſſes, ſome months before they are ploughed for corn; the rains waſhing it into the earth makes it incorporate more intimately with the ſoil. Otherwiſe on fallows, when they are clean from weeds and worked fine. Winter being the ſeaſon roads want cleaning, what is thrown in winter or ſpring may be carried and ſpread upon paſture, and meadow the following autumn; as the winter rains will waſh it into the earth before ſpring, and the land receive benefit in the ſummer. Let it be noticed, that the virtues of this manure are not exhaled by the air and ſun, like animal and artificial manures. Should any doubt ariſe, or the foregoing account prove unſatisfactory, we are of opinion, the gentleman who has uſed it with ſuch ſucceſs would willingly give his ideas to any gentleman on the ſubject with pleaſure.

MUD.

Mud is of different kinds and qualities, according to the ſource from whence it is collected; if the drainings of yards, or the waſhings of rich hills, run into ponds, or ſlow running brooks, the mud or cleanings are valuable; and if from barren hills, or poor unmanured clays, its virtues are not of much conſequence. Mud ſhould be thrown out of ponds and brooks a conſiderable time before it is uſed, and if mixed in compoſt with lime, is reckoned the moſt advantageous way of uſing it on land; or if aſhes made from either coal or wood can be procured, they may be mixed with mud to a good purpoſe. As this is the reſult of univerſal experience, we by all means recommend it to the practice of thoſe who have it in their power to procure mud to mix it with lime, or aſhes. When it has lain in compoſt a few month, it will be found an excellent manure for paſture or arable, and the poorer the ſoil, the greater will be the advantage. We will now conſider the virtues of

COMMON SALT.

The Scotch Encyclopædia pronounces ſalt ineffectual, as a manure, which we deny; as experience, the moſt ſatisfactory of all evidences, proves the contrary. Common ſalt, loaded with the heavy duty government have at different times laid upon it, is ſo expenſive an article, that its virtues muſt be great indeed, to compenſate for the expence, if uſed as a manure. But there is a cheaper kind to be obtained at all places where ſalt is made, which is the cleanings of the pans or boilers, and called foul ſalt, and is an incruſtation of the ſalt to the ſides and bottoms of the pans, occaſioned by the heat of the fire. This is ſold very reaſonable, and is always attended by an officer to ſee that it is made uſe of as manure only. It has been uſed round *Droitwich in Worceſterſhire* as manure, as long as ſalt has been made there, and with ſucceſs: to proportion the quantity to the ſoil ſhould be attended to with care, as too large a quantity is very injurious.

The following communication of R. Legrand, Eſq. to Mr. Young, Annals, &c. Vol. 5. p. 149. contains a decided proof of the efficacy of ſalt.

"Having tried it upon a ſmall ſcale, upon a ſandy ſoil, I can aſſert ſixteen buſhels to be a proper quantity for one acre: it gradually advanced in its effects to 16, and as gradually diminiſhed to 40 buſhels, when vegetation was deſtroyed. Twice only have I had an opportunity of buying a few tons of foul ſalt, and uſed it both times upon a barley tilth; ſowing the ſalt immediately after the barley, the event was perfectly ſatisfactory.

"The verdure in the ſpring exceeded any thing of the kind I ever ſaw, and the ripened appearance was whiter by many ſhades than I ever beheld.

"N. B. Salt is noxious both to weeds and vermin."

If ſalt is uſed on paſture it ſhould be mixed well in compoſt, with mud or loamy earth, 15 or 20 loads of earth to one of ſalt, and turned in the heap two or three times to incorporate it properly. This compoſt ſhould be laid on and ſpread in autumn; a common mould dreſſing will be ſufficient, and there are few kinds of ſoil but will be benefited.

VEGETABLE MANURE.

It has been cuſtomary in many places, particularly in England, to ſow buck wheat, vetches, &c. and then to plough them in for manuring the land: this being ſimilar to that operation of nature by which ſhe renders the uncultivated ſoils ſo exceedingly fertile, cannot fail of being attended with ſingular advantages; and might be looked upon preferable even to laying dung on the land to fatten it, was it not attended with the entire loſs of a crop for that year. Where manures cannot be obtained, and on outlying lands, ploughing in thoſe ſucculent plants is certainly good management. Before ſuch management is attempted, the ſoil ſhould be cleaned from weeds, and after the crop is buried, ſhould be rolled with a heavy roller, which will be the means of facilitating fermentation.

This method will anſwer on any kind of ſoil, and ſhould be put in practice in the following manner. Sow winter tares or vetches in autumn, and mow or eat them off the ſpring following; and immediately, on one ploughing, ſow buck wheat, which plough in and roll, and the land will be in excellent condition for wheat, or the more ſo for barley the next ſpring.

GYPSUM.

Gypſum, in the form of powder, has ſometimes been highly celebrated in many countries as a means of promoting vegetation. Its utility in all probability has been ſhewn only relative to a certain

tain kind of ſoil; as an univerſal manure it can hardly be recommended. In one reſpect it may act as a mere meagre earth; but beſide this, it may alſo as a ſoluble earth enter in the compoſition of the proper nutritious parts of vegetables, and help to promote their growth, by the addition of ſolid matter. It is ſtrewed ſhortly after or before rain, or in general, when the leaves of the plants are wet with rain or dew, upon meadows in February and March, as ſoon as the ſnow is melted; and upon ploughed land ſoon after the ſeed is put into the ground, in the ſpring or autumn; and upon other field-plants, ſuch as coleſeed, turnips, pulſe, and clover, while they are young. It is ſtrewed as thick as rye is uſually ſown, and ſometimes twice as thick, and muſt be repeated annually. It is chiefly ſerviceable upon dry, light, and hot ſoils; while, on the contrary, upon cold, ſhaded, or wet ſoils it is prejudicial. It is a ſure and eaſy remedy againſt the fleas that infeſt vegetables, alſo againſt ſnails and mice.

Before we enter on the next Head, we ſhall give the following Extract from YOUNG's Annals.

EXPERIMENTS ON GYPSUM.

By R. PROCTOR ANDERSON, *of Henlade, Somerſetſhire.*

"DEAR SIR,

"Laſt ſpring I procured 2 cwt. of alabaſter, or gypſum, from "a rock at Hurcott, near Somerton, in this county, at 2s. 6d. per "cwt. at the quarry, which I got beaten to powder with ham- "mers, and ran it through a fine hair ſieve, or cleanſing range, "and then through a malt-mill, which was not injured by the "operation; but to pulveriſe it on a large ſcale in this manner "would be too expenſive for the farmers practice, if it were to be "much uſed for a manure.

"The 2 cwt. produced about 10 pecks in powder; a peck of the "powder weighed 21lb. 10 oz. At the rate of 6 buſhels to an "acre, it would be 1lOz. 4¾ to a ſquare yard; at that rate, "cwt. is ſufficient for an acre, and 41lb. allowed for waſte. "The rough material at the quarry 12s. 6d. per acre; but there "are rocks againſt the ſea, in this county, near Minehead [redacted] "Devonſhire, on the ſouth coaſt, near Sydmouth; and moſt "likely on the ſea coaſt in moſt parts of the iſland, which may "probably be come at on more eaſy terms. The difficulty will "be, to reduce it to powder at a ſmall expence, if it ſhould be "found anſwerable.

"In April and May laſt, at different times in gentle rains, on "five different places on a clayey ſoil, on a paſture laid down "more than twenty years ago with rye-graſs, I ſowed in each "place one peck of the powder; alſo one peck on fallowed in its "fifth year's growth: one peck on young oats; and one peck on "ſpring vetches or tares; all at the rate of 6 buſhels per acre, "and it has had no apparent effect on either of thoſe places.

"But on the ſame day on which I ſowed 4 pecks of the above "experiments, viz. April the 13th, I ſowed 1½oz. of this flour "of gypſum on a ſquare yard of graſs ground, where no ſtock "goes, which was laid down 16 or 17 years ago, partly with "Dutch *clover* ſeed. *There* (the ſoil an heavy loam), from the "middle of May to the end of June, when it was mown, the graſs "was greener than that around it. In the beginning of July "ſlight rains falling, it appeared greener, and by the end of Au- "guſt, the graſs on that ſpot was not only greener, but thicker "and higher, and the leaves of the Dutch clover broader than on "the outſides of it. Auguſt the 31ſt it was mowed again, and "the ſame appearances enſued and continued until the 10th of "November, when it was mowed again. It is obſervable, that "at the time of ſowing the gypſum powder, the wind blew S. E. "and it is viſible to an inch how far beyond the line, and from "peg to peg, the powder was blown towards the N. W. From "hence I conclude, ſo far as my experiments go:

"That on many plants, or in many ſoils, or both, gypſum "powder will have no effect; but that it has an effect on old "clover in a loamy ſoil; and that a greater effect may be rea- "ſonably expected from it, when applied to the younger plants "of the ſame ſort or nature.

"I am, dear Sir,

Henlade, Dec. 28, 1791. "Your obedient and obliged ſervant,

"R. PROCTOR ANDERDON."

ONE SOIL USED AS MANURE ON ANOTHER.

The preparation or melioration of a tract of land conſiſts, on the one hand, in the artificial production of the *compoſition* or *elementary mixture* neceſſary for it, or of that kind of coheſion, which a fertile ſoil naturally ought to have; and, on the other hand, of imparting *nutritious particles* to it, or augmenting the number of them, accordingly as either the nature of the ſoil or the vegetables that are to be cultivated in it, require.

In the firſt of theſe views, conſequently, when the requiſite compoſition does not naturally ſubſiſt in the ſoil, it is neceſſary to produce this by mixing with the ſoil other kinds of earths fit for the purpoſe. This may be eaſieſt done when theſe kinds of earths, as is ſometimes the caſe, do not lie deep under the ſurface of the true ſoil; thus ſometimes a clayey ſoil is found underneath a ſandy one; by the commixture of both which a fertile ſoil may be produced. Here nothing more is requiſite than ploughing or digging to a tolerable depth. The affair is ſomewhat more difficult, when the earths that are to be mixed with the ſoil muſt be fetched from ſome diſtance. But, when the earths are not to be found within a moderate diſtance, ſo that the expence would amount to more than the profit, in this caſe nothing more can be done by art.

Sand, or a very *ſandy earth*, do not of themſelves contribute eſſentially to vegitation, becauſe they poſſeſs no ſoluble parts. They can both only accidentally prove of ſervice, when they are mixed with clayey or marſhy ſoils, in as far as they diminiſh their ſtiffneſs or hardneſs, promote the exſiccation of them, and give them more warmth. A *looſe turfy ſoil*, by the weight of the ſand, is made more compact, and conſequently fitter for uſe. But as mere ſand cannot be perfectly and uniformly diſtributed among moiſt clay, in this caſe ſome other ſandy earth is frequently preferable for this purpoſe.

Clay, or *an earth mixed with much clay*, promotes fertility alſo, ſo far only as it is mixed with a looſe and porous chalky or ſandy ſoil, becauſe their coheſion is ſtrengthened by this means, and they are made fit to retain moiſture ſomewhat longer. The clay muſt be laid in lumps upon the land, with which it is to be mixed, in order that it may be diſſolved by the rain, and uniformly mixed with the reſt of the ſoil. Clayey earths, which are found rather in a dry powdery ſtate, may be ploughed in.

The cloſe texture of clay, and the looſe and friable nature of ſand, form a contraſt in the nature of ſoils, by no means friendly to vegetation: when thoſe oppoſites are united, the ſoil becomes more fertile, and when blended with native or vegetable mould, is further improved. Thus clay is conſidered as a manure to ſand, and on the contrary ſand to clay.

As thoſe ſoils are ſeldom found very near each other, improvements are not to be effected, without expence and difficulties which a prudent man would be afraid to encounter with. Although there are thoſe formidable obſtacles in the way, improvements of the kind are often practicable; and a ſpirited perſeverance performs wonders. Clay is generally found more beneficial on ſand, than [redacted]lay. Clay enriches a ſandy ſoil, by giving it body or firmneſs; and ſand in clay by breaking its toughneſs. Clay is alſo uſed with ſucceſs on ſome gravelly ground; but there are ſome kinds of clay and gravel, which will not unite; this happens when the ſoil conſiſts of ſmooth round pebbles, and a ſmall portion of mould.

Loam is a manure on any ſort of land, provided the ſoil you manure with is not inferior to that you intend to manure. When land has been exhauſted by long continued cultivation, freſh mould from under hedges, the ſides of roads, or other places, where it is to be procured, ſurprilingly fertilizes and refreſhes the ſoil.

Chalk, or *calcareous earths*, on account of their natural dryneſs, are very much diſpoſed to attract moiſt moiſture and acids; they may therefore be ſucceſsfully mixed with boggy clayey ſoils, where they prove of ſervice in three different ways. They diminiſh its ſtiffneſs, imbibe moiſture and acidity, and give more warmth to the ſoil. Burned calcareous earth or lime would prove too expenſive, neither indeed is it neceſſary for the mere melioration of the compoſition.

Pure marle, and earths of the *marley kind*, may be employed in various ways, according to the various differences in their compoſition. The former of theſe, conſiſting of equal parts of clay and chalk, may, in reſpect to the clay it contains, be of ſervice on a looſe light ſoil; but by virtue of its calcareous earth may alſo, when added in ſufficient quantity, looſen a heavy ſoil. The other kinds of marle, which ſhould be claſſed, according to their various admixtures, into *calcareous*, *gypſeous*, *argillaceous*, and *ſandy-marles*, may be uſed for the ſame purpoſes as the purer kinds of the earths themſelves. At the ſame time as theſe are mixed earths, they are more eaſily mingled with each other in the great, than chalk, clay, and ſand are. The more ſolid ſorts of them, before this mixture can take place, muſt be left during a certain time in the fields, to fall to pieces by expoſure to the air. Thus we find that notwithſtanding each particular ſoil is adapted to ſome particular produce, the union of oppoſite ſoils is moſt conducive to vegetation.

For inſtance, *ſandy* ſoil is very well adapted to certain vegetables, which ſpread their roots far around, are of a dry, reſinous and aromatic nature, and of a rapid growth; and alſo for ſuch, as either perſpire much, or elſe, according to their different natures, attract large quantities of moiſture from the air. In a *chalky* ſoil, various vegetables of a dry woody texture are capable of growing. In a *clayey* ſoil, ſuch will thrive as are of a ſlow growth, have ſolid and ſtrong fibres, and contain either acid or aſtringent particles in their compoſition. But a *mixed* ſoil, on the contrary, is fit for growing almoſt all kinds of vegetables. For this reaſon, the plants that are to be cultivated muſt either be choſen ſuitable to the natural properties of the ſoil, or the ſoil adapted to the nature of the vegetables.

From the repeated good effects which have been obſerved to attend on ſimilar mixtures of the different kinds of earth, ſome have falſely imagined, that theſe bodies are actual manures: nothing however can be more erroneous than this ſuppoſition. All ſeeds and vegetables ſtand in need for their growth of certain ſubtile and ſoluble homogeneous ſubſtances, by the actual acceſſion of which they can ſolely be ſupported; and theſe are certainly neither mere

earths nor ſalts. Though it has been proved, that all vegetables receive a nutritious matter by their branches and leaves; nevertheleſs, experience ſhews, that this is not ſufficient for the profitable cultivation of them without an appropriated and more ſubſtantial nutriment. Hence it is a maxim confirmed by experience, that to every fertile ſoil ſhould be reſtored, from time to time, the nutritious particles, which it yearly loſes; and this is effected by *natural* and *artificial* manuring.

A *duly proportioned and well mixed ſoil* muſt unite in itſelf all the above-mentioned good qualities, in order to be adapted to the growth of many different kinds of vegetables. For a deficiency of any one of the former kinds, when it is mixed with another ſort, ceaſes to be a defect, and even produces advantages. The proportion of ſuch a compoſition as will anſwer univerſally, cannot be well determined. In moſt caſes equal parts of calcareous earth, clay and ſand appear to be the propereſt mixture. From what has been ſaid, it follows, that the *ſoil* itſelf ſhould be conſidered in two different ways. In fact, for a *ſoil* to be *fertile*, it is requiſite, 1. That, conſidered as earth, it ſhould be of a *mixed kind*, conſequently it muſt conſiſt of different kinds of earths, which may be called the natural compoſition of it; but beſide this it is neceſſary, 2. That it ſhould contain a ſufficient quantity of ſoluble nutritious particles. Upon its mixed nature depend the requiſite properties of ſuch a ſoil, viz. that it has the proper degree of coheſion, retains moiſture moderately, and does not reſiſt too much the ingreſs of air and heat into it. In ſuch a ſoil none of the ſimple kinds of earths muſt predominate in any conſiderable degree.

SHELLS.

The perpetual fertility of calcareous earth, ſo confidently mentioned in the Scotch Encyclopædia, is a phenomenon in Agriculture, with which we are unacquainted, and can only inform our readers by an extract from that work, viz.

"Near Sandſide, in the county of Caithneſs, there is a pretty extenſive plain on the ſea-coaſt, endowed with a moſt ſingular degree of fertility.

"In all ſeaſons Mr. Anderſon affirms that it produces the moſt luxuriant herbage, and never got any manure ſince the creation, and has been from time immemorial ſubject to the following courſe of crops:

"1. Bear, after once ploughing from graſs, uſually a good crop. 2. Bear, after once ploughing, a better crop than the firſt. 3. Bear, after once ploughing, a crop equal to the firſt. 4, 5 and 6. Natural graſs, as cloſe and rich as can be imagined, might be cut, if the poſſeſſor is ſo inclined, and would yield an extraordinary crop of hay each year.

"After this the ſame courſe of cropping is renewed. The ſoil that admits of this ſingular mode of farming appears to be a pure coherent ſand, deſtitute of the ſmalleſt particle of vegetable mould; but, upon examination, it is found to conſiſt almoſt entirely of broken ſhells: the fine mould here bears ſuch a juſt proportion to the calcareous matter, as to be ſcarce perceptible, and yet it forms the moſt fertile ſoil that ever we yet met with.

"I have ſeen, continues the ſame author, many other links (downs) upon the ſea-ſhore, which produced the moſt luxuriant herbage, and the cloſeſt and ſweeteſt pile of graſs, where they conſiſted of ſhelly ſand; which, without doubt, derive their extraordinary fertility from that cauſe.

"A very remarkable plain is found in the iſland of Jir-eye, one of the Hebrides. It has been long employed as a common; ſo that it has never been diſturbed by the plough, and affords annually the moſt luxuriant crop of herbage, conſiſting of white clover, and other valuable paſture-graſſes, that can be met with any where. The ſoil conſiſts of a very pure ſhelly ſand.

"From theſe examples, I think it is evident, that a very ſmall proportion of vegetable mould is ſufficient to render calcareous matter a very rich ſoil. Perhaps, however, a larger proportion may be neceſſary when it is mixed with clay than with ſand; as poor chalky ſoils ſeem to be of the nature of that compoſition.

"This is a miraculous ſoil, and if the fact is as related, place ſhells and other calcareous ſubſtances before every other manure, in as great a degree as the ſun exceeds the moon in brilliance."

Thus have we endeavoured to deſcribe the nature and qualities of the ſeveral manures, as well as given ſome direction with reſpect to their application to agricultural purpoſes, according to our beſt judgment.

And as manures are the grand ſupport of Agriculture, we have entered rather fully into the nature of thoſe we deemed moſt uſeful, and upon the whole have noticed all that are in uſe, as far as our experience and obſervation led us.

In the courſe of this Syſtem I have introduced many obſervations and remarks on the nature of vegetation, and the food of plants, as moſt conſentaneous to my ideas. But as I write as a farmer, and not as a philoſopher, and as the plan of the Editors of this work is to give the opinions of others, as well as their own, on important and controverted points, I ſhall refer the reader to the Syſtem of AEROLOGY, and add ſome remarks, extracted from a Treatiſe (written in the German Language and tranſlated by Dr. Hopſon) on the general principles of vegetation, and the food of plants, with Dr. Prieſtley's experiments and obſervations on the ſame.

FOOD OF PLANTS.

"The nutritious particles of vegetables chiefly conſiſt of a mucilaginous ſaline compound ſoluble in water; and containing a large proportion of oleaginous and phlogiſtic particles, which, being extracted from the earth, by means of water, are introduced into the vegetables through their roots, and being diffuſed throughout their whole ſubſtance, are ſecreted and changed into the ſeveral different juices and ſolid parts of the plants. This is the reaſon, why neither *water* alone, nor even a *meagre poor earth* combined with *water*, can, without other admixtures, promote vegetation. Some kinds of vegetables, it is true, may be made to vegetate with water alone; but it is alſo a fact, that they never arrive at that perfection, as when they have ſtood in a fertile earth, becauſe the former is poſſeſſed of very few nutritious particles. Water is requiſite to vegetation, in ſo far only, as by its means the nutritious particles from the earth are diſſolved, and tranſported into the ſubſtance of the vegetables.

"Moreover, it is in conſequence of theſe nutritious particles, that what is called *mould*, by which term is underſtood a porous, black and fertile ſpecies of earth, copiouſly impregnated with the putrified parts of organized bodies, promotes vegetation much more than an exhauſted and worn-out earth; farther, that by *dung* or manure, which, in fact, contains the above-mentioned nutritious particles, though as yet in a crude and undeveloped ſtate, fertility may be imparted to any poor ſoil, or a ſoil that is already fertile, may be improved. Theſe materials conſequently muſt neceſſarily be added to every ſoil in proportion to its exigencies, or according to what the nature and quantity of the plants that are to be cultivated in it, require.

"When therefore we conſider the nature of a good and fertile mould, and compare it with a mere ſwampy bog and mooriſh peat ſoil, which contains a portion of acid, we diſcover a conſiderable difference, and likewiſe the cauſe, why theſe latter are not fertile in themſelves; but the principles alſo are eaſily diſcoverable, upon which ſome of them may be rendered fit for culture, and others uſed as manure. At all events, ſuch ſoils as theſe, in their natural ſtate, are favourable to the vegetation of thoſe plants which are of a quick growth, and require for this reaſon a conſiderable quantity of moiſture.

"With regard to dung, the *difference* alſo between the different ſpecies of it remains to be conſidered, which difference depends entirely upon the quantity of oleaginous and phlogiſtic particles, contained in the ſoluble mucilaginous compound inherent in it. Conſequently the richer the dung is, the hotter it will be in effect. Hence the dung of birds, which moſtly feed upon ſeeds, forces more than horſe dung, (in which latter attention ought to be paid to the quantity of oats theſe animals have eaten) and this again forces more than cow dung."

As a principal agent, may be conſidered the influence of light or heat, and of the air by which the aſcent of the ſap, the developement of the organized form of each vegetable, and (by the depoſition of ſolid particles on the internal parts) its increaſe and growth to the deſtined ſize are promoted.

We ſhall not here ſpend time in refuting the theories of thoſe who imagined the vegetable food to conſiſt of oily and ſaline ſubſtances. A more probable ſuppoſition has been, That Water and Air are the proper vegetable food, to which alone they owe their increaſe in bulk and weight. That plants cannot be ſupported without both theſe, is very certain; but we know, that air is a compound fluid; and water is never without ſome impurities, ſo may alſo be conſidered as a compound. Is it then the aqueous, the earthy, the acid, or the phlogiſtic part of the air, which nouriſhes plants? In like manner, is it the pure elementary part of water which nouriſhes them? or does it contribute to their growth only by the heterogeneous ſubſtances which it contains?

From Dr. Prieſtley's experiments on different kinds of air, it appears that the pureſt kind of that fluid is not the fitteſt for the purpoſes of vegetation. On the contrary, vegetables flouriſhed in a ſurpriſing degree when confined in a ſmall quantity of air made perfectly noxious by the putrid effluvia, or, in other words, the eſſence of corrupted matter, conſtitute at leaſt one ſpecies of vegetable food; and when vegetables are put into ſuch circumſtances that the ſteams of putrefying bodies can have acceſs to them, we are ſure they will thrive the better.

The Doctor alſo found, that by agitating putrid air in water, part of which was expoſed to the atmoſphere, the water acquired a very putrid noxious ſmell; which ſhows, that water, as well as air, is capable of abſorbing thoſe effluvia which are found proper food for vegetables. We cannot help concluding, therefore, that in the continual aſcent of water in vapour, and its deſcent again in rain, which is a much more effectual *agitation* than could be made by Dr. Prieſtley, the water muſt be very intimately combined with the *phlogiſtic* or putrid effluvia which are contained in the air. To this union we are led ſtrongly to ſuſpect that rain-water owes its fertilizing qualities; for the pureſt ſpring waters, though moſt wholeſome

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wholesome for animals, are not found to be fittest for promoting the growth of vegetables. As, therefore, vegetables evidently receive nourishment both by their leaves and roots, and increase remarkably in bulk by absorbing the putrid effluvia from the air; and as they likewise increase in bulk by admitting water to their roots, and more so when the water contains much of that kind of effluvium than when it contains less: so we would conclude, that the nourishment received by the roots of plants is of the same kind with that received by their leaves; and that this food may be given them in greater plenty than they naturally receive it, by impregnating the air which surrounds them, or the water which moistens them, with a greater quantity of putrid matter than what they contain in a natural state. See the article FOOD OF PLANTS.

SECT. III. WHEAT AND ITS CULTIVATION.

WHEN we are mentioning Wheat, our subject may be justly deemed of the first importance, it being on what is very emphatically called the "STAFF OF LIFE." We therefore propose to consider the preparation of the soil for the growth of Wheat—the different kinds in use—the time of planting—the various methods of planting or depositing the seed in the earth—the casualties or diseases to which Wheat is subject;—with a few other observations.

Wheat should be planted on land that is fresh, and in good heart; there is no prescribed rule what crop it should follow, although it is a general maxim with farmers not to let Wheat and Barley follow each other; and we believe the prohibition is founded on experience; as exhausting crops should not succeed each other.

To summer fallow for Wheat is an old practice, and certainly a good practice on cold stiff land, yet the custom of sowing Wheat on fallow may be varied, by letting the fallow lie all winter, and sow Barley in the spring; after Barley, Beans; and the Wheat crop succeed the Beans; but this, although called good husbandry, we by no means think equal to sowing Wheat on fallow, Beans next, and then Oats or Barley with Clover, and Wheat again on the Clover lay. This we call a round of management on land which will not bear Turnips; but it is contrary to the opinion of those gentlemen who call themselves anti-fallowists, who contend that Beans, Pease, Vetches, or Clover, answer the purpose of fallows; in some respects they may; but be assured they will not keep land clean, particularly from Couch grass.

Let it be understood, that with those meliorating crops, as they are called, drilling and horse-hoeing is to be pursued; but how drilling and horse-hoeing are in all seasons to be effected on stiff clay, or sour tough loam, is the question. The discussion of this matter must be when we treat of Ploughing, &c. If fallows can be abolished on stiff land, the Wheat crop will of course follow Beans or clover; but how drilling can be performed on this kind of soil, on a Clover lay, and as autumn seasons are very precarious, is a circumstance beyond our experience or observation.

When Clover is intended to be sowed after Wheat, plough the land, and let it lie three, four, or more days to dry (that is, on low, wet land) before you sow the seed, which will make the harrows perform their work better, and the seed will be better covered, and not so subject to malt or burst in the ground, a circumstance which frequently injures the crop: be also careful to plough the furrows narrow. On hill land, and others, that will bear turnips, and permit them to be eat off in a proper manner, Wheat is either sowed on Clover, or Rye-grass and Clover, or according to the drill management on potatoe fallow: where potatoes are properly cultivated, this is certainly a valuable and improved branch of husbandry, and must get land in fine condition for Wheat.

Different Kinds of Wheat.

The kinds of Wheat are *Cone* and *Lammas*; the cone with a beard like Barley, and the Lammas smooth in the head: these seem the only sorts where the distinction is so visible; but they are branched into a variety of sorts, bearing a similitude in appearance to either Cone or Lammas. Red Lammas is the Wheat of that kind most generally sowed on hill and vale, and had no other kind of Lammas Wheat been known, we do not know the loss would have been material. There are variety of other sorts of Lammas Wheat, as yellow, white, &c. sowed in different countries, and frequently changed from curiosity or experiment, generally with great expectations at first, which seldom last long. The Cone, or bearded Wheat, in general cultivation, is commonly sowed on strong rich land, generally in vales on strong loam, where its produce is very great; and being strong and large in the straw, is not so liable to fall down by wet weather on the approach of harvest.

There is often an advantage on high lands, where the soil is good, in sowing Lammas and Cone Wheat, mixed about one third Cone. We have observed often great benefit from this method, as where one half of a ground has been sowed with mixed Wheat, and the other Lammas alone, the mixed has been much superior both in quantity and quality.

There is another kind of Wheat lately introduced, or rather revived, in this kingdom, quite different in its nature to those in general use: this is called spring Wheat, it is of the beard or Cone kind, and instead of being sowed in autumn, is not sowed till spring; great advantages were expected when first this kind of Wheat was announced; but a few experiments convinced those who made them, that spring Wheat was not adapted to this climate, at least that Barley, Oats, or other spring corn, were preferable to spring Wheat.

Mr. Young has lately introduced a kind of Wheat which he calls *Velvet Wheat*; and remarks upon it, that it is very promising to become an acquisition: should that be the case, it cannot be in better hands to distribute it; and we sincerely wish Mr. Young on this, as on every other occasion, the greatest success.

Times of Sowing Wheat.

The times of sowing Wheat differ very materially; on the hills and rocky land, they begin sowing the latter end of July, if the weather permits; and it is no uncommon thing to see a person have two crops of Wheat of different years, growing at the same time. This early seeding is mostly on a Rye-grass and Clover sward of two years, or on saintfoin breast ploughed and burned, and gives the Wheat sufficient strength to endure the winter;—before the frosts are severe, you will see the Wheat matted together on the land. The Wheat seeding on those hills is generally finished before the middle of September, provided the weather suits, as particular regard is paid towards the land being sufficiently wet; if that is not the case, it renders the crop hazardous. In the vales and low lands, in general on fallows, Wheat sowing begins about the middle of October, and continues till Christmas; the latter Wheat sowing is generally prolonged by too much wet weather, as the early is by dry. Spring Wheat is generally sowed in April, or the beginning of May.

The quantity of Wheat generally sowed on hill land, (and sowed early) is from two and a half to three bushels per acre. On low or vale land not so much, the general quantity being about two and a half bushels, if sowed in October, and two bushels, or something less, if in November, or later in the season; as early sowing should not be sowed dry, so the later seeding should be wet.

Attempts at improvements are certainly laudable and praiseworthy; and the man who renders service to the art of Agriculture is a real friend to his country; but new inventions are generally introduced with such zealous and positive assurances of success, that the great theoretic promises, which are previously made, always fall short when put in practice. Were improvements brought forward with more diffidence, we are of opinion general practice would sooner follow, if the invention merited public attention. *Setting of Wheat* is a practice recently brought into use, and in all probability is a method deserving public attention; as we have never seen it in extensive practice, we beg leave to lay the following before our readers.

Various Methods of planting and depositing the Seed.

Setting of Wheat, a method which is reckoned one of the greatest improvements in husbandry that has taken place this century. It seems to have been first suggested by planting grains in a garden from mere curiosity, by persons who had no thought or opportunity of extending it to a lucrative purpose. Nor was it attempted on a larger scale, till a little farmer near Norwich began it about 17 years since, upon less than an acre of land. For two or three years only a few followed his example; and these were generally the butt of the neighbours merriment for adopting so singular a practice. They had, however, considerably better corn and larger crops than their neighbours: this, together with the saving in seed, engaged more to follow them: while some ingenious persons, observing its great advantage, recommended and published its utility in the Norwich papers. These recommendations had their effect. The curiosity and inquiry of the Norfolk farmers (particularly round Norwich) were excited, and they found sufficient reason to make general experiments. Among the rest was one of the largest occupiers of lands in this country, who set 57 acres in one year. His success, from the visible superiority of his crop, both in quantity and quality, was so great, that the following autumn he set 300 acres, and has continued the practice ever since. This noble experiment established the practice, and was the means of introducing it generally among the intelligent farmers in a very large district of land; there being few who now sow any Wheat, if they can procure hands to set it.

It has been generally observed, that although the set crops appear very thin during the autumn and winter, the plants tiller and spread prodigiously in the spring. The ears are indisputably larger, without any dwarfish or small corn; the grain is of a larger bulk, and specifically heavier per bushel than when sown.

The lands on which this method is particularly prosperous, are either after a clover stubble, or on which trefoil and grass-seed were sown the spring before the last. These grounds, after the usual manuring, are once turned over by the plough in an extended flag or turf, at two inches wide; along which a man, who is called a *dibbler*, with two setting-irons, somewhat larger than ram-rods, but considerably bigger at the lower end, and pointed at the extremity, steps backwards along the turf, and makes the holes about four inches asunder every way, and an inch deep. Into these holes the droppers (women, boys, and girls) drop two grains, which is quite sufficient. After this, a gate bushed with thorns is drawn by one horse over the land, and closes up the holes. By this method, three pecks of grain are sufficient for an acre; and being immediately buried, it is equally removed from

vermin of the power of froſt, and the regularity of its riſing gives the beſt opportunity of keeping it clear from weeds, by weeding or hand-hoeing. This method is peculiarly beneficial when corn is dear; and, if the ſeaſon be favourable, may be practiſed with great benefit to the farmer.

Sir Thomas Beevor, of Hethel-Hall in Norfolk, found the produce to be two buſhels per acre more than from wheat which is ſown; but having much leſs ſmall corn intermixed, the ſample is better, and always fetches a higher price, to the amount generally of two ſhillings per quarter.

This method, too, ſaves to the farmer and to the public ſix pecks of ſeed-wheat in every acre; which, if nationally adopted, would of itſelf afford bread for more than half a million of people. Add to theſe conſiderations, the great ſupport given to the poor by this *ſecond* harveſt, as it may be called, which enables them to diſcharge their rents, and maintain their families, without having recourſe to the pariſh.

The expence of ſetting by hand is now reduced to about ten ſhillings per acre; which, in good weather, may be done by one dibbler, attended by three droppers, in two days. This is five ſhillings per day; of which, if the dibbler gives to the children ſixpence each, he will have himſelf three ſhillings and ſixpence for his day's work, which is much more than he can poſſibly earn by any other labour ſo eaſy to himſelf. But put the caſe that the man has a wife who dibbles with him, and two or three of his own children to drop to him, you ſee his gains will then be prodigious, and enough to enſure a plenty of candidates for that work, even in the leaſt populous parts of the country.

It is, however, to be obſerved, with regard to this method, that in ſeaſons when ſeed corn is very cheap, or the autumn particularly unfavourable to the practice, it muſt certainly be leſſened. In light lands, for inſtance, a very dry time prevents dibbling; as the holes made with the inſtrument will be filled up again by the mould as faſt as the inſtrument is withdrawn. So, again, in a very wet ſeaſon, on ſtrong and ſtiff clays, the ſeeds in the holes cannot be well and properly covered by the buſhes drawn over them. But theſe extremes of dry and wet do not often happen, nor do they affect lands of a moderately conſiſtent texture, or both light and heavy ſoils at the ſame time, ſo that the general practice is, in fact, never greatly impeded by them.

The ſetting of wheat is certainly an invention of utility on rich ſtrong land, which has ſtrength ſufficient to nouriſh a number of ſtems or ſtraws from the ſame root. Setting may be performed on a foil, and in weather in which drilling is impracticable; but where a real uſeful and commodious drill can be uſed, a very material ſaving in the expence will be made, which is certainly an object of conſequence to a farmer.

Improvements in the planting of Wheat go ſtill further; *dividing and tranſplanting the roots* have been practiſed, (an account of which has been publiſhed in the Philoſophical Tranſactions, and likewiſe by the Rev. Mr. PIKE, of Edmonton, in his correſpondence with Mr Young) as a rational and pleaſing amuſement; and at the ſame time inveſtigating the works of nature: theſe experiments do honour to thoſe who make them; and communicating them to the public is gratifying the curious. As an acquiſition to Agriculture, we cannot rank the tranſplant of Wheat, as ſo tedious a proceſs can never become uſeful.

Diſeaſes to which Wheat is ſubject.

As vegetables, like animals, are ſubject to diſeaſes, the principal maladies which affect Wheat, are ſmut and mildews. Smut is a diſeaſe very injurious to a crop of Wheat in every other reſpect fair and promiſing; the grains which are affected with the ſmuts, inſtead of being filled with the natural mealy ſubſtance, contain a black powder like lamp black, of a very diſagreeable ſmell, which, by the operations of thraſhing and grinding, communicates its diſagreeable properties to the bulk.

Smut.

Dr. Home, in his principles of Agriculture and Vegetation, claſſes the *ſmut* in grain among the diſeaſes ariſing from the following cauſe. He is of opinion, that too great an abundance of juices in a vegetable will produce diſeaſes ſimilar to thoſe occaſioned by repletion in animal bodies; viz. ſtagnations, corruptions, varices, carluſities, &c. along with the too great luxuriancy, which he expreſſes by "too great an abundance of water-ſhoots." Hence he is induced to claſs the ſmut among diſeaſes ariſing from this cauſe; it being a corruption happening moſt in rainy ſeaſons, and to weak grain.

Like other contagious diſeaſes, he tells us, the ſmut may be communicated from the infected to healthful grain. As a preventative, he recommends ſteeping the grain in a ſtrong pickle of ſea-ſalt. Beſides the effect which this has upon the grain itſelf, it is uſeful in ſeparating the good from the bad; the beſt ſeed falling to the bottom, and the faulty ſwimming on the top of the liquor. For the ſame purpoſe, a ley of wood-aſhes and quicklime is recommended by ſome; and, by others, a ſolution of ſaltpetre or copperas; after which the grain is to be dried with ſlacked lime.

How far Dr. Home may be right in his conjectures on the cauſe of ſmut, we cannot determine, opinions on the ſubject being ſo various; but his prevention is according to the prevailing practice. A ſtrong lye, or lixivium, is the remedy in general uſe, and Mr. Andrews, an ingenious gentleman, who correſponds with Mr. Young, gives the following receipt:

"Make half a hogſhead of ſtrong lye from wood aſhes, put it into a boiler, and add 7lb of common ſalt, and half a pound of arſenic; boil it in a copper about five minutes, which will ſo far take off the poiſonous quality of the arſenic, as to prevent its deſtroying fowls, or birds, ſhould they pick up any of the uncovered ſeeds. After the lye is boiled put it into a tub, (an old wine pipe will make two) and let it ſtand till cold; then get a ſtrong cloſe made baſket, that will hold about two buſhels, and ſet it in the lye, put half a buſhel of wheat into the baſket at a time, ſtirring it, and ſkim off the light grains that ariſe; then take it out of the lye, and ſpread it on a floor, and mix as much quick lime powdered as is neceſſary to prepare it for ſowing; you may prepare a quantity three or four days before it is wanted. The quantity of lye will ſerve about 50 buſhels of Wheat."

From experience and obſervation, as alſo from the opinion of that excellent cultivator, Mr. Macro, we think the great benefit of ſteeping Wheat ariſes from the opportunity it gives of taking the light unhealthy grains from the quantity; added to which, that the ſaline mixtures which are uſed tend to ſtrengthen and promote the growth in its firſt ſtate, and to protect the root of the plant from the ſeverities of the weather.

Such are the obſervations on the cauſe and remedy of this diſorder in Wheat, as introduced by the Author of this Syſtem. Having, however, in our reſearches for further improvements in this the Second Edition, diſcovered ſome ingenious obſervations on the ſame ſubject, in the Bath Papers, vol. v. page 244, *we ſhall add them* verbatim et literatim.

"MANY, (ſays the writer) are the noſtrums which are ſaid to be infallible in preventing or remedying this common evil; and many more are the pretenders to choice ſecrets, which are effectual, certainly to the ſame moſt valuable purpoſe. But every practical farmer, of common obſervation, knows, aſſuredly, to his ſorrow, that in unfavourable ſeaſons none of the boaſted means he has uſed hath ever effectually anſwered his purpoſe.

The firſt ſtep towards the remedying any evil, either in the animal or vegetable kingdom, is the true knowledge of its cauſe; without it all is quackery, and too often the artifice of deſigning adventurers, who hope to make a ſiniſter advantage of the weak and credulous, who are too apt to ſwallow the hook which is covered with a gilded bait. Every one embraces with pleaſure what he is perſuaded will promote his intereſt.

The previous queſtion is, what is the cauſe which generally produces the ſmut in Wheat?

To this no poſitive or probable anſwer can be given. It has been generally ſuppoſed, if one may judge by the means commonly uſed to prevent it, that it proceeds from the ſeed, whoſe ſtamina, by ſome means or other, have been vitiated; for all the means of prevention, I ever heard of, were uſed in the preparation of the ſeed previous to its being ſowed.

The moſt common method is brining and liming the day before ſowing, which is done either with ſea-water, the brine of meat, or of ſea-ſalt diſſolved in water made ſtrong enough to bear an egg. To this, ſome whimſical people have capriciouſly added ſeveral ingredients, which are much more likely to deſtroy the vegetative principle of the ſeed, than to remedy any evil the rudiments of which might latently ſubſiſt in it. To this purpoſe, flour of brimſtone, aloes, copperas, and verdigreaſe in fine powder, aſſafœtida, and even arſenic, have been recommended to be infuſed in the pickle; but this is ſo very abſurd, and even dangerous, that men of ſober common ſenſe are both afraid and aſhamed of the practice.

The practice of brining and ſteeping was ſuggeſted by accident, eſtabliſhed by cuſtom, and continued againſt all reaſonable conviction of its inutility. In unfavourable ſeaſons, every one knows, that ſmut generally prevails in ſpite of every precaution that has been hitherto taken. Brine, pickling, liming, change of ſeed, and ſeed of one year old and upwards, avail nothing. In cold wet ſummers the ſmut prevails, notwithſtanding the uſe of every means which invention hath urged, or ingenuity practiſed.

The circumſtances that firſt attracted my notice, and engaged my attention to this ſubject, were as follow:—Some years ſince I ſet a ridge with Wheat, by way of experiment, in rows at various diſtances; in the courſe of the ſpring it was hoed two or three times, and was as healthy, vigorous, and fine, as ever was ſeen. In general it was from four to five feet and a half high, the ſtraw uncommonly large and ſtrong, and the ears from four to five inches and a half in length. No corn ever appeared more promiſing. Thus it continued till the bloom appeared, about the middle of June. The weather then became wet and cold, and frequently deprived the corn of what is uſually called its bloſſoms. Before the end of the month, the ears put on a ſickly look, and, upon examination, it was found amazingly ſmutty; more ſo, indeed, than I had ever obſerved any before. In vain I examined the roots, the ſtraw, the joints, &c. all appeared ſound and perfect, till I came to the ear; there the evil began, but from what cauſe, or by what means, not the leaſt veſtige could be found.

As the plants were vigorous, perfectly healthy, and ſound, till

the bloom appeared, and then turned ſickly and diſtempered, and at length immoderately ſmutty, it ſeemed very clearly to follow, that it could not be owing to any imperfection in the ſeed, but entirely to the inclemency of air, which by ſome means or other infected the grain in its embryo-ſtate, and converted the milky ſubſtance, which conſtitutes the meal or flour of the corn, into a black, fœtid, unwholeſome powder, known by the name of ſmut.

Strongly impreſſed with this opinion, I determined to embrace every opportunity of gaining all poſſible information of the ſubject. For ſome two or three years the ſeaſons were favourable, and afforded no opportunity for obſervation; but 1787 was an unproſperous year, and gave us ſmutty Wheat in abundance. But though I was very attentive to its progreſs after it was diſcovered, I gained no additional intelligence reſpecting the cauſe; but a full confirmation of my former opinion, that the ſmut was generally, if not totally, cauſed by the inclement and vitiating principles of the atmoſphere which happened at the time of its bloſſoming; for till then it was free from every appearance of defect whatever. This, however, did not relax my reſolution of endeavouring, by every means in my power, to inveſtigate the true cauſe; whether it originated from any defect or imperfection in the ſeed, or was principally owing to a deſtroying diſtemperature or blighting principle of the air.

The next year, 1788, was very favourable to the growth and ripening of Wheat. The ſummer was dry and healthy, and the corn ſound and good, though the ſtraw was very ſhort and ſcanty. The ſeed I ſowed was of my own ſaving, of the ſame year's growth, and ſowed on the ſame land, without any change whatever, yet I had no ſmutty Wheat that year, and therefore no opportunity of making remarks. The next ſeed time I had a mind to try the white cone Wheat, and therefore procured my ſeed from a different county, and took all the uſual precautions to guard againſt the ſmut. The ſeed was perfectly ſound and good, yet I had not a ground that was perfectly free from it this year.

Moſt of my Wheat this year was ſown in drills at various diſtances, for the ſake of experiments, and was all horſe and hand hoed. In the months of April and May it was amazingly fine, ſo as to be the admiration of all that ſaw it. The farmers in the neighbourhood declared they had never ſeen any thing equal to it before, for height, ſize, vigour, ſtrength of ſtalk, and length of ear. In this flouriſhing ſtate it continued till above the middle of June. About this time the weather grew cold and ſtormy, and continued ſo till towards the end of July, a few fine days intervening. The Wheat was now in full bloom, but frequently ſtripped of it by the haſty ſhowers that fell. Such, however, is the wonderful œconomy of nature, that if Wheat be ſtripped of its bloom by the intemperance of the weather, a fine warm day re-inflates it, and the bloom becomes as fair and promiſing as ever. This I have obſerved it to do ſeveral times in alternate ſucceſſion; but there is a limit which the return of the bloſſoms cannot ſurvive, and if it happens before the embryo is duly impregnated, then the kerning or granulating ſucceeds badly, and at harveſt the corn proves defective and ſmutty.

During the growth of the corn this year (1789) I was very attentive to it from the firſt appearance of the ear in the inſide of the ſtalk, to the time of its maturity. Soon after the ſhowery time above-mentioned, I obſerved a great number of the ears turned quite brown, as if they were ripe; but upon examination they proved to be abortive ears, without any corn in them; they handled as looſe and ſoft as corn that had been threſhed. This circumſtance ſurpriſed me very much. To ſee corn, which ſo ſhort a time before was ſo very fine and flouriſhing, prove to be nothing more than chaff, was exceedingly mortifying indeed. I imagined the roots had been deſtroyed by ſome inſect or reptile; but, upon examination, I found them as ſound and perfect (as indeed was the whole plant, the ear only excepted) as corn could poſſibly be.

Soon after this, I obſerved the ſouth ſide of one of the fineſt fields was grown very ſmutty. It was ſufficiently diſcouraging to ſee corn five feet high, with ears five or ſix inches long, and as healthy and vigorous as ever was ſeen, in a few days converted into ſmut. This unwelcome circumſtance furniſhed opportunities more than enough, to exerciſe the moſt inquiſitive mind in ſearch of the cauſes of thoſe evils, which blaſt at once the hopes and expectations of the moſt ſagacious and induſtrious huſbandman. To inveſtigate the cauſe, I began by examining the roots of the ſmutty ears, then the ſtems or ſtraw, the joints, and every part up to the ear, in any of which no defect whatever was to be found. I had not proceeded far, however, before I obſerved, that both ſmutty and ſound ears were frequently produced and nouriſhed by the ſame root, and conſequently were both produced from one and the ſame individual ſeed. This circumſtance alone goes very far towards proving, that the cauſe of the ſmut does not exiſt originally in the ſeed; for if its *ſtamina* were vitiated or corrupted, it is not poſſible to conceive that it ſhould produce plants ſound, healthy, and vigorous, for eight or nine months, and then ſome ears full of corn perfectly ſound and good, and others nothing but ſmut balls.

Not fully ſatisfied with this, I purſued my intention, and ſpent much time in examining the ſmutty ears, I ſoon diſcovered it was no uncommon thing for the ſame ear to contain both ſound and ſmutty corn.

In ſome ears the tops were moſtly ſmutty, and the bottoms ſound; in others the tops were ſound and the bottoms ſmutty; but more generally, one ſide of the ear was all ſmut, and the other moſtly ſound. One of the laſt ears I examined contained forty ſmut-balls, twenty-one corns that were perfectly ſound and good, and five corns that had one end ſmutty and the other ſound.

From this ſtate of facts it is hardly poſſible to reſiſt the conviction that the ſmut is cauſed by the inclemency of the atmoſphere, and that conſtantly and invariably in the ſeaſon of its blowing.

To ſum up the whole of this matter then, it ſeems as certain as demonſtration can render it, that the ſmut is not owing to any defect or imperfection in the ſeed, but entirely to ſome corrupt vitiating principle of the atmoſphere, in the blowing ſeaſon, which blights and deſtroys the grain in ſome ſhape or another, according to the time it has been blowing, when it is ſtruck with the blight. Thoſe ears which are totally deprived of their blowings at the beginning of the ſeaſon, before the corn in its embryo ſtate is duly impregnated with the *farina fecundans*, or male duſt, become abortive, and are abſolutely without any corn at all. Thoſe that are further advanced, and have the embryo formed ready for impregnation, if in that ſtate they are deprived of the fecundating principle, either wholly or in part, the milky matter, which conſtitutes the ſubſtance of the grain, for want of the vivifying principle, is wholly, or in a certain proportional part, converted into a ball of black ſtinking powder, or ſmut. Sometimes, even after the corn is well formed and filled with the milky juice, ſufficiently impregnated with the male principle, it is ſtruck with the blight, which, though it comes too late to prevent the perfection of the vivifying principle, and thereby render it unfit for ſeed, yet it is little more than two rinds, it being in a manner ſtarved, the mealy ſubſtance of which the flour conſiſts being almoſt entirely wanting.

From hence it very clearly appears, that all the boaſted ſteeps prepared for preventing the ſmut are chimerical, and void of all reaſonable foundation whatever. In warm dry healthy ſummers the ſmut is ſeldom if ever found, though the land be ſown with ſeed that is ſmutty, and without any preparation at all. I would however recommend waſhing the ſeed in fair water a day or two before ſowing. By this means the light imperfect corns, chaff, and ſeeds of weeds, if any, are ſeparated from the ſeed corn, ſwim at top, are eaſily ſkimmed off, and the remainder rendered much more clean and perfect.

The writer has now ſeveral experiments in proſecution, by which the above obſervations may probably be ſatisfactorily confirmed, which he hopes to have the honour of communicating in due time. He does not preſume to claim the promiſed premium, being ſenſible he has not performed the *literal* conditions, which he apprehends no power is by any means equal to but THAT only which "rides in the whirlwind, and directs the ſtorm." The Power which is competent to the prevention of the ſmut in Wheat, is equally ſo to the preſervation of the bloom of the fruits of the orchard, the hop garden, from the maggot in peas, the black dolphin in beans, the fly in turnips, and the caterpillar in all the cabbage tribes, whoſe devaſtation at this very time has laid the whole country waſte. Inſtead of cabbages nothing is to be ſeen but the bare ribs of the leaves, like mere ſkeletons, the hearts, &c. being entirely deſtroyed.

However great the evil be which attends a crop of very ſmutty Wheat, the ſound grain may be made clean, ſweet and wholeſome, with little trouble, and a moderate expence, as appears by the following account:

In the year 1787, I had a great deal of very ſmutty Wheat, which would ſell for little more than one-half, or at moſt two thirds of the price of good Wheat, which put me upon making the following experiment:—I took about a gallon of the Wheat, and put into a pail of fair water, and ſtirred it about well for a minute or two with a ſtubbed broom. It made the water almoſt as black as ink. This water was then poured off and a ſecond added, in which it was again very well ſtirred, and then poured off as before. This cleared it entirely from the ſmut and all diſcolouring matter. Then when it was well drained, it was put into a broad ſhallow pan and ſet before the fire, when in a ſhort time it became dry enough to grind; for ſtaying ſo ſhort a time in the water it imbibes very little of it, and what adheres merely to the ſuperficies is ſoon exhaled by a moderate heat. When dry it was no way diſtinguiſhable from the cleaneſt and ſoundeſt Wheat, but by the ſuperior brightneſs of the colour. It had a fairer and more delicate complexion than unwaſhed Wheat, by which it was to be diſtinguiſhed only, even by thoſe who had long dealt in the article and were in the ſecret. Encouraged by the ſucceſs of this experiment, I had a load of it waſhed, ſent it to a malt-houſe in the neighbourhood, and had it kiln-dried by a very moderate fire. I ſent a ſample of it to market by a neighbouring farmer, of long experience, without taking any notice to him of what had been done. He ſaid it was a very bright pretty ſample, but did not diſcover it had been ſmutty or waſhed, till he had ſhewn it to a miller of great buſineſs, who preſently knew what muſt have cauſed its brightneſs; at the ſame time he owned it was not a penny the worſe, as it was now clean and ſweet and perfectly dry. The waſte in waſhing and drying was about two buſhels; ten ſhillings I paid the maltſter for drying, &c. which made the expence about a guinea, whereby at leaſt three or four were ſaved. From this account it appears, that a ſmutty crop is not an evil of ſuch intolerable magnitude as hath been generally thought.

In

In the conditions of the premium, it ſeems, are involved, what is impracticable and impoſſible. In the preceding account the writer flatters himſelf, that he has thrown as much light upon the ſubject as is diſcoverable by human means, and begs leave to ſubmit it to the candid conſideration of the honourable Society, whether ſuch an inveſtigation merits their approbation and *encouragement* or not.

Premiums offered for preventing evils which originate from intemperate ſeaſons and deſtroying blights, may excite invention, artifices, cunning, impoſture, and deception, but can never extend the boundary, or expand the circle of human knowledge, or human power. He and He only who can repel the malignant blaſts of the Eaſt, frought with myriads of conſuming inſects, which originate from what and where none but Omniſcience knows, and ſubſtitute the ſoft, healing, balmy zephyrs of the Weſt, can reward the labours of the induſtrious huſbandman with plenty and happineſs!"

Mildew.

Another diſeaſe to which Wheat is liable, is the mildew, which appears on the ſtraw in black ſpots, and ſometimes inclining to yellow: this generally attacks the Wheat when it approaches towards ripening.

In ſome places thin Wheat does not eſcape the mildew one year in ten, and it is oftener affected with this diſeaſe, than any other grain.

The mildew in grain is a very bad diſorder, and an incurable one; ſituation and early ſowing may in part, and ſometimes wholly, prevent the evil. This diſorder ariſes from a ſtoppage of circulation in the plant, and as the grain grows near ripe, the circulation becomes more languid, which makes it at that ſtage more liable than any other to be ſeized with the diſorder. Some people are of opinion, that a thick glutinous matter, which ſometimes falls in the night, and what is commonly called *a honeyfall*, if, not ſoon expelled by the ſun, will bring it on.

When it proceeds from froſt, and the mildew is only partial, then low hollow places, and ground much confined, only ſuffer; the reaſon is, in hollow and confined ſituations the vapours are in greater quantities, which being condenſed by the cold, and falling on the grain, congeal the juices of the plants, which ſtagnate, and, according to the degree, become more or leſs affected. When the grain is near ripe, it is ſooner affected than when frether; but then the damage is not ſo great as when the grain is farther from maturity. When the froſt is attended with a thick fog, which is not uncommon in the latter part of ſummer, then almoſt inevitable deſtruction enſues; the fog preventing the rays of the ſun from taking effect as they otherwiſe would.

The mildew affects the grain like a mortification in the human frame, becomes full of little black places, and of conſequence brings on a premature death.

The cauſe of the mildew in Wheat is, in all probability, occaſioned by froſts in the ſpring, which cauſes a ſtagnation of the vegetable juices; the ſoil being ſoaked by wet, and froſt immediately ſucceeding, has a greater effect than if the ſoil was dry; for this reaſon, a dry ſpring is always kind for Wheat. A thin crop of Wheat is more apt to mildew than one which is thicker, as thoſe caſual froſts find a more ready admiſſion by the ground not being ſo well defended.

If the mildew happens through the too hollow texture of the ſoil, the land ſhould not be too often ploughed, previous to its being ſowed with Wheat. Eating it off, and treading in ſpring, may be of ſervice as a preventative. Land which is ſubject to mildew Wheat, renders the crop very precarious, as it very ſeldom eſcapes; it is therefore neceſſary for a farmer to be very circumſpect in his inquiries in this reſpect before he enters upon a farm to which he is a ſtranger. Let it be particularly noticed, that ſteeping of Wheat effectually prevents its deſtruction by inſects in autumn.

OBSERVATIONS.

Reſpecting the growth of Wheat, nothing ſhould be neglected either in reaſonable expence or labour, to procure good crops; at the ſame time the return which expence and induſtry require, ſhould be kept in view; for that man is the beſt farmer who obtains the greateſt crops of corn at the leaſt expence; for little does it avail to get 40 buſhels of Wheat or upwards, upon an acre, if the expence has been greater than the return will be.

To riſque Wheat or Barley on land, which is foul with weeds, or poor in condition, is bad management; ſeed and expence are nearly the ſame; and the greateſt good fortune of ſeaſons and other circumſtances will only bring forth a ſaving crop, and the land is doubly exhauſted. The management of Wheat at the time of harveſt is generally known, and pretty uniformly purſued throughout the kingdom; there is one error we would wiſh to point out to the public, which is the cuſtom of letting Wheat, and indeed all kinds of corn, grow too long in the field before it is cut. By this means, if wet ſucceeds, the grain is ſtained and diſcoloured immediately, and will quickly grow in the ſheaf: whereas, if it is cut juſt as it begins to bend the head, and while a few of the ſtraws retain ſome of their green appearance, and tied up in ſmall ſheaves, it will ſtand in the field a conſiderable time, and neither grow nor loſe its colour.

In oppoſition to this, we may be perhaps told, that corn cut green will not threſh ſo eaſy; it may not, perhaps; but we will venture to aſſert, that one penny per buſhel will make up the deficiency, which the ſuperior colour of the grain will doubly repay. This being the reſult of experience, we communicate it as ſuch, and are confident it merits attention.

SECT. IV. BARLEY AND ITS CULTIVATION.

THIS is a culmiferous plant that requires a mellow ſoil. Upon that account, extraordinary care is requiſite where it is to be ſown in clay. The land ought to be ſtirred immediately after the foregoing crop is removed, which lays it open to be mellowed with the froſt and air. In that view, a peculiar ſort of ploughing has been introduced, termed *ribbing*; by which the greateſt quantity of ſurface poſſible is expoſed to the air and froſt. The obvious objection to this method is, that half of the ridge is left unmoved. To obviate that objection, the following method is offered, which moves the whole ſoil, and at the ſame time expoſes the ſame quantity of ſurface to the froſt and air. As ſoon as the former crop is off the field, let the ridges be gathered with as deep a furrow as the ſoil will admit, beginning at the crown and ending at the furrows. This ploughing looſens the whole ſoil, giving free acceſs to the air and froſt. Soon after, begin a ſecond ploughing in the following manner. Let the field be divided by parallel lines croſs the ridges, with intervals of 30 feet or ſo. Plough once round an interval, beginning at the edges, and turning the earth toward the middle of the interval, which covers a foot or ſo of the ground formerly ploughed. Within that foot plough another foot ſimilar to the former; and after that, other rounds, till the whole interval be finiſhed, ending at the middle. Inſtead of beginning at the edges, and ploughing toward the middle, it will have the ſame effect to begin at the middle and plough toward the edges. Plough the other intervals in the ſame manner. As by this operation the furrows of the ridges will be pretty much filled up, let them be cleared and water-furrowed without delay. By this method, the field will be left waving like a plot in a kitchen garden, ridged up for winter. In this form, the field is kept perfectly dry; for beſide the capital furrows that ſeparate the ridges, every ridge has a number of croſs furrows that carry the rain inſtantly to the capital furrows. In hanging grounds retentive of moiſture, the parallel lines above-mentioned ought not to be perpendicular to the furrows of the ridges, but to be directed a little downward, in order to carry rain-water the more haſtily to theſe furrows. If the ground be clean, it may lie in that ſtate winter and ſpring, till the time of ſeed-furrowing. If weeds happen to riſe, they muſt be deſtroyed by ploughing, or breaking, or both; for there cannot be worſe huſbandry, than to put ſeed into dirty ground.

Barley is the grain, next to Wheat, in general utility; and, like Wheat, is an exhauſting crop; for that reaſon they ſhould not follow each other. Land which will bear good turnips, and permit ſheep to eat them off in the winter, is generally kind for Barley; but that is a rule to which we can make an exception, as a ſandy loam, without a mixture of ſtones, ſeldom or ever bears Barley of a good body or colour; there is generally ſtraw plenty, but the corn indifferent, and this ſoil turnips well.

The ſoil which grows Barley to the beſt advantage, is a braſh, ſtone loam, and after a crop of turnips ſeldom diſappoints the expectation. The ſort of Barley ſowed on turnip land is generally the long eared Barley, which ripens early.

There is a cuſtom prevails of procuring ſeed from Patney, in Wiltshire, and the Iſle of Thanet, in Kent, which, according to the popular notion, yields its produce earlier in ſeaſon than Barley brought from any other place, although the change of ſoil be equally good: in ſome inſtances, this idea has been confirmed, and in others no difference has appeared. From theſe proofs on each ſide the queſtion, it may be reaſonable to conjecture, that when perſons go to the extra price of this far-fetched ſeed, to inſure ſucceſs, they plant it on the beſt manured and moſt promiſing ſoil, that their hopes may not be diſappointed; this accounts for its being fit to harveſt a week ſooner than the other parts of the crop.

On the advantage of ſowing Barley early, we cannot preſent the public with a more exact ſtatement of circumſtances than that given by the Right Honourable the Earl of Orford, to Arthur Young, Eſq. Vide Annals, Vol. IX. p. 385.

ON THE TIME OF SOWING BARLEY.

BY THE EARL OF ORFORD.

"The common management of the turnip huſbandry in Norfolk has this evil in it, that the crop is kept feeding ſo late in the ſpring, that ſucceeding Barley often ſuffers conſiderably, ſometimes to the amount of the value of the turnips.

"To aſcertain what would be the effect of much earlier ſowing than is ever practiſed here, I made the following experiments upon a ſandy or an imperfect chalk bottom, but deep, and worth about ſeven ſhillings an acre.

"1785. Twenty-three acres of turnips being fed off in time, were ribbled, that is half ploughed, on to four-furrow ridges, ſowing the Barley 3½ buſhels an acre, the 7th of February, in the manner of Wheat ſown on the ridge. Sharp froſts, with and without ſnow, followed the ſowing, and the ſeed laid five weeks before it appeared; but the crop received injury. It was reaped. The produce,

duce five quarters, one buſhel, and one peck per acre; a very good and ſhort ſample.

"I threw the land on a ridge work, for three reaſons; 1. Becauſe it promiſed to preſerve the plants dryer in caſe of much wet weather; 2. To afford the hares, which abounded very much here, eaſy paths, to prevent their making others acroſs the lands; 3. To have the power of ploughing the furrows with a broad double-winged ſhare, to anſwer the purpoſe of horſe-hoeing.

"1786. Fourteen acres were this year cultivated exactly as in the preceding. The turnips were fed off in time for giving the ſame tillage as before, and the land was ſowed the 8th of February; reaped as before. The produce four quarters, ſeven buſhels, one peck per acre; a ſhorter and better ſample than any I had from later ſowing.

"1787. Thirty acres were ſown this year as before on turnip land, and in ridge and furrow. Began the 6th of February; ploughed between the ridges once; reaped; one ſtack has been threſhed; the reſt is equal; the produce five quarters one peck per acre; the ſample ſhort and good; weight 14 ſtone 7lb. the ſack.

"From theſe particulars it is evident, that the practice, however contrary to the common method, has ſucceeded remarkably well; nor do I ſee any well founded objection to purſuing it on the largeſt ſcale. It has been ſaid, *if you feed off your turnips ſo early in the ſeaſon, what do you do for your food later?* To me it appears, that the right time to eat a crop is when it will yield the moſt food, and go the fartheſt. Turnips are often kept till they are good for nothing; and every one knows, in this county, that it is no uncommon thing to ſee them given away to have them fed off, for what the farmers call time for Barley; that is, in April and even in the beginning of May. This late feeding occaſions the loſs of two crops; the turnips are worth nothing; the land is impoveriſhed by them, and there is no chance of good Barley.

"Would it not be much better for the farmer to have other reſources for his ſheep, than ſuffer ſuch certain loſs, and run ſuch great hazard? I am ſo well convinced of this, that I do not venture Barley after late fed turnips, but reſerve the land for cabbages. But beſides this reply to the objection, I may obſerve that the practice is directly applicable to all the lands fed off by the end of January, and to all other preparations for Barley, excluſive of the queſtion of late feeding; but the farmers leave their lands till the common ſeed time, giving twice the tillage that I do, to get worſe crops.

"You will obſerve that I ſow no clover or other ſeeds with Barley. I think the expectation of having two crops growing on the land at once not very well founded: indeed, ſucceſs is the worſt thing that can be looked for; as we often find in late harveſts, in which the Barley is left out ſo late for the clover to dry as to become black, and in every reſpect a bad ſample.

"It is better to ſow the ſeeds alone. But thoſe who will perſiſt in this bad management, may do it at an early ſeaſon as well as at the common one, ſeeing that all the plants ſo cultivated are indigenous, and therefore may be ſown at any time. Another advantage of ſowing early is early harveſt; from a fortnight to three weeks is thus gained: every one knows the conſequence of this."

We perfectly agree with Mr. Young in the very juſt eulogium he beſtows upon the noble Earl, and conſider the minute attention a perſon ſo elevated in life as his lordſhip, beſtows on Agriculture, as a happy circumſtance to this country. At the ſame time we cannot help thinking that a few acres of turnips in ſpring, are of more conſequence than his lordſhip conceives them; particularly on cold backward ſoils, where herbage lies late.

To eat turnips off in ſpring as early as poſſible, is certainly good management, as when they begin to put forward for ſeed, they exhauſt the land, and oftentimes keep feeding back to the injury of the Barley crop. But with theſe diſadvantages, the value of turnips, to thoſe who have a flock of ſheep, and no graſs or other herbage to put them to, cannot be diſpenſed with; and taking one ſeaſon with another, we do not think prolonging a part of the Barley ſowing to the middle or latter end of April, a circumſtance of material conſequence, as the late ſowed Barley is ſometimes ſuperior.

THE Bath ſociety papers being held in eſtimation, and as they contain a variety of information not generally known or practiſed, we ſhall preſent our readers with the following letter to that ſociety.

"The beſt ſoil for Barley is that which is dry and healthy, rather light than ſtiff, but yet of ſufficient tenacity and ſtrength to retain the moiſture. On this kind of land the grain is always the beſt bodied and coloured, the nimbleſt in the hand, and has the thinneſt rind.

"Theſe are qualities which recommend it moſt to the maltſter. If the land is poor, it ſhould be dry and warm; and when ſo, it will often bear better corn than richer land in a cold or wet ſituation. In the choice of your ſeed, it is needful to obſerve, that the beſt is of a pale lively colour, and brightiſh caſt, without any deep redneſs or black tinge at the tail. If the rind be a little ſhrivelled, it is the better; for that ſlight ſhrivelling proves it to have a thin ſkin, and to have ſweated in the mow.

"The neceſſity of a change of ſeed by not ſowing two years together what grew on the ſame ſoil, is not in any part of huſbandry more evident than in the culture of this grain, which, if not frequently changed, will grow coarſer and coarſer every ſucceeding year. It has generally been thought that ſeed-barley would be benefited by ſteeping; but liming it has, in many inſtances, been found prejudicial.

"Sprinkling a little ſoot with the water in which it was ſteeped has been of great ſervice, as it will ſecure the ſeed from inſects. In a very dry ſeed-time, Barley that has been wetted for malting, and begins to ſprout, will come up ſooner, and produce as good a crop as any other.

"If you ſow after a fallow, plough three times at leaſt. At the firſt ploughing, lay your land by in ſmall ridges, and let it remain ſo during the winter, for the froſt to mellow it; ſecond ploughing ſhould be the beginning of February. In March ſplit the ridges, and lay the land as flat as poſſible, at the ſame time harrowing it fine. But in ſtrong wet lands (if you have no other for Barley) lay it round, and make deep furrows to receive the water.

"I have often taken the following method with ſucceſs; on lands tolerably manured, I ſowed clover with my Barley, which I reaped at harveſt; and fed the clover all the following winter, and from ſpring to July, when I fallowed it till the following ſpring, and then ſowed it with Barley and clover as before. Repeating this method every year I had very large crops but would not recommend this practice on poor light land. We ſow on our lighteſt lands in April, on our moiſt lands in May; finding that thoſe lands which are the moſt ſubject to weeds produce the beſt crops when ſown late.

"The common method is to ſow the Barley-ſeed broad-caſt at two ſowings; the firſt harrowed in once; the ſecond twice; the uſual allowance from three to four buſhels per acre. But if farmers could be prevailed on to alter this practice, they would ſoon find their account in it. Was leſs ſeed generally ſowed the produce would be equal, and the corn leſs liable to lodge: for when corn ſtands very cloſe, the ſtalks are drawn up weak; and on that account are leſs capable of reſiſting the force of winds, or ſupporting themſelves under heavy rains.

"From our great ſucceſs in ſetting and drilling Wheat, ſome of our farmers tried this method with Barley; but did not find it anſwer their expectations, except on very rich land. I have myſelf had 80 ſtalks on one root of Barley, which all produced good and long ears, and the grain was better than any other; but the method is too extenſive for general practice.

"In poor land, ſow thin, for your crop will be worth little. Farmers who do not reaſon on the matter will be of a different opinion; but the fact is indiſputable. When the Barley is ſowed and harrowed in, the land muſt be rolled after a ſhower of rain, to break the clods. This will cloſe the earth about the roots, which will be a great advantage to it in dry weather. When the Barley has been up three weeks or a month, it is a very good way to roll it again with a heavy roller, which will prevent the ſun or air from penetrating the ground to the injury of the roots. This rolling before it branches out will alſo cauſe it to tiller into a great number of ſtalks; ſo that if the plants be thin, the ground will be thereby filled, and the ſtalks ſtrengthened.

"If the blade grows too rank, as it ſometimes will in a warm wet ſpring, mowing is a much better method than feeding it down with ſheep; becauſe the ſcythe takes off only the rank tops, but the ſheep being fond of the ſweet end of the ſtalk next the root, will often bite ſo cloſe as to injure its future growth.

"By attending to what I here recommend, many of our farmers uſually get forty buſhels of Barley per acre, from land of no extraordinary quality. On ſome that is rich, I have had fifty-two buſhels without manure; but I never ſow more than ten, and often only eight pecks of ſeed per acre.

Steeping or ſoaking of Barley has been a cuſtom recently adopted, to guard againſt the injuries and inconveniences attendant on a dry ſeed time. To ſay it has anſwered the intended purpoſe, would be ſaying too little, as wonders have been performed, by means of ſteeping Barley; as the following Letter to the Secretary of the BATH SOCIETY, by Mr. JAMES CHAPPLE, of BODMIN, will teſtify.

ON STEEPING SEED BARLEY IN A DRY SEASON.

"MY great ſucceſs in making the following experiment, occaſions my communicating an account of it to you, for the benefit of the public, if thought worthy a place in the Bath Society's Experimental Papers.

"The laſt ſpring being remarkably dry, I ſoaked my ſeed-barley in the black water, taken from a reſervoir, which conſtantly receives the draining of my dung-heap and ſtables. As the light corn floated on the top, I ſkimmed it off, and let the reſt ſtand twenty-four hours.

"On taking it from the water, I mixed the ſeed grain with a ſufficient quantity of ſifted wood aſhes, to make it ſpread regularly, and ſowed three fields with it. I began ſowing the 16th, and finiſhed the 23d of April; the produce was ſixty buſhels per acre, of good clean Barley, without any ſmall or green corn, or weeds at harveſt; no perſon in this country had better grain.

"I ſowed alſo ſeveral other fields with the ſame ſeed dry, and without any preparation; but the crop, like thoſe of my neigh-

bours

bours, was very poor; not more than twenty bushels per acre, and much mixed with green corn and weeds when harvested. I also sowed some of the seed dry on one ridge in each of my former fields, but the produce was very poor in comparison of the other parts of the field."

The important advantages which Mr. Chapple derived from steeping Barley, are greatly in favour of the method, and his laying the result before the public deserves every commendation. The success attending his experiment would appear incredible, if the testimony had not been so respectable and conclusive. Mr. Chapple's land must have been of a superior quality, as sixty bushels on an acre is a crop almost unprecedented: at all events the material difference between the seed which was steeped before it was sowed, and that which was sowed dry, will certainly bring the custom into general practice.

BROAD EARED BARLEY AND BEAR.

Broad eared Barley is known by the grain being of a broad flat make, both shorter and broader than the long eared Barley, and generally somewhat larger and heavier; this kind is best suited to stiff loam or clay, and should be sowed early, as it does not ripen so soon as the long eared. It produces a small quantity of straw, and that rather coarse, and not so fit for fodder; when kind in its nature it makes strong malt, and yields much meal or flour.

Bear, or Big, is mostly cultivated in Scotland and Ireland, and is sowed in autumn, as we do wheat; it is harder in its nature than the Barleys in general use in England, and inferior in quality, neither producing such good beer when brewed, nor yielding so fine a spirit when distilled.

There is another grain classed with Barley, and called Siberian Barley; it is smooth in the skin like wheat, in colour more resembling rye; it weighs heavy, and of course yields a large quantity of meal; it is not suitable to any purpose except for pigs and cattle, for which it is equal to our common kinds of Barley.

If the practice of cutting Barley more early than is usually done was adopted, samples would be produced at market of a better colour, and the corn would have a much better advantage in case of a casual HARVEST.

SECT. V. OATS AND THEIR CULTIVATION.

OATS are in their nature more suited to our climate than any other kind of grain we are acquainted with; one species of the Oat seems a native, as it grows spontaneous on cultivated land, and cannot be destroyed; but this is a very bad sort, and commonly called a rough Oat: it is held in no greater estimation than the most common weed; all those in cultivation are probably exotics.

The Oat family are very numerous, and, like the human species, are black, white, and of a reddish or copper colour. Those of the white kind are the thin-skined Oat commonly called the Dutch Oat, and the Poland Oat, brought into England from Poland.

Those of the Black kind are, the common Black Oat, in its nature much resembling the Dutch Oat, (colour excepted) and the Siberian Black Oat, resembling the Poland Oat, with the former exception; for which reason it will be needless to speak of them any otherwise than as two sorts, the tawny not being materially different from the Poland Oat.

The White Dutch Oat, and the common Black Oat, are alike thin in the skin or husk, and produce a large kernel. White Dutch Oats as imported in large quantities for seed, every year, from Holland, as they degenerate by being repeatedly planted in this kingdom; and, in process of time, a great many of them become grey. The common Black Oat we believe is seldom introduced from any foreign climate, neither is it cultivated so much as it was some years past. One objection to the Black Oat is, those corns which drop on the land at harvest, growing again the next year with Wheat or Barley, and being mixed with them, has a very unsightly appearance, otherwise they are in every respect as useful and prolific as any Oat that grows.

The Poland Oat, and the Black Siberian, are much thicker in the skin or husk than those we have just mentioned, and the kernel is not larger. This being a material disadvantage, we shall let them pass, and recommend for general cultivation, the White Dutch Oat, which for the food of horses, or to make oatmeal, ranks foremost of those we are at present acquainted with.

Oats accommodate themselves to any kind of soil, and are a more certain crop than any other kind of grain; but, like all others, they never return much profit without good management; and the person who expects a good crop of Oats, because his land is not in condition to produce any thing else, will deceive himself. Although, in the South part of England, Oats are not used for any other purpose except for horses, and a small quantity for grots and oatmeal; in the northern parts of the kingdom they are in great and general estimation, as food for the human species, to which by the temperate mildness of their nature, they are well adapted; and if we judge of the quality of the food by the health and strength of those who eat it, where can we find a race of beings more healthy and strong than the inhabitants of Scotland, and the north of England? where the product of the Oat makes the chief part of the food of the middle and lower classes of the people.

The seed usually allowed for an acre is four bushels, but sometimes more are sowed; but if it is good, and to be depended upon, and the land clean and in good tilth, four bushels are sufficient. Changing the seed from a different kind of soil is by no means to be neglected.

Formerly the custom of sowing Oats was in March and April, and sometimes after the barley seeding; but that custom is now altered, and Oats are generally sowed the beginning of February, or as soon as the season will permit, and are commonly the grain which brings in harvest. We have seen excellent Oats sowed in autumn, which were ripe a month before any other corn; but it is not a custom to be recommended to general practice, as a severe winter will be very likely to destroy them. When Oats are sowed early, it is not requisite to soak or steep the seed, but on the contrary dangerous; but should the seeding, from circumstances, be deferred till the latter end of April, they who steep them all night in water, before they distribute them on the earth, will, taking one season with another, find it much to their advantage.

Oats well managed, and sowed in proper season, are a productive and profitable crop: and as the following experimental information, published in the Bath Society's Papers, and addressed to the Secretary, is curious, and to the purpose, we present it to our readers.

ON BLACK OATS.

"The preceding year the land had carried potatoes, and received one ploughing for a winter fallow.

"In February last another ploughing was given, and on the 27th and 28th of the same month four Winchester bushels per acre of Black Oats were sown; this was earlier by about a month than Oats are generally sown in our parish, and I did it with a view to ascertain the effects of early sowing. When the Oats were ripe, I caused exactly half an acre to be cut with the sickle and sheaved; these were threshed out, the produce was 49½ Winchester bushels, a quantity most amazing in these parts. The success of the crop I impute partly to early sowing, and partly to good deep tillage; and, I believe, the half acre was a fair average of the whole piece.

Expences of an Acre.	£.	s.	d.
Rent	1	0	0
Two ploughings, at 5s.	0	10	0
Cutting	0	3	0
Harvesting	0	5	0
Four bushels of seed, at 2s. 6d.	0	10	0
Sowing and harrowing	0	3	0
	£3	11	0

Produce.			
98½ bushels of Oats, at 2s.	9	16	6
Deduct expences	3	11	0
Profit	£6	5	6

"The straw may be valued in lieu of threshing, conveying to market, &c. but is worth abundantly more than what would defray those expences. NEHEMIAH BARTLEY."

As fodder, the straw of Oats is reckoned sweeter and of more value for cattle than the straw of any other kind of grain, particularly if the crop was not very large and strong. When Oats are a very plentiful crop and grow high, it is good husbandry to reap and bind them in sheaves, as is customary with wheat; by this means they are not so liable to be lost on the land, as no grain so easily beats out as Oats, and although the expence is greater, the saving from waste amply repays it. If the crop is not large, and they do not grow high in the straw, the usual custom of mowing them with the scythe is to be preferred.

Oats are certainly a grain not so exhausting in their nature as wheat, barley, or rye, and better suited to the great variety of soils with which this country abounds; neither does it require so much care to deposit them in the earth, as we have frequently seen in a dry spring Oats sowed upon a clay soil fresh broke up, where apparently they could not be sufficiently buried in the earth to cause them to vegetate, and the heaviest drag or harrow made little impression on the soil, and yet this management has been productive of an excellent crop. We do not mean to infer from this, that it is immaterial whether they are tilled in a proper manner or not, but only to shew the probable advantages which may be expected, provided circumstances are not so favourable as could be wished.

As a proof of the possible produce of a crop of Oats, we should not think ourselves justified if we did not lay before the public an extract from Mr. Young's Annals of Agriculture, Vol. 8. p. 104. and with which we conclude the article; and trust the reader will say, we conclude well.

AN EXTRAORDINARY CROP OF OATS.

"Reaped last harvest by the Rev. Mr. CARNE, Vicar of "ABERFORD, in Yorkshire. The land contained exactly 3 "acres, 1 rood, 10 perches. Before it was under the plough it "produced nothing but rushes, being a wet swampy soil. Mr. "CARNE drained it, and sowed it with Oats, and reaped 314 "bushels. He sold the Oats for 36l. 13s. 6d. and the Straw for "12l. 6s. 2d. amounting to 48l. 19s. 8d."

Let it be remarked, there was neither drilling nor horſe-hoeing in producing this crop.

SECT. VI. BEANS, PEAS, AND THEIR CULTIVATION.

BEANS are of various kinds, but thoſe in common cultivation for agricultural purpoſes are not very numerous; the large common horſe Bean of a longiſh ſhape is moſt in general uſe; and one of a much ſmaller kind approaching in ſhape and ſize to that of a pea, but rather long than round; this in ſome counties is called the Berkſhire Bean, and in others the tick Bean. They are doubtleſs very prolific in their nature, branching a number of ſtems from the ſame root, each of which is frequently armed with pods from top to bottom; curious perſons have been induced to number the product of a ſingle Bean, and have diſcovered three hundred and upwards ariſe from one.

This brings to our recollection a circumſtance, a-propos, which happened at Bourton on the Hill, in the county of Glouceſter. A perſon, by profeſſion a taylor, walking in the field, accidentally picked up a Bean-ſtalk, and on a minute inveſtigation diſcovered that its contents of fair marketable Beans amounted to upwards of eighty; revolving this demonſtrative truth in his mind, the obvious profits attending on the buſineſs of a farmer wanted no further proof; and having a ſmall farm of his own in the parish, which he had acquired by induſtriouſly purſuing his trade, gave his tenant notice to quit, and immediately commenced farmer, converting his *ſhears* into plough ſhares, and his *needles* into weeding hooks. Thus having quitted the ſhop-board, his next object was, to ſtarm out of the beaten track of obſtinate farmers; of courſe being a man of letters, he purchaſed books, and became an admirer and diſciple of the celebrated Jethro Tull. Drilling and horſe-hoeing were the only profitable methods for an enlightened farmer to purſue; if one bean produce an hundred, what occaſion could there be to throw ſeed away in the common method? Like a true experimentaliſt, this ſhred of a farmer went drilling on, condemning and deſpiſing every body who was not as wiſe as himſelf; till at length he diſcovered that the ſyſtem which he followed was deſigned for experiment only, and that thoſe who were its advocates never thought of getting money; it was having too much that made them diſcontented and whimſical.

To alter his plan it was too late, for his eſtate was mortgaged, and his credit became bad: there was no reſource, but to return to the deſerted *bodkin and thimble*; but, alas! his eyes were waxed dim; he could not ſee to thread the needle; hard labour had made his hands ſhake; he pricked his fingers as often as the cloth. To conclude this detail, this unfortunate and induſtrious man from this period lived and died a pauper. We hope to be excuſed for this ſhort digreſſion, which contains nothing but the plain truth; our readers may comment upon it as they pleaſe.

Beans are reckoned a meliorating rather than an exhauſting crop, and are beſt to plant on wheat or barley ſtubble, where the ſoil is of a mellow, friable nature, and the roundneſs or convexity of ridges not too great. Drilling Beans may anſwer the purpoſe very well; but on ſtiff clay, or loam, drilling will ſcarcely be found practicable, except the land is in excellent tillage, and the ſeaſon very favourable. Dibbling, or ſetting, may be practiſed almoſt any ſeaſon, and on any kind of ſoil; the diſtance between the rows about twelve inches, and between each Bean in the row two inches; it is an error to drop more than one Bean into each hole you make with the ſetting ſtick or dibble: Beans planted in this manner ſhould be well hoed twice or thrice in the courſe of their growing, obſerving each time to hoe before the weeds become high or ſtrong, as cutting them in their infant ſtate bids fair to deſtroy them.

As novelty is generally ſought after with eagerneſs, particularly when it is blended with ſomething of the wonderful, we preſume the following letter by Mr. JOHN BULT, of Kingſtone near Taunton, to the Secretary of the Bath Society, will be acceptable.

ACCOUNT OF A CROP OF BEANS AND TURNIPS IN ALTERNATE ROWS.

"IN reply to your inquiries relative to my drilled crop of Beans, with the turnips in the intervals, I ſend you the following particulars: The field meaſures ſix ſtatute acres and a quarter, and is a good clayey ſoil. The Beans were planted in drills near two feet a-part on two ploughings, and horſe hoed three times, the turnips being ſowed in the intervals at the third or laſt hoeing.

"There has been no kind of manure or dreſſing laid on the land for ſix crops paſt, nor is there any need of it; as I find by experience that drilling and horſe-hoeing fully anſwer the end. The crop of Beans was near three quarters per acre.

"The quantity of turnips was thirty ſeven tons five hundred weight, as meaſured and weighed by Mr. Pavier, and Mr. Headford: theſe turnips are now feeding off. Thirty-one head of horned cattle, ſixty-ſeven ſheep, and twenty-ſix pigs, have been maintained by them for a month paſt; and what remains will keep them at leaſt a month longer. The whole expence of drawing and carting them into an adjacent field for the cattle, is between ſix and ſeven ſhillings per acre. "I am, &c.

"JOHN BULT."

Mr. Bult's ſurpriſing ſucceſs is enough to rouſe every farmer, who regards his own intereſt, to the horſe-hoeing ſyſtem; thoſe who feel themſelves diſpoſed to make the experiment, we wiſh them ſucceſs. This account by Mr. Bult is further confirmed by two letters on the ſame ſubject, by Mr. Thomas Pavier, of Weſt-Monckton. Were we to form any conjecture on this buſineſs, it would be that Mr. Bult's land was of a ſuperior quality; but admitting that to be the caſe, he has no reaſon to repent his management.

Mr. Wimpey, in a letter addreſſed to the Secretary of the Bath Society, Vol. V. p. 38. remarks, "that Dr. Anderſon is of opinion, the Pea and Bean tribe continue the ſame without varieties, though they ſhould be reared in the moſt promiſcuous manner. With reſpect to the Doctor's obſervations upon Peas, he has nothing to offer againſt it; but he obſerves, with all due ſubmiſſion to the Doctor, he muſt think he is certainly miſtaken with reſpect to Beans; for (ſays Mr. Wimpey) I planted a field chiefly with garden Beans of moſt of the ſorts known; they were planted in rows about a yard aſunder, in the following order: mazagan, white bloſſom, long-podded, ſandwich toker, and laſtly, Windſor. The mazagan and white-bloſſom were threſhed firſt, when to my great ſurpriſe, I found I had quite a new ſpecies, or rather ſeveral. The mazagan, inſtead of being of their natural colour, were mottled black and white; the white-bloſſom, inſtead of their natural jetty ſhining black, were brown and yellow blended together, and both much larger than uſual. The long-podded, were alſo very much of the ſame colour. Here then is an undeniable proof that Beans, of ſome ſorts at leaſt, are as ſubject to ſeminal variations, as any claſs of plants whatever. I aſſert this with great confidence, as the experiment was not made on a ſmall trifling ſcale, for I had eight or ten ſacks of theſe Beans, which I had agreed with a ſeedſman for, at 5s. a buſhel. When they were threſhed, I wrote him word what happened, and diſpoſed of them among my hogs and horſes. It may be of ſome uſe to obſerve here, that I ſuffered no loſs by this unexpected accident, as at firſt was apprehended, for they turned to better account than they would have done if ſold at the price before-mentioned. I have ſince found, by repeated experience, that Beans are a much more hearty and profitable food for horſes than oats. Being out of old oats the two laſt ſprings, I ſubſtituted horſe-beans in their ſtead. In the room of a ſack of oats with chaff, I ordered them a buſhel of Beans with chaff to ſerve the ſame time. It very ſoon appeared the Beans were ſuperior to the oats, from the life, ſpirit, and ſleakneſs of the horſes. Valuing the Beans at 40s. per quarter, and the oats at 20s. the keep of the horſes with oats would coſt juſt double what it did in Beans, and not ſo well kept."

As the broad Windſor Beans are ſometimes planted for agricultural purpoſes, we ſhall mention a few circumſtances reſpecting their cultivation. They ſhould be planted on ſtrong rich land about the beginning of April, if the weather permits, and ſet or dibbled in rows of eighteen or twenty inches aſunder, and four inches diſtance from Bean to Bean in the rows, and ſhould be hoed twice or three times. To make them pod the better, and to facilitate their ripening, it is good management, if the crop is luxuriant and ſtrong, to cut about two inches off the top of each Bean (with a reaping hook, or ſome ſuch inſtrument) juſt at the time the bloſſom begins to fall; this labour is quickly performed, and gives the ſun admiſſion, and keeps the ſap down to nouriſh the Beans, which is eſſentially neceſſary, as the principal objection to their cultivation for ſeed is the lateneſs of their ripening.

Theſe Beans, and all others of the Bean kind, when the crop is large and good, ſhould be reaped as ſoon as the ſtraw begins to turn black. The beſt method of managing Beans is what they call, in the inland counties, pucking them; that is, ſetting them up in ſingle ſheaves extended wide at the bottom, and tied together at the top, in a conic ſhape, reſembling a ſugar loaf; this, in the countries where it is practiſed, is done for four or five ſhillings per acre, and we have known them ſtand in the field till the middle of November, and when threſhed there has not been a black or decayed Bean in the ſample.

PEAS.

There are ſeveral kinds of Peas in cultivation, of various colours and ſhapes. The grey Peas moſt commonly ſowed in fields are the early Charlton and the common late ripe pea; theſe do not flouriſh ſo well in the clayey ſoil; but on all ſoils, which bear corn good of other kinds, you may naturally expect good grey Peas; they ſhould be planted as early as the ſeaſon will permit, and generally ſowed under furrow or ploughed in; but the only proper management is to drill them if circumſtances will admit, and if not, ſet or dibble them. White and blue Peas ſhould be planted on a good friable loam, or on a ſandy or gravelly loam; in March, or the beginning of April, ſome land will produce ſuch Peas as will boil tender, and other kinds of land will not; there is no juſt and infallible rule by which the proper ſoil to produce ſuch as will boil tender can be aſcertained, therefore experience alone muſt determine this point. As Peas are planted for a meliorating crop, they ſhould never be

ſowed

ſowed broad-caſt, as by that means hoeing is prevented, which is of great ſervice to the crop of Peas, and doubly ſo to the land for the ſucceeding tillage. There is a large egg ſhaped Pea lately introduced, called the American Pea; which, if planted on warm rich land, anſwers extremely well; but if land is not of that deſcription, we by no means would recommend its cultivation out of the garden; but for culinary purpoſes they are ſuperior to any kind that are known in this country.

Peas of all kinds ſhould be cut before they are too ripe, otherwiſe the pods will open, and a great loſs will be ſuſtained by their ſhedding on the ground, particularly ſhould the weather be unfavourable. Mowing Peas with a ſcythe may with juſtice be called a ſlovenly practice, whether they were planted broad caſt, or in rows by drilling or ſetting. The beſt method to cut them is with a hook, like a reaping hook fixed to a ſtick 3 feet long or upwards, and generally called a ſtaff-hook; although ſome prefer a common reaping hook to cut them with, and a hooked ſtick or an old ſickle in the other hand, which is very uſeful in parting them, in order to place them in ſmall cocks or heaps. Practice, which renders all things familiar, induces ſome to prefer one way and ſome the other; in either method care ſhould be taken not to make the heaps too large; in fact, you cannot err by making them too ſmall.

SECT. VII. VETCHES OR TARES, RYE, BUCK-WHEAT, LENTILS OR TILL, AND THEIR CULTIVATION.

THE kinds of Vetches (or perhaps, as they are more generally called Tares) which are cultivated in this kingdom, are the winter Vetch, which is of a ſmall kind, and ſowed in autumn; and the ſpring Vetch ſowed in ſpring; theſe are ſeldom uſed for any other purpoſe, except as green food for cattle of all kinds.

Sometimes they are mowed and given to horſes in the ſtable, or to horned cattle in yards, and ſometimes eat off the land by ſheep or young cattle, in the manner of turnips. As Vetches, when they are ſowed on warm dry land in autumn, or the latter end of ſummer, produce early ſpring-feed, their cultivation is particularly neceſſary where graſs lies backward, to ſupply the ſpace between the finiſhing of the turnip crop and the time when natural graſs is in condition to have cattle turned into it. This is an acquiſition of material conſequence to every farmer, as green food is always at that time much wanted, for ſheep in particular; for breaking or turning cattle into paſture early in ſpring before graſs has attained any forwardneſs, is keeping herbage low all the ſummer, by nipping the tender plant before it has arrived at any degree of ſtrength. Winter Vetches ſhould be ſowed as ſoon as poſſible after the preceding crop is cleared off the ground, that they may acquire ſufficient ſtrength before the ſeverities of winter appear, which will alſo render them forward in the ſpring.

Spring Vetches are ſowed any time in ſpring to follow thoſe of the winter kind, and may, if requiſite, be ſowed from time to time, to procure a ſucceſſion of crops during the ſummer. After early Vetches are ſpent, there is a very good opportunity of giving land a partial ſummer fallow. We have known buck-wheat ſowed in May, or the beginning of June, after Winter Vetches, and ploughed in to manure the land for a crop of wheat or ſpring corn; and if land is clean from weeds, it is certainly excellent management, particularly on land of a light texture.

The Rev. Mr. LAURENTZ, of Bury St. Edmunds, an intelligent gentleman, who correſponds with Mr. Young, has proved, from ſeveral demonſtrative experiments, that the winter and ſpring Vetch are by no means calculated as ſubſtitutes for each other, although it is a prevailing opinion that both will anſwer the ſame purpoſe: theſe experiments are ſo clear, that we would wiſh to caution the huſbandman in this particular.

The wild Vetch, or Tare, has been lately cultivated in a particular ſucceſsful manner by the Rev. Mr. Swayne; and if the ſeeds can be preſerved, bids fair to become an article of importance in Agriculture. As we cannot do juſtice to this gentleman's curious and uſeful experiment if we abridge or alter his letter, we ſhall lay it before the public in his own words, as communicated to the Bath Society.

ON THE CULTURE OF THE BUSH VETCH.

By the Rev. Mr. SWAYNE, of PUCKLECHURCH.

"The plant which the ſtatement reſpects is, the Buſh Vetch, or, botanically, according to Linnæus, (Vicia Sepium.) It is not only a perennial, but an ever-green: it ſhoots the beſt ear in the ſpring of any plant eaten by cattle with which I am acquainted, vegetates late in autumn, and continues green through the winter; add to this, cattle are remarkably fond of it.

"IN the autumn of the year 1782, I collected a quantity of theſe ſeeds from the hedges, &c. March 15th, 1783, I ſowed them in drills in a plat of ground in my kitchen garden, which meaſured exactly five yards ſquare; they were ſown in eight drills, as thick in the drills as I would have ſown peas. They came up very thin and irregular; in ſome places there was more than a foot vacancy between plant and plant. This I was much ſurpriſed at, as the ſeed had been carefully preſerved during the winter, and I could not, from their appearance at the time of ſowing, ſuſpect them to be in the leaſt defective. The plants grew very ſparingly till towards the autumn, but before winter they made a tolerable appearance. This plat is in the moſt expoſed part of my garden; the ſoil a blackiſh loam, rather ſtiff; it had been planted with potatoes the year before, for which I believe it was dunged, but am not certain; the two preceding years it was uſed as a nurſery for Lombardy poplars.

"Early in July 1783, I collected ſome more of theſe ſeeds from the hedges, tied them up in a paper, and put them in a drawer of my bureau. Upon opening the paper in September, I obſerved a vaſt number of dead flies in it, and many of the ſeeds with a ſmall hole in each. The number of the flies were 280. The whole number of the ſeeds 1080. Theſe flies, upon examination, proved to be a ſmall ſpecies of ichneumon. This puzzled me not a little, as I had learnt that theſe inſects were termed a race of cannibals, from their larvæ or caterpillars always feeding on other inſects. Upon this I opened many of the other ſeeds that had no holes in them, and in ſeveral of theſe diſcovered another inſect, alive, and in different ſtates of its growth. This proved to be the *bruchus piſi* of Linnæus, a near relation of the weevil [*curculio*] and the atelabus. From hence I ſurmiſed, that at the time when the buſh-vetch bloſſoms the female bruchus lays her egg within the bloſſom, and the ichneumon immediately after depoſits her egg in the ſame place.

"After the froſts were over, I was much pleaſed to obſerve, that ſcarce a plant of my vetches had been killed by them, and their verdure very little injured. In April 1784, they had entirely filled up the ground, and were beginning to flower; at this time I found, as I expected, numbers of the bruchi intruding themſelves into the bloſſoms, before they were ſcarcely open, and the attendant ichneumones ready to follow them. I uſed every method I could think of to chaſe away theſe inſects from my crop, by ſtrewing ſoot over, kindling ſmoaky fires around, &c. but all to no purpoſe.

"In the beginning of May the Vetches were in full bloſſom, and it was amazing to ſee what a crowd of inſects were ſwarming about them. At that time I intended to preſerve the Vetches for ſeed; but ſome time after, obſerving that they were beginning to rot from their over-luxuriance, I cut them, without taking any particular account of the produce. They were cut twice afterwards during the ſummer. Having remarked in general that the produce of theſe cuttings was very great, I was determined this year to keep a particular account.

"Accordingly, March 16, 1785, I began to cut the Vetches for the firſt time this ſeaſon. This cutting weighed green 16lb. I did not dry any part of it, but muſt ſuppoſe, that if dried, it would have weighed at leaſt one-fourth, as it was not near ſo ſucculent as any of the after-cuttings. May 17th they were cut a ſecond time, in full bloſſom, and weighed 130 pounds,—36lb. of the green fodder weighed when dry ſix pounds. July 21ſt. they were cut a third time, and weiged 62lb.—33½ lb. green weighed 8lb. dry. Sep. 30th, they were cut the fourth time, and weighed green 72½lb.—15lb. green weighed 2½lb. dry. The whole plat then of twenty five ſquare yards produced,

	lb.			lb.	
1ſt cutting	16	green	ſuppoſed	4	dry
2d ditto	130	ditto, would have weighed		21½	dry
3d ditto	62	ditto, would have weighed		14	dry
4th ditto	76½	ditto, would have weighed		12½	dry
Total	284½	green		52	dry

"An acre therefore, (reckoning 4840 ſquare yards to the acre) in the ſame circumſtances would have produced the total amount of

Tons.	cwt.	qrs.	lb.	
24	11	3	3	green
4	9	3	15	dry fodder.

"N. B. You are to recollect, that at the time the firſt cutting was made, there was ſcarce a blade of graſs to be ſeen; and that the ſeaſon, till after the third cutting, was as unfavourable to vegetation as perhaps any in the memory of man.

"Your obliged humble ſervant,

PUCKLECHURCH, Oct. 13, 1785. G. SWAYNE."

As every perſon converſant in Agricultural concerns muſt have ſeen this plant in its wild ſtate, we can only wiſh to impreſs the probable idea of its promiſing utility on the minds of thoſe who endeavour to promote the art, not doubting but their labours will be crowned with ſucceſs.

RYE.

Rye was formerly ranked next to wheat as bread corn, but its reputation as food for the human ſpecies has been on the decline for many years, although in ſome places a ſmall quantity continues to be mixed with the wheat: this gives bread a diſagreeable ſweetneſs, and, to thoſe who are not accuſtomed to eat it, is productive of pains in the bowels, and other unpleaſant ſymptoms. It is adapted to a ſandy ſoil, not kind for any other ſort of grain, which may be the cauſe of preſerving the ſhare of repute it continues to hold as grain.

Rye ſown upon ſtubbles in autumn produces very early ſpring feed, for which purpoſe it is very uſeful. For ſheep, ewes and lambs in particular, it is of infinite ſervice, as it vegetates earlier in the ſpring than any other kind of ſeed; this was the motive

which induced us to range it with ſpring ſeed. It is for want of providing ſpring food for cattle, that people are obliged to have their ewes yean late, and without which they cannot ſupport their lambs, ſhould they come earlier; and if that is the caſe, without rye or ſome other early feed, they are under the neceſſity of eating the grounds which are intended to be mowed for hay, till perhaps the middle of May.

If a dry ſeaſon follows, theſe grounds are burned up, and the expected produce of hay wholly, or in a great meaſure, deſtroyed: this might frequently be prevented by ſowing rye, and eating it off early, and then plough and manage as neceſſity or convenience permits for turnips. Rye is a very exhauſting crop, if harveſted; but not ſo if it does not ſtand the ſummer.

BUCK WHEAT

Is a native of the Eaſt, and uſed for making bread, in the country from whence it was imported into this kingdom; but with us it gives place to Wheats of a much ſuperior quality. Buck Wheat will grow on a very barren ſoil, which requires very little previous preparation, and ſhould not be ſowed till all other ſpring ſeeding is over. Buck Wheat is only proper to ſow on land of low value, and, as a Norfolk gentleman obſerves, "can never anſwer on deep rich land worth a guinea per acre, as on ſuch land it produces too much ſtraw. Like all other full running crops it prevents the growth of weeds, and in Suffolk is ſown with graſs ſeeds for the purpoſe of laying down land;" but we can by no means ſubſcribe to a doctrine of that kind, as what prevents the growth of weeds will of courſe prevent the growth of tender graſſes.

The principal advantage of Buck Wheat in Agriculture is, undoubtedly as manure on light lands, which are awkwardly ſituate for manures of other kinds: ſowing Buck Wheat after rye or winter vetches, about the latter end of May, ſeems a very rational and improving ſyſtem on poor land.

E. HOLMES, Eſq. of Scorton in Yorkſhire, obſerves, in his correſpondence with Mr. YOUNG, that turnips on ſuch ground are to be preferred: we agree with him that turnips, in every reſpect where profit is conſidered, would be ſuperior; but on poor land, which has been run too hard and exhauſted, and has alſo been frequently ſowed with turnips, there is more difficulty to raiſe a tolerable crop of them than perhaps Mr. HOLMES is aware of.

Moſt farmers who have been uſed to the turnip cultivation are well convinced they are not raiſed on land, which has growed them ſeveral times, without expenſive dreſſing of good manure, even on good loamy rich ſoil. Buck Wheat being adapted to light land we make no heſitation in recommending it as excellent management as above directed, and greatly before turnips on a poor light ſoil. (See VEGETABLE MANURE, in Sect. II.)

LENTIL, OR TILL.

The common *Lentil* with compreſſed ſeeds which are convex, is cultivated in many parts of England, either as fodder for cattle, or for the ſeeds, which are frequently uſed for ſoups. This is an annual plant. It riſes with weak ſtalks a foot and a half high, garniſhed with winged leaves at each joint, compoſed of ſeveral pair of narrow lobes, terminated by a tendril or claſper, which faſten to any neighbouring plant, and is there ſupported; the flowers come out in May, upon ſhort foot-ſtalks from the ſide of the branches; they are ſmall, of a pale purple colour, and are ſucceeded by ſhort flat pods, containing two or three ſeeds, which are flat, round, and a little convex in the middle. The ſeeds of this plant are ſown in March on dry land, and in April on wet land and ripen in July. The uſual quantity allowed, is from a buſhel and a half to two buſhels an acre. If theſe are ſown in drills, like peas, they will ſucceed better than when ſowed the common way; the drills ſhould be a foot and a half aſunder, to allow room for the Dutch hoe to clear the intervals.

Lentils make excellent green and ſweet fodder, and are therefore to be preferred to all other kinds for calves and other young cattle. They are likewiſe the beſt as well as cheapeſt food for pigeons, and for hay to make horſes in good condition, ſuperior to every other kind: when deſigned for hay they ſhould be cut juſt after the pods or kids are formed.

The ſeeds of Lentils are frequently the common food of the poor, in ſome of the iſlands of the Archipelago, and other warm countries, when they can meet with no better fare.

Another ſort of Lentils has of late years been cultivated in England, under the name of French Lentil. This is the *lens Major* of Caſper Baukine; and being twice the ſize of the common Lentil is by ſo much the better worth cultivating. This is called till in many parts of England. Miller's Gard. Dict.

SECT. VIII. TREFOIL OR CLOVER, AND RYE-GRASS.

The ſpecies of Trefoil, or Clover, commonly cultivated in the open fields for food of cattle, are the red Dutch clover, the white Dutch clover, and the hop-clover.

Red Clover.

The *common Red Clover* is well known, though it has been ſometimes confounded with the red meadow *Trefoil*, which is a diſtinct ſpecies. The ſeeds of the common clover have, in conſequence of the extenſive cultivation of it for many years, been ſpread over moſt of the Engliſh paſture, ſo that there are few of them which have not clover mixed with the other graſſes; and hence, ſome botaniſts have been led to ſuppoſe, that the meadow *Trefoil* has been improved to this by dreſſing of the land.

Since the Red Clover has been cultivated in England, our clay lands, which before produced little but Rye-graſs and other coarſe bents, have been greatly improved: for by being ſown with Red Clover, they have produced more than ſix times the quantity of fodder they uſed to do, whereby farmers have been enabled to feed a much greater ſtock of cattle, and the ground has been enriched and prepared for corn. Where the land is kept in tillage, it is the uſual method among farmers, to lay down their ground with Clover, after having had two crops of corn whereby there is a conſtant rotation of wheat, barley, clover, or turnips, on the ſame land. The clover ſeed is commonly ſown with barley in the ſpring, and when the barley is taken off, the clover ſpreads and covers the ground, and this remains two years, after wich the land is ploughed again for corn. If the land be very dry, ſome recommend ſowing it with black oats as early in the ſpring as poſſible, that it may get up while the ſpring rains laſt, and acquire ſtrength before the dry weather ſets in. Some ſow it with wheat or rye at Michaelmas; this gives it an opportunity of ſhedding its ſeed on the ground, and thus the crop of the next year is rendered much ſtronger than it would have been made by any other means; but in this caſe it is beſt to ſow it upon dry lands, which will bear the ſowing both of wheat and rye upon broad ridges which is uſually very ſucceſsful, if a mild winter follows; but if there are long and ſevere froſts, or deep ſnow, it is very hazardous.

Some farmers ſow rye-graſs with the corn at Michaelmas, and early in the ſpring they ſow clover, which they only cover by rolling it. The beſt management ſeems to be the feeding of it bare before winter comes on and then it is ſafe; for the froſts, though they often deſtroy the leaves of the clover, yet never hurt its roots, unleſs they happen to lie bare.

Clover is a biennial plant, whoſe roots decay after they have produced ſeeds; but by eating it down, or mowing it when it begins to flower, the roots are made to ſend out new ſhoots, and the plant is continued longer than it would naturally. The common allowance of ſeeds for an acre of ground is ten pounds. In the choice of the ſeed, that which is of a bright yellow colour inclining to brown ſhould be preferred, and the pale coloured thin ſeed rejected. The goodneſs of the ſeed may be eaſily determined by throwing it into a glaſs of water; that which ſinks is good, but that which ſwims is bad, and will never vegetate. Clover delights moſt in a rich warm ſoil, and always thrives beſt in thoſe lands which have been well dunged or manured; but the clay lands which are long in ſwarding, or acquiring a coat of graſs, and are little ſubject to weed, are the beſt lands for clover; becauſe in thoſe light lands, where the common graſs grows ſpeedily, it ſoon eats out the clover. Beſides, the ſoil in theſe light lands is eaſily waſhed away from the roots of the clover after ſhowers of rain, and then the roots, thus left bare, are killed by the firſt froſt that happens. In good ground clover will bear crops for three or four years, but no longer, even in the moſt proper ſoil, and with all the neceſſary cautions.

The clover-ſeed, when ſown with barley, ſhould be ſown after the barley is harrowed in, otherwiſe it will be buried too deep; and the ground ſhould be afterwards rolled, in order to preſs the ſeeds into the ground; but this ſhould be done in dry weather, leſt the ſeeds ſhould burſt, or adhere to the roller.

Such is the method generally practiſed in the ſowing of this ſeed with corn; but Mr. Miller and others recommend ſowing it alone; for the corn prevents the growth of the plants until it is reaped and removed, ſo that one whole ſeaſon is loſt, and a great crop of corn ſpoils the clover; where, when it is ſown without another ſeed, the plant will come up more uniformly and much quicker than that which was ſown the ſpring before under corn. Mr. Miller therefore adviſes to ſow the ſeeds in Auguſt, when there is a proſpect of rain, which will cauſe the plants to ſpring, and thus they will get ſtrength before winter. In October, when the ground is dry, the clover ſhould be well rolled, which will preſs the ſoil cloſe to the roots, and cauſe the plants to ſend out more ſhoots; the ſame operation ſhould be repeated in March. Mr. Miller prefers this ſeaſon for ſowing the ſeeds rather than the ſpring, becauſe in the ſpring the ground is cold and wet, and if much rain falls after the ſeeds are ſown, they will rot, and when they are ſown late, they often will not grow.

About the middle of May the clover will be fit for mowing, when great care ſhould be obſerved in making it, as it will require more labour and time to dry than common graſs, and will ſhrink into leſs compaſs; but if it be not too rank, it will be found exceeding rich food for cattle. The time for cutting it is when it begins to flower; for if it ſtands much longer, the lower part of the ſtems, and the under leaves, will begin to dry, and yield a leſs quantity of hay, and that not ſo well flavoured. Some perſons cut three crops in one year of this graſs; but the beſt way is to cut but one in the ſpring, and feed it the remaining part of the year, whereby the land will be enriched, and the plants grow much ſtronger.

One acre of clover will feed as many cattle as four or five acres

acres of common graſs; but care ſhould be taken to let them feed upon it gradually at firſt, leſt it burſt them. For this purpoſe they ſhould be allowed to eat it only for half an hour or an hour in the middle of the day, when there is no dew upon the graſs; and ſo every day they may remain a longer time, till they are fully ſeaſoned to it. But they ſhould never be fed on clover in wet weather; when they have been accuſtomed to it, they ſhould be turned out at night, and ſupplied with hay or ſtraw, which will prevent the pernicious conſequences of the clover. Some ſow rye-graſs among the clover, in order to check the richneſs of the crop; but this is not adviſeable, as the rye-graſs will obſtruct the growth of the clover, and the ſeeds ſcatter and fill the ground with bents.

When the cattle are fed with the hay of clover, the beſt way is to put it in racks, otherwiſe they will tread a great quantity of it down with their feet. Clover is much better for moſt other cattle than for milch-cows, which ſhould rarely have any of it; though, when it is dry, it is much leſs injurious to all cattle than when it is green.

When clover is preſerved for ſeed, the firſt crop in the ſpring ſhould ſtand till the ſeeds are ripe, which may be known by the ſtalks and heads changing to a brown colour; then it ſhould be cut in dry weather, and houſed till winter, when it may be threſhed; or if the ſeeds are wanted for immediate ſowing, it may be threſhed out before it is houſed or ſtacked. In either caſe it ſhould be well dried, otherwiſe the ſeeds will not quit their huſks. By proper precaution two buſhels of ſeed may be procured out of an acre of good land, where the clover has throve.

WHITE CLOVER.

The *white Dutch clover* grows naturally in moſt of the paſtures in England, and is generally known by the name of white honeyſuckle graſs. It is an abiding plant, and ſends out roots from every joint, ſo that it makes the cloſeſt ſward of any of the ſown graſſes, and is the ſweeteſt food for all ſorts of cattle yet known. In land deſigned for continued paſture, a quantity of ſeeds of this plant ſhould be ſown with the graſs-ſeeds. It ſhould never be ſown with corn; but if it be ſown in the ſpring without corn, it will afford a crop of hay fit for being mowed by the middle or latter end of July, and a much better after-feed for cattle the following autumn and winter, than the graſs which is ſown with corn will produce the ſecond year. The ſeed may alſo be ſown with graſs-ſeeds in autumn, as before directed for the common red clover; and this autumnal ſowing will afford a good early crop of hay the following ſpring; and if, after the hay is taken off, the ground is well rolled, it will cauſe the clover to form a thick ſward. The ſeeds of this ſort of clover are annually imported from Flanders, by the way of Holland, whence it is called Dutch clover. In this country the ſeeds have not been long collected for ſowing; but this ought to be done by the farmer, who ſhould ſow an acre or two of this white clover by itſelf for ſeeds.

HOP CLOVER.

The *hop-clover*, or yellow meadow *trefoil*, grows naturally among the graſs in moſt of the upland paſtures in this country; but the ſeeds are frequently ſold in the ſhops, and are mixed with other ſorts of clover and graſs-ſeeds, for laying down ground to paſture. There are two ſorts which grow naturally in England, one called the *hop-clover*, becauſe the flowers are collected into oval imbricated heads, with naked empalements, lying over each other like ſcales, in a manner reſembling the flowers of hops; the other ſort is the *leaſt yellow hop-trefoil*, called non-ſuch, or black ſeed; and as the plants of this ſort are not abiding, they are not proper to be ſown where the ground is deſigned to continue in paſture; but in ſuch places where one or two crops only are taken, and the land is ploughed again for corn, it may do well enough when mixed with other ſeeds, though the cattle are not very fond of it when green, unleſs it be very young. The large ſort is the moſt profitable, though it is often mixed with a ſmaller kind, and alſo with the ſmaller melilot, which is commonly called non-ſuch, and ſometimes black-ſeeds. But theſe ſeeds deſtroy the beauty of the verdure, as they form unſightly yellow patches.

The *hop-clover* is greatly recommended for the following reaſons. 1. It not only grows, but flouriſhes in the moſt barren lands, and therefore muſt be a very proper graſs to cultivate on ſuch unfertile ſoils where any other graſs that is worth notice will not grow at all. 2. It is not ſo apt to ſwell cattle as the red clover does. 3. In good ground it will continue long, and bear a very good ſeed or crop, and by its flouriſhing both on ſands and clay, which have not been ploughed for many years, it ſeems likely to continue long in any ſoil. They commonly allow twelve pounds of ſeed to an acre. Clover is better adapted to all kinds of chyey, ſtrong ſoils, than any other kind of graſs, and is very frequently, and with great propriety, ſowed among wheat on ſtrong land in the ſpring. Land that has been repeatedly planted with Clover becomes ſatiated, or tired, particularly if it is mowed twice the ſame ſummer, or let ſtand for ſeed: when either of theſe methods are practiſed, a more exhauſted crop than clover cannot be cultivated, nor any more profitable if attended with ſucceſs in harveſt. When Clover is cut for hay it ſhould be at the time the bloſſom begins to put forth, which moſtly happens the end of May or the beginning of June: the earlier it is cut the firſt time, the more luxuriant and quick will the ſhoots put forward for the next crop, and the leſs will the land be exhauſted.

RYE GRASS.

This valuable plant ſeems to have loſt ſome of its reputation amongſt the experimental gentlemen of the preſent day. Mr. Young, in particular, bears it no kind of good will: if he cultivated a large track of light loamy land, we have not a doubt but he would mix one or two buſhels of Rye Graſs with four pounds of white clover and ſix of trefoil, in laying it down for two or three years, as light lands and braſhy loams require more reſt than one year. For lands which are tillage and paſture alternately, no artificial graſs is equal to Rye Graſs: its early appearance in ſpring, and its kind flouriſhing ſtate on land that is tired with, or not natural for, clover, will ſecure Rye Graſs a reſpectable name among artificial graſſes.

SECT. IX. SAINTFOIN, LUCERNE, AND BURNET.

SAINTFOIN, in ſome countries called Cinquefoil, is ſaid to have been introduced into this kingdom as early as the reign of Richard II. who brought the ſeeds with him from Paleſtine on his return from the Holy Wars, and is on that account called Saintfoin. It is a plant of great and important utility in Agriculture, and the more ſo as it flouriſhes beſt on poor rocky land, where no other cultivated graſſes will; this is certainly a very material advantage, and, what is further extraordinary, the cultivators of Saintfoin deem poor light land in the beſt ſituation for planting Saintfoin, even when ſo foul with couch graſs, and ſo exhauſted by being over-cropped, that it will produce nothing elſe. This doctrine is really ſurpriſing, but we have frequently ſeen excellent Saintfoin grow on land exactly in the condition of that we have juſt deſcribed; whether it would have been better if the land had been clean and in good condition we know not, but the proprietor aſſerted that he was well ſatisfied with his management.

Saintfoin is ſometimes ſowed alone, always in ſpring about the time of barley ſowing, after the land has had two or three winter ploughings; but the beſt and moſt common method is to ſow it with oats or barley, and not to ſuffer any cattle to feed it the next winter or ſummer following, nor yet to mow it the firſt ſummer; but let the ſeed drop on the land, which will greatly increaſe the plant. It is deemed good management to mow Saintfoin for hay every year, and ſome perſons are ſo particular that they never ſuffer a ſheep to feed upon it; we do not apprehend ſheep do a material injury to Saintfoin, if they are kept from it in autumn and all the winter; indeed, it is neceſſary it ſhould be kept free from cattle during this ſeaſon. Saintfoin may be ſowed after the ſpring corn is up, as it requires a very ſlight harrowing to bury it ſufficiently, it being natural to ſtrike root. Three buſhels and an half, or four buſhels, are ſufficient to plant an acre.

A great fault reſpecting Saintfoin hay, is permitting it to grow too long before it is cut; the cuſtom being not to cut it till it is in full bloſſom; whereas if it was mowed juſt at its coming into bloſſom, the hay would be greatly ſuperior in quality, the leaves would not beat off in making, and the ſecond crop or aftermath, would grow much ſtronger. There is very little nourliſhment in Saintfoin hay which has been over-grown, and when it is cut with its juices in perfection, there is not any hay equal to it in goodneſs for all kinds of cattle.

The experimentaliſts recommend the drill and horſe-hoeing ſyſtem with Saintfoin; this may anſwer in a garden, or on a ſmall ſcale for the ſupport of a horſe and cow, but to keep good land in ſuch an expenſive courſe of tillage, to produce a crop which will grow without trouble or expence on a ſoil which will ſcarcely grow any thing elſe, muſt be extreme folly. Saintfoin ſtrikes its root very deep, particularly on a hollow rocky land which is the beſt adapted for its culture, and will continue in perfection from twelve to twenty years; when the land is brought into tillage again, the beſt method is to pare and burn it, and plant turnips, or wheat. Let it be noticed, that when a crop of Saintfoin has ſtood its time, and the land is again converted to tillage, Saintfoin will not grow kind a ſecond time without a long interval.

LUCERNE.

Lucerne is the *Herba Medica* of the ancients; the high eſteem they held it in appears by the extraordinary attention they beſtowed on its culture. Its roots are very large: thoſe which are above the ſurface are clothed with bark like a tree. From this, and by its ſtalk ſpringing juſt below the place where they were cut off, and the hardneſs of the ſtalks when they ſtand too long without cutting, it ſeems that Lucerne is of a nature nearly approaching to that of a ſhrub. As green fodder it is excellent for all ſorts of cattle, and as hay it is eſteemed of a very ſuperior quality; and with reſpect to quantity, it yields a much larger than any other plant that is known in cultivation.

With all theſe great advantages it may be aſked, why are Britiſh farmers ſo blind to their intereſts to neglect the culture of this valuable plant? The reaſon we ſuppoſe ariſes from the great trouble and expence requiſite to keep it in proper order, without which it

is in vain to attempt the growth of Lucerne. It has been frequently tried in the common broad-caſt method, but always failed; drilling and hoeing are abſolutely neceſſary, and to this expenſive management a large quantity of the beſt manure muſt be added annually, otherwiſe Lucerne will not flouriſh.

The proper ſeaſon to plant Lucerne is in April, and the only method by which any ſucceſs can be expected is to drill it in rows of two feet diameter, or upwards. As ſoon as it has grown a ſmall height, it ſhould be cleaned with the hand-hoe from weeds, and the plants ſhould be thinned in the row, leaving thoſe which appear the moſt promiſing at about ſix inches diſtance from each other. After this, Lucerne is principally kept in order, and cultivated with the horſe-hoe at leſs expence. Manure is generally laid in the intervals in winter, and by ploughing gradually brought to the roots of the plants. Its great uſe is to give it green to cattle in the ſtable or elſewhere, for which it has no equal.

The proper time to cut Lucerne is before the bloſſom begins to open, and cannot be performed ſo well with any inſtrument as a reaping hook. We would not recommend the culture of this valuable plant to any perſon who will not determine with themſelves to give it the greateſt attention, and ſpare neither expence in labour or manure, for without theſe it cannot anſwer, and with them it will. R. LEGRAND, Eſq. obſerves, that he manured an acre of Lucerne, which he has in cultivation, with forty buſhels of ſoot annually, and does not repent his management: at this rate the produce muſt be prodigious.

BURNET.

Burnet is a plant which grows wild in many of our Engliſh meadows, and will likewiſe grow on very poor ſandy, or other dry ſoil, which makes it valuable. An anonymous correſpondent in the Bath Society's Papers has given a very ſatisfactory account of Burnet from experiment, and which the SCOTCH ENCYCLOPÆDIA have quoted without an acknowledgment, and accepted it as their own; but ſuch plagiariſm we do not deem liberal, and when we give any thing not our own, think it our duty to declare to whom we are indebted. The following is from the Bath Society's Papers, Vol. II. p. 128.

"SIR,

"YOUR letter of December 20 reached me in due courſe, wherein you informed me that Burnet is a graſs but little cultivated in Somerſetſhire, and requeſt my thoughts on its uſefulneſs. I ſhall at all times be happy in communicating any thing that may tend to promote the views of a ſociety eſtabliſhed on ſo liberal a plan as that of Bath, and therefore it is with pleaſure that I comply with your wiſhes, ſo far as the knowledge of the ſubject will admit.

"Burnet is not generally cultivated in this country, but ſome of our moſt intelligent farmers have raiſed it, of late years, with conſiderable ſucceſs. I apprehend that one principal cauſe of its not having been more attended to, is the goodneſs of our ſoil, which will produce other crops that in general pay better than Burnet. But this is a reaſon which ought not to operate in countries which abound with poor land, to which this plant is better adapted than many others.

"The cultivation of this graſs is attended with one principal advantage, beſides that of not requiring a rich ſoil; which is, that it proves an excellent winter paſture when hardly any thing elſe vegetates. I might indeed mention ſeveral others; it makes good butter; it never blows or ſwells cattle; it is fine paſture for ſheep; and will flouriſh well on poor, light, ſandy, or ſtony ſoils, or even on dry chalk hills. The cultivation of it is neither hazardous nor expenſive. If the land is prepared, as is generally done for turnips, there is no danger of its failing. After the firſt year, it will be attended with very little expence, as the flat circular ſpread of its leaves will keep down or prevent the growth of weeds.

"On the failure of turnips, either from the fly or the black worm, ſome of our farmers have ſown the land with Burnet, and in March following had a fine paſture for their ſheep and lambs. It will perfect its ſeed twice in a ſummer; and this ſeed is ſaid to be as good as oats for horſes; but it is too valuable to be applied to that uſe. It is ſometimes ſown late in the ſpring with oats and barley, and ſucceeds very well; but it is beſt to ſow it ſingly in the beginning of July, when there is a proſpect of rain, on a ſmall piece of land, and in October following, tranſplant it in rows two feet apart, and about a foot diſtant in the rows. This is a proper diſtance, and gives opportunity for hoeing the intervals in the ſucceeding ſpring and ſummer. After it is fed down with cattle, it ſhould be harrowed clean. Some horſes will not eat it freely at firſt, but in two or three days they are generally very fond of it. It affords rich pleaſant milk, and in great plenty.

"A gentleman farmer near Maidſtone, ſome years ſince, ſowed four acres as ſoon as the crop of oats were got off, which was the latter end of Auguſt. He threw in 12 pounds of ſeed per acre, broadcaſt; and no rain falling until the middle of September, the plants did not appear before the latter end of that month. There was however a good crop, and in the ſpring he ſet the plants out with a turnip-hoe, leaving them about a foot diſtant from each other. But the drill method is preferable, as it ſaves more than half the ſeed. The land was a poor dry gravel, not worth three ſhillings an acre for any thing elſe. The ſevereſt froſt never injures this plant; and the oftener it is fed the thicker are its leaves, which ſpring conſtantly from its root."

In confirmation of the value of Burnet, Mr. YOUNG obſerves, "that Mr. COKE, of HOLKHAM, ſowed forty acres, mixing a ſmall quantity of white clover and rib graſs with it. The reſult was as ſatisfactory as can be poſſibly imagined; the field has been full ſtocked with all ſorts of cattle, eſpecially ſheep, and is conſtantly pared as cloſe to the ground, as a favourite ſpot in a paſture is by horſes."

Burnet, from its warm aromatic quality, is eſteemed very ſerviceable to ſheep, that are touched with the rot; but if any benefit is to be obtained, they ſhould be turned into a field of Burnet immediately on their coming from a ſuſpected paſture.

SECT. X. OTHER GRASSES NOT IN GENERAL USE, AND THEIR CULTIVATION.

WE ſhall commence this ſection with an account of ſix valuable *Britiſh Graſſes*, collected and brought into cultivation by the ingenious Mr. CURTIS of Lambeth Marſh, author of the FLORA LONDONIENSIS, and that much admired work the BOTANICAL MAGAZINE now publiſhing.

It is with the greateſt pleaſure we inform our readers that Mr. Curtis has not only favoured us with the following valuable deſcription of the Graſſes now before us; but will likewiſe render us every aſſiſtance in his power in the Botanical department of our work.

On the Advantages which may reſult from the Introduction of the Seeds of our beſt Graſſes.

That much of our meadow and paſture land may be rendered infinitely more valuable than it is at preſent, by the introduction of ſome of our beſt Graſſes, is an opinion which has long prevailed among many of the more enlightened agriculturiſts of the preſent age. And while ſome of theſe have endeavoured to excite the huſbandman to collect and cultivate ſeeds of this ſort, by writings fraught with the ſoundeſt reaſoning; others have attempted to attract him by the offers of well-directed premiums. But, hitherto, neither the writings of the one, however convincing, nor the premiums of the other, however alluring, have been productive of the deſired effect: Rye-Graſs ſtill continues to be the only Graſs whoſe ſeeds can be purchaſed for the purpoſe of laying down meadow and paſture land; and how inadequate that Graſs is for ſuch a purpoſe, is known to every intelligent farmer. Why indeed the *Lolium perenne*, or Rye-Graſs, ſhould originally have been made uſe of, in preference to all the other Graſſes, cannot, perhaps, be ſatisfactorily accounted for; moſt probably it owes its introduction to accident, or to its being a common Graſs whoſe ſeeds were eaſily collected, rather than to its being preferred from an inveſtigation of its merits compared with the others; however this may be, there appears to be no reaſon for excluding the others, for it would appear exceedingly improbable that of upwards of a hundred different Graſſes growing wild in this country, the Author of Nature ſhall have created one only as ſuitable to be cultivated for paſturage or fodder.

The difficulty of diſtinguiſhing the Graſſes one from another has, no doubt, proved one grand obſtacle; many of theſe plants are ſo much alike, that the moſt diſcerning botaniſt is often at a loſs to know ſome of them apart; if ſo, how eaſily may the huſbandman be deterred from the arduous taſk.

From the numerous applications made to me, by a variety of gentlemen for Graſs Seeds, it has appeared incumbent on me to do ſomething which might gratify them, and render the public an eſſential ſervice; I wiſh, at leaſt, to put it into their power to decide on a matter which has been long agitated, and from which I am far from being the only one that entertains the moſt ſanguine hopes of its proving a great national advantage. The Graſſes recommended, will, I am certain, do all that our *natural Graſſes* can do: there are ſix of thoſe which conſtitute the bulk of our beſt paſtures; moſt of them are early, all of them are productive, and they are adapted to ſuch ſoils and ſituations as are proper for meadows and paſtures. But let no one expect them to perform wonders; for, after all, they are but Graſſes, and, as ſuch, are liable to produce great or ſmall crops, according to particular ſeaſons, or to the fertility or barrenneſs of the ſoil on which they are ſown.

OBSERVATIONS ON THE GRASSES RECOMMENDED.

1. ANTHOXANTHUM ODORATUM. *Sweet-ſcented Vernal-Graſs.*

NEXT to the *Cynoſurus Cæruleus*, or *Blue Dog's-Tail Graſs*, this, of all our Engliſh Graſſes, comes firſt into bloſſom; it is therefore valuable as an early Graſs; it is valuable alſo for its readineſs to grow in all kinds of ſoil and ſituation, being found in bogs in woods, (eſpecially ſuch as are of low growth, or have had the underwood cut down) in rich meadows, and in dry paſtures: in point of crop, it is not ſo productive as ſome, yet more ſo than others; cattle appear to be fond of it; and it is well known to be

the only English Grass which is odoriferous; the agreeable scent of new-made hay arises entirely from this Grass, hence its name of *odoratum*, or sweet-scented; the green leaves, when bruised, readily impart this perfume to the fingers, by which means the foliage may at all times be known; and persons not deeply skilled in botany may distinguish it when in blossom, by its having only two threads or stamina to each flower. Of the several Grasses here recommended, it is the least productive in point of seed.

4. ALOPECURUS PRATENSIS. *Meadow Fox-Tail Grass.*

THIS plant produces its spike almost, and in some situations, to the full, as early as the *Anthoxanthum*; hence it is equally valuable as an early Grass; and as it is much larger, and quicker in its growth, it is consequently much more productive: it shoots very rapidly after mowing, producing a very plentiful aftermath: and where land is rich, and two crops are not thought too much for it to bear, of all our English grasses this appears to be the best adapted to such a purpose, and ought to form a principal part of the crop: its foliage may, perhaps, appear coarse to some, but it should be remembered, that no English Grass can be productive that is not in some degree coarse; but if mown early, just as it comes into bloom, though the leaves are large, the hay will not be coarse; in general, the great advantage arising from the earliness of this and the preceding Grass is entirely lost at a distance from London, where hay-making commences late, and where the husbandman seems to wait for a crop of general indiscriminate herbage, rather than of Grass.

The Meadow Fox-Tail is more confined as to its place of growth, growing naturally in a moist soil only; hence it is best adapted to improve very wet ground that may be drained of its superfluous moisture, or to form or meliorate meadows that have a moist bottom, and are not apt to be burnt up in dry summers. Its seeds are easily collected, but a great number of them, we believe at least one-third, are yearly destroyed by a very minute orange-coloured larva or maggot, which feeds on the embryo of the seed, and produces a very small musca or fly, probably the *Musca-Frit* of Linnæus.

This Grass is distinguished, in some degree, by the largeness of its foliage, and by its producing a soft spike on a long stalk early in May. The *Meadow Cats-Tail Grass* produces a spike somewhat similar, but rougher to the touch, and much later in the summer.

3. POA PRATENSIS. *Smooth Stalked Meadow-Grass.*

The foliage of this Grass begins to shoot, and to assume a beautiful verdure very early in the spring, but its flowering stems are not produced so soon, by at least a week, as those of the *Alopecurus*; this trifling difference, however, in point of earliness of flowering, does not prevent it from ranking very properly with the two preceding; and, where early grassy pasturage is a desideratum, we are of opinion it cannot better be obtained than by a combination of these three; if crop be at the same time an object, the *Meadow Fox-tail Grass* should predominate. This Grass rather affects a dry than a moist situation, and hence it keeps its verdure in long-continued dry weather better than most others, but it will thrive in either; will grow on the top of a dry wall, but much more luxuriantly in a rich meadow: it is to be observed, however, that it has a root which creeps like the *Couch Grass*, and is almost as difficult to extirpate; it ought therefore to be cautiously introduced where the pasturage is not intended to be permanent.

Of the trifling improvements which we flatter ourselves to have occasionally made in some of the specific characters of the English plants, none have given us more satisfaction than those which relate to this species and the *Poa Trivialis*, two Grasses so very similar, as scarcely to be distinguished, even by the most discerning eye, at a little distance, and very obscurely characterised by Linnæus, but which, by attending to two characters only in each Grass, may now, in a moment, be distinguished with the utmost facility and certainty.

The *Poa Pratensis* has a smooth stalk, the *Trivialis* a rough one, perceptible when drawn betwixt the thumb and finger, and which arises from little sharp points, visible when the sheath of the leaf which covers the stalk is magnified. The *Trivialis* has a long pointed membrane at the base of the leaf, the *Pratensis* a short blunt one. These Grasses differ specifically in a variety of other particulars, not necessary here to dwell on: those who wish to be more particularly informed, may consult the Flora Londinensis.

4. POA TRIVIALIS. *Rough-Stalked Meadow-Grass.*

SIMILAR as this Grass and the preceeding are in their appearance, particularly in their mode of flowering, they differ very essentially in their qualities. While the *Smooth-Stalked Meadow-Grass* is found chiefly in dry pastures, the *Rough-Stalked* principally occurs in moist meadows, or on the edges of wet ditches; it loves moisture, and a situation that is rather shady; hence, though there are few Grasses more productive, or better adapted, for hay or pasturage, it is a tender Grass, and liable to be injured by severe cold, or excessive drought: in wet ground near the Thames, we have observed it grow very tall, while in poor land we have, on the contrary, seen it altogether as diminutive; it is, perhaps, no small recommendation to it that it is a principal Grass in that uncommonly productive meadow near Salisbury, mentioned by Stillingfleet, and more particularly described in the Memoirs of the Bath Agricultural Society, Vol. I. p. 94. We may remark that the seeds of the *Poa Trivialis* and *Poa Pratensis*, but more especially those of the former, are apt to be entangled and adhere to each other, as if cobwebs had been intermixed with them.

5. FESTUCA PRATENSIS. *Meadow Fescue-Grass.*

OF the several Grasses here recommended, this comes the nearest in its appearance to the Rye-Grass, to which, however, it seems to us, in many respects, to be greatly superior, at least for the purpose of forming or improving meadows; it is larger, and more productive of foliage; it is strictly perennial, very hardy, and will thrive not only in very wet, but also in dry ground: we have found it growing in all situations, from the sandpits at Charlton to the osier-grounds at Battersea; and it abounds in the very best meadows about London: In short, we know of no grass more likely to supply the deficiencies complained of in Rye-grass; and yet it has not, that we know of, been particularly recommended. It has one quality which bids fair to introduce it quickly into more general use; it produces more seeds than any of the others, which are easily gathered, and readily grow. In one respect, it is inferior to the three first Grasses; it does not produce its flowering stems earlier than about the middle of June, a fortnight or three weeks later than the *Meadow Fox-Tail Grass*, yet it cannot be considered as a late Grass, as most of the Agrostis tribe, and the *Meadow Cats-Tail Grass*, flower at least three weeks later. It must be carefully distinguished from the *Festuca Elatior*, or *Tall Fescue Grass*, which is a very similar but much coarser Grass.

6. CYNOSURUS CRISTATUS. *Crested Dogs-Tail Grass.*

IT is chiefly from the great character which this Grass bears as a favourite and wholesome food for sheep, and from its being found in our soundest and best pastures, that it is here recommended. It grows naturally in dry situations, and will not thrive in meadows that are very wet: it flowers about the same time as the *Meadow Fescue-Grass*, and is not very productive of foliage, as its flowering stems are always left untouched by cattle, its seeds may easily be collected where the pasturage is fed, not mown.

Of the said SIX GRASSES, it will appear that the

Meadow Fox-Tail, and Rough-Stalked Meadow-Grass	are best for	Moist Land.
Meadow Fescue, and Sweet-Scented Vernal	are best for	Land either moist or moderately dry.
Smooth-Stalked Meadow-Grass, and Crested Dogs-Tail	are best for	Dry Pasture.

The ORDER of their FLOWERING.

1. Sweet-Scented Vernal.	4. Rough-Stalked Meadow.
2. Meadow Fox-Tail.	5. Meadow Fescue.
3. Smooth-Stalked Meadow.	6. Crested Dogs-Tail.

We could easily add many more Grasses to this list, and to those too which, perhaps, may be highly deserving of it; but we have our doubts, whether, by recommending more, we might not increase the difficulty of introducing Grass seeds without any adequate advantage.

DIRECTIONS for Sowing the GRASS SEEDS above described.

IF a piece of ground can be had, that is neither very moist nor very dry, it will answer for all the seeds; they may then be sown on one spot: but if such a piece cannot be obtained, they must be sown on separate spots, according to their respective qualities, no matter whether in a garden, a nursery, or a field, provided it be well secured and clean. Dig up the ground, level, and rake it, then sow each kind of seed thinly in a separate row, each row about a foot apart, and cover them over lightly with the earth: the latter end of August, or beginning of September, will be the most proper time for this business. If the weather be not uncommonly dry, the seeds will quickly vegetate, and the only attention they will require will be to be carefully weeded: in about a fortnight from their coming up, such of the plants as grow thickly together may be thinned, and those which are taken up transplanted, so as to make more rows of the same Grass. If the winter should be very severe, though they are natives, yet, as seedlings, they may receive injury, therefore it will not be amiss to protect them with mats, fern, or by some other contrivance.

Advantage should be taken of the first dry weather in the spring, to roll or tread them down, in order to fasten their roots in the earth, which the frost generally loosens: care must still be taken to keep them perfectly clear from weeds. As the spring advances, many of them will throw up their flowering stems, and some of them will continue to do so all the summer. As the seed in each spike or pinacle ripens, it must be very carefully gathered, and sown in the autumn, at which time the roots of the original plants, which will now bear separating, should be divided and transplanted, so as to form more rows; the roots of the *Smooth-Stalked Meadow-Grass*, in particular, creeping like *Couch-Grass*,

may

may readily be increaſed in this way; and thus, by degrees, a large plantation of theſe Graſſes may be formed, and much ſeed collected. While the ſeed is thus increaſing, the piece or pieces of ground which are intended to be laid down ſhould be got in order. If very foul, perhaps, the beſt practiſe (if paſture land) will be to pare off the ſward and burn it on the ground; or, if this ſhould not be thought adviſeable, it will be proper to plough up the ground and harrow it repeatedly, burning the roots of *Couch Graſs*, and other noxious plants, till the ground is become tolerably clean: to render it perfectly ſo, ſome cleanſing crops, as potatoes or turnips, ſhould be planted or ſown. By this means, the ground we propoſe laying down will be got into excellent order without much loſs; and being now ready to form into a meadow or paſture, ſhould be ſown broad-caſt, with the following compoſition:

Meadow Fox-Tail one pint.—*Meadow Feſcue*, ditto—*Smooth-Stalked Meadow*, half a pint—*Rough-Stalked Meadow*, ditto—*Creſted Dogs Tail*, a quarter of a pint—*Sweet-Scented Vernal*, ditto.—*Dutch Clover (Trifolium Repens)* half a pint—*Wild Red Clover (Trifolium Pratenſe)* or, in its ſtead, *Broad Clover of the Shops*, ditto.—For wet land, the *Creſted Dogs-Tail*, and *Smooth Stalked Meadow* may be omitted, eſpecially the former.

Such a compoſition as this, ſown in the proportion of about three buſhels to an acre, on a ſuitable ſoil, in a favourable ſituation, will, I am bold to aſſert, form in two years a moſt excellent meadow; and as all the plants ſown are ſtrong, hardy perennials, they will not eaſily ſuffer their places to be uſurped by any noxious plants, which by manure or other means, in ſpite of all our endeavours, will be apt to inſinuate themſelves; if they ſhould, they muſt be carefully extirpated, for ſuch a meadow is deſerving of the greateſt attention; but if that attention cannot be beſtowed on it, and, in proceſs of time, weeds ſhould predominate over the crop originally ſown, the whole ſhould be ploughed up, and freſh ſown with the ſame ſeeds, or with a better compoſition, if ſuch ſhall be diſcovered; for I have no doubt but, at ſome future time, it will be as common to ſow a meadow with a compoſition ſomewhat like this, as it is now to ſow a field of wheat or barley.

Mr. Curtis has here laid before the public, information and inſtructions of the utmoſt importance, and has opened ſuch a field for agricultural improvement as will cauſe poſterity to revere his name.

SECT. XI. CABBAGE, AND RAPE, WITH THEIR CULTIVATION.

THE culture of Cabbage for the purpoſe of feeding cattle probably will never become general, as to grow them to perfection require rich land, and the expence and trouble in preparing the land, and other contingencies, is very conſiderable. On lands that will produce full crops of them, Cabbages are certainly cultivated to great advantage: the kind of ſoil is not material, provided it is in good tillage, and capable of producing ſtrong luxuriant crops.

As it is neceſſary we ſhould preſent our readers with directions for raiſing, and applying them to the purpoſes for which they are beſt ſuited, we cannot do it in a more conciſe and practical manner than by the following extract from Mr. Young's Annals, vol. III. p. 183.

ON THE CULTURE OF CABBAGES.

By Mr. William Green, *of Sutton Hall, near Bury, Suffolk.*

"SOW the ſeed on a very rich bed the beginning of March; 1lb. of ſeed on 10 rods of ground for three acres; the ſort drum-head, from its flat top, and as hard as a ſtone; price of the ſeed 2s. 6d. per lb. this is better then the tallow-loaf, being heavier and harder. The land where they are to be planted to be ploughed up at Michaelmas; let it lie till ſpring; plough four or five times; dung before the laſt ploughing; 15 loaded (three horſes) an acre dung, or 20 dung an earth; plough it on three-feet ridges the latter end of June ready to plant, that is to wait for rain. Much depends on having large ſtout plants; the ſeed-bed is therefore drawn; when rain comes, all hands ſhould be put to work. The expence is about 3s. an acre planting. In about a month plough between, by drawing the lands into balks, and then ſhut up, after which hoe with hand-hoes; but do not hand-hoe before ſhutting up, for by the hoe following the plough, the clods which roll on to the plants are eaſily removed; another reaſon is, the ſpace of land on which the plants ſtand after drawing out, being too narrow to bear a hoeing. Hand-hoe thrice, each time 2s. an acre, 6s. in all. I have cultivated them ſix years, and never loſt a crop but once for want of rain. About three weeks after planting, taking the opportunity of rain, replant the vacancies from failure.

Begin to uſe them a month after Michaelmas for milch cows, and keep uſing them ſo till the end of March; but they ought to be off the land the middle of that month, as they then ſhoot and draw the land. Three good acres will ſerve my dairy of 20 cows, with ſtraw and ſome hay; but if abſolutely no hay, then five acres of cabbages will be neceſſary. For weanling calves they are moſt excellent. Turnips are apt to give them the garget, by which they very commonly die; but in ſix years I have loſt only one calf in above 40, by feeding them on Cabbages, nor can any calves thrive better. In fattening beaſts, I find that a middling crop will fatten in the proportion of ¼ of an acre for two beaſts of 50 ſtone that have had the ſummer graſs.

"Hogs prefer them exceedingly to turnips; of this I have a ſtriking inſtance the preſent ſeaſon; for having a field part under turnips and part cabbages, my ſows, &c. have at various times this winter got into the field, and I do not think they have eaten turnips in the whole field, but conſtantly got to the Cabbages.

"In regard to value, I have no poſitive data to calculate on, for it is not eaſy to keep accounts accurate enough to aſcertain it, but in a general way I reckon a good acre worth from 4 to 5l. or, more generally, to be double the value of turnips. "I am ſenſible that this practiſe leaves the farmer without the aſſiſtance of Cabbage for a month or ſix weeks in the ſpring; part of this time may be ſupplied by drawing Cabbages for about a fortnight; and the remainder by a practiſe which I have followed many years with ſucceſs. It is to keep about 20 acres of my meadow rouen (after graſs) till April, never turning any thing in from the ſcythe till that time. This is excellent for cows, for ewes, and lambs, eſpecially crones; and I believe it will be found (it has proved ſo with me) that any piece of rouen that is worth 5s. at Michaelmas, will be worth 10s. in April, and ſo in other proportions; but the value will depend much on the weather; in a dry time it goes very far, but in a wet ſeaſon it is much ſpoiled. Let it alſo be remembered, that this graſs is ſaved from a ſeaſon (autumn) when food is exceedingly plentiful, and of little value to thoſe who do not ſell.

Expences of an Acre of Cabbages.

	£.	s.	d.
Rent	0	10	0
Tythe	0	1	6
Poor rates	0	1	3
Five ploughings	1	0	0
Two harrowings	0	0	6
Manuring	2	0	0
Seed-bed ſeed, &c.	0	1	6
Planting	0	3	0
Deficiencies	0	0	6
Hand-hoeings	0	4	0
Horſe-work in hoeing	0	4	0
Cutting and carting ¼ of a mile	0	11	0
	5	1	3

"This is giving the total expence the manure to the Cabbages; but if the advantage is divided, as it certainly is, then not more than 15s. ſhould be laid to the crop, which will make the total expence 3l. 16s. 3d.

"The barley or oats that follow Cabbages have been thought by ſome to be inferior to that which ſucceed turnips, but in my experience I have not found it ſo, for I have ſeveral times had turnips and Cabbages in the ſame field equally dunged, and the ſoil and management the ſame, but I have found that crop to give the beſt barley which is taken off earlieſt.

Sutton Hall. W. GREEN."

This explicit and excellent account of the cultivation of Cabbages for the purpoſes of Agriculture is as much as can be ſaid on the ſubject, where volumes wrote upon it. We can only remark that in Mr. Green's calculation of expence, we think him below the mark in the articles Rent and Labour; but countries differ in theſe matters conſiderably.

RAPE.

Rape, or Cole, is generally cultivated on account of the ſeed, from which a large quantity of oil is extracted; for this purpoſe it is generally ſowed in June, in the ſame manner, and the ſame quantities of ſeed to the acre, as turnips. About the middle or latter end of Auguſt the plants ſhould be hoed, and left ſtanding from twelve to ſixteen inches aſunder; by no means leave them thicker; this, if well preformed, will be four or five ſhillings per acre. Should any part fail, it will be requiſite to fill up the vacancies by tranſplanting in October, from thoſe parts of the field which are too thick. The following Auguſt, Rape becomes fit to cut and harveſt; great attention is neceſſary to preſerve it from birds; thoſe which are called finches in particular.

It is generally threſhed in the field, as ſoon as it is ſufficiently dry after it is cut; and great care muſt be taken in collecting it together, at the time it is carried to the threſher, which is performed with cloths brought into the field for that purpoſe. The quantity on good land varies from thirty to forty buſhels per acre, and the uſual price for good black ſeed is about ſix ſhillings and ſix-pence per buſhel. Let it be noticed that Rape for ſeed ſhould be ſowed on freſh rich land; and if on an inferior ſoil, it ſhould be mixed with late ſowed turnips, deſigned for ſpring feed, and anſwers the purpoſe very well.

SECT. XII. TURNIPS AND THEIR CULTIVATION.

TURNIPS are of the greateſt conſequence in Britiſh Agriculture; as ſuch we preſent the public with a particular account of their cultivation from Mr. Young's Annals, Vol. III. p. 297; without flattering the author, we pronounce his account really inſtructive.

The

AGRICULTURE.

The Culture of Turnips, recommended to those Counties where they are not yet common. By Mr. W. Macro.

THE Turnip culture being the beſt winter proviſion for almoſt all kind of ſtock, and yet very little known in ſome counties in England, where I think it might be practiſed to great advantage, I ſhall, under the different titles of ſoil, tillage, &c. give an account of the Suffolk manner of managing that uſeful root.

Soil.

"The right ſoil for this root is a deep ſand, ſuch as has adheſion enough to make it of the value of from 5s. to 10s. an acre, land of 14s. or 15s. has generally too great a mixture of loam; for, if the land is wet or ſtiff, ſuch as yield good wheat-crops, the culture may not be advantageous, eſpecially if uſed, as it ſhould be, as a preparation for barley: on ſuch ſoil it would ſhorten the crop at leaſt 10 or 12 buſhels an acre; I ſhould ſooner prefer blowing ſands of 3s. 6d. and even 2s. 6d. per acre, which, when folded and the ſeaſon happens to be wet, yield profitable crops; indeed, ſuch lands can be farmed no other way, for if no turnips are gained, no corn will be had; and a mere ſheep-walk is then the only uſe that can be made of them. Where a farmer has no proper ſoil for Turnips, I think it would be prudent to give up the winter-feeding of more cattle than his hay and ſtraw will do for, unleſs he depends on buying Turnips, which may ſometimes be advantageous, and ſometimes the contrary. I will juſt obſerve, that I have a neighbour upon a wet ſoil, with about 30 ſcore of very fine ſheep, who, one year with another, cannot grow 20 acres of turnips, but depends on buying of his neighbours.

Tillage.

"The firſt earth ſhould be given before Chriſtmas, of a common ſtaple depth; and if, before the ſpring-feed time, a ſecond earth can be given, it will be very uſeful; for, if there ſhould be any ſpear-graſs in the land, that pernicious weed is apt to get too great a hold before barley-ſowing is over; immediately after the barley is in, the third earth ſhould be given, this will be in May; the fourth about the ſecond week in June; and the fifth, or feed-earth, the latter end of the ſame month, unleſs the ſoil is ſubject to the mildew, in which caſe old Midſummer will be full ſoon enough. And let it be obſerved, that harrowing with every earth is very neceſſary, for the ſurface ſhould always be kept in fine friable order, that the feed-weeds may grow, otherwiſe, if that is omitted, till the feed-earth, they will then grow ſo powerfully as to ſmother many of the young plants.

Manure.

"For Manure we depend on the fold or farm-yard, uſually both; of farm-yard dung not leſs than 12 loads ſhould be ſpread on an acre, ſuch as was made the preceding winter, and once turned over. In reſpect to the length of dung, it ſhould neither be long nor quite rotten; the beſt condition is, when it is in ſuch a ſtate that the labourers ſay it will neither ſpit nor fork. I never tried any other Manure for this root, except once an experiment on ſhell marle from Woodbridge-ſide, called there *crag*. I had ſeen ſuch great effects there from it, that, through curioſity, I brought a waggon load (back carriage) and tried it on a light turnip ſoil, and alſo on a good ſtrong loam, and it was with great ſurpriſe I found that it did ſcarcely any good on either: the advantage was, if any thing, rather greater on the former, but not ſufficient to induce me to carry it a ſingle mile had a crag-pit been found on the farm. When the dung for turnips is rather long and ploughed in with the ſeed earth, the ſeed ſhould be only rolled in.

Seed.

"The quantity of ſeed depends on the ſoil; upon a naturally good Turnip ſand a pint an acre, evenly delivered by a good hand, or ſowing engine, will be enough; no ſoil demands ſo much ſeed as chalky land when the chalk comes quite to the ſurface; upon ſuch ſoil, a quarter of a peck an acre will ſeldom be too much, the reaſon of the difference is, that the fly is ſure to attack the plants upon this ſoil much more voraciouſly and with greater certainty than on any other. I do not, therefore, recommend this ſoil for Turnips in general, but where it ſo happens, that one end, or one ſide of a piece of Turnip land is of this ſort (which is often the caſe) to be careful to lay the ſeed thick enough on thoſe parts.

"Having mentioned the ſowing engine, I ſhould remark, that though it is, with care, a good tool, yet it is liable to have the holes ſtopped by two ſeeds ſticking in them, ſo that if the ſeedſman is not very attentive, he may go ſome diſtance without a regular delivery.

"The ſeaſon for ſowing extends from New-Midſummer to the end of July: this variation is neceſſary for two reaſons; firſt, becauſe the land cannot be all manured to ſow early; and, ſecondly, becauſe the late ſown will laſt much longer than the early ones, which are apt to mildew, and conſequently more likely to be rotted by hard froſts afterwards, for which reaſon, all farmers ſhould take care to have ſome late ſown; I have had them from a ſowing the firſt week in Auguſt, which proved the moſt profitable crop on my farm, owing to the froſt killing others while theſe eſcaped.

Hoeing.

"Hoeing is ſo eſſential towards getting a good crop, that I am ſurpriſed a farmer ſhould think of ſowing them with any other view. As ſoon as the plants are ſtout enough they ſhould be harrowed with a light harrow once in a place, which aſſiſts the hoeing; it is not eaſy to deſcribe the ſtate of the plants when they are ready for the hoe, age will not diſcriminate, becauſe the ſeaſon will vary from three weeks to eight, and even nine from the time of ſowing; but a better rule is, to begin when the plants in general ſpread a circle of about four inches diameter. If any of the fields, after the hoeing begins, are getting too forward, which in a wet ſeaſon is often the caſe, a ſecond harrowing (the contrary way) may ſafely be given.

"I find, by ſowing my Turnips at different ſeaſons, that ſix men will hoe 100 acres twice; but thoſe who do not equally vary their ſeaſons, muſt of courſe proportionably increaſe the number. The ſecond hoeing is given about a fortnight or three weeks after the firſt, at half the expence, that is 2s. an acre; this is ſometimes omitted, but it anſwers exceedingly well.

Application of the Crop.

"In regard to conſuming the crop, I would recommend feeding ſheep with them upon the land as by far the beſt preparation for barley, provided the ſoil is true turnip-land, that is dry. The benefit will, however, vary with the time of eating off, for thoſe that are eaten early in the winter, will not, by any means, give ſo good barley as thoſe which are eaten later, provided the plants do not run for bloſſom, for then they exhauſt the land, and the ſucceeding crop ſuffers. Carting off is common, but the expence, allowing for the damage done to the ſucceeding crop, is too great, and I ſhould never recommend the culture with that view.

Accidents.

"It is neceſſary to ſay ſomething on the failures that Turnip crops are liable to, which are the fly, the mildew, the black canker, and to rotting from froſt. I calculate that the froſt deſtroys half the crop once in ſix or ſeven years; the fly not only deſtroys ſome crops entirely, but even then a ſecond or third ſowing yields ſomething, which is gained at the expence of one or two ploughings, harrowings, and ſeed. When no tillage is wanting for the land, this may, on an average, be calculated to amount to the loſs of a whole crop once in five or ſix years; the mildew is rather connected with the rot, and the black-canker has not yet been ſo common with us as to demand a particular calculation.

"I would, for the above reaſons, notwithſtanding all the praiſe that is due to this moſt uſeful root, recommend to all ſheep-maſters, eſpecially thoſe with breeding-flocks, not to truſt ſingly to them. I have found very great advantage from having certain breadths of cole-ſeed, rye, and winter tares ſown early on the firſt ſtubbles that were cleared the preceding autumn; indeed, ſuppoſing no failures, it is abſolutely neceſſary to have ſome ſuch proviſion for the couples, by the time the lambs begin to feed, as it will put them on a great deal faſter than the beſt turnips that can be given."

Mr. Macro's ideas on the cultivation of Turnips are certainly replete with uſeful and practical information, as much ſo, we are of opinion, as ever appeared in print; our obſervations will therefore be conciſe. Mr. Macro is certainly right in cultivating Turnips on ſandy land, but we cannot think ſoil, of the deſcription he mentions, will produce them in any quantity to be of ſervice, either to the land by eating off, or pay expences by the Turnip or the future crops; except the ſandy ſoils in Suffolk are let cheaper than they are in the North and Weſt parts of the kingdom. For we have never ſeen blowing ſands of 2s. 6d. or 3s. 6d. per acre, that would repay expenſive cultivation, unleſs there was ſome peculiar advantage to the ſituation, with reſpect to manure or other local circumſtances.

We beg leave alſo to diſſent from Mr. Macro, when he calls ſand the moſt proper ſoil for Turnips, as we have generally found from practice and obſervation, that a braſhy limeſtone loam not too thin in the ſtaple, has produced Turnips, and the ſucceeding crops to more advantage than ſandy land of equal value.

With reſpect to feeding Turnips off the land, the beſt method both for the ſheep and land is by means of hurdles, to be removed in part, in ſuch a manner that they may have them freſh every day; by this means they eat the Turnips clean, the land is regularly manured, and the ſheep fare every day alike. As many countries do not purſue this method, we think thoſe who do not, loſe a great part of the benefit belonging to the Turnip culture; and would by all means recommend the practice. In Turnip countries we preſume the method of giving ſheep their feed every day is general; as ſuch we refer thoſe who want information to thoſe countries: a ſhepherd will remove a quantity of hurdles ſufficient to give 200 ſheep their feed in an hour.

Turnips in their infant ſtate, are always in a precarious ſituation with reſpect to the fly or ſlug; they will perhaps appear promiſing and in good condition one day, and on the morrow be all deſtroyed. Mr. Vagg of Chilcompton, aſſured the public by advertiſement and other means of diſtributing information, that he was in poſſeſſion of an infallible receipt for the protection of young turnips from the fly, and that he would diſcover it to the public, provided a thouſand perſons would ſubſcribe two guineas each;

The Binder *is deſired to obſerve that this* Half Sheet (A a 1) *is to be placed before* Sheet (A a 2) *in this Number, it being an* Additional Half Sheet *to the Second Edition of this Work.*

this we have been informed was effected; and the great and important ſecret was diſplayed to the world: which was nothing more than this, "when the turnips are ſuſpected to be in danger from the fly or ſlug, cauſe a heavy roller to be drawn over them in the night, repeating the ſame every night till you think them ſafe." This remedy, if effectual, is eaſily performed, and at a ſmall expence; and if Mr. Vagg is in poſſeſſion of the 2000l. we give him joy! And ſhould our readers wiſh to know how he came by the ſecret, we beg leave to refer them to a Treatiſe on Agriculture, wrote in the year 1744, called MODERN HUSBANDRY, page 131, by William Ellis, who ſold the ſecret Mr. Vagg has adopted as his own legitimate offſpring, and a number of others of equal importance, for no more than TWO SHILLINGS.

SECT. XIII. POTATOES AND THEIR CULTIVATION.

POTATOES are a root of ſuch ineſtimable value, as food for the human ſpecies and the brute, that in all probability ages to come will be amazed to think, how it was poſſible the inhabitants of this country could ever have ſubſiſted without them. They have been introduced into Britain upwards of two hundred years; the firſt century after they were known, (conſidering their preſent value) their general utility made a very ſlow progreſs indeed; to the inventive induſtry of the preſent age every praiſe is due which belongs to the cultivation of this uſeful root.

Moſt kinds of ſoil (ſtiff clay excepted) will produce Potatoes; a looſe ſandy loam ſeems the beſt adapted to grow them in large quantities, and of good quality: rich black loam will unqueſtionably yield the largeſt produce, and equally ſerviceable for cattle; but by no means pleaſant food for the table. As good information, ſanctioned by practice, is what we wiſh to communicate to the public, we truſt the following, extracted from the Bath Society Papers, will prove highly acceptable.

On the Culture of Potatoes by the Rev. H. J. Cloſe, *Trimley Suffolk.*

"THE following practical obſervations on the culture and uſe of Potatoes, will not, I hope, appear entirely unintereſting. They are the reſult of various experiments made for five years ſucceſſively on that valuable root, the growth of which cannot be too much encouraged. When the potatoe crop has been the only object in view, I have adopted the following method with the greateſt ſucceſs.

"The land being well pulverized by two or three good harrowings and ploughings, is then manured with fifteen or twenty cartloads of dung per acre, before it receives its laſt earth. Then it is thrown on to what the Suffolk farmers call the *trench balk*, which is narrow and deep ridge work, about fifteen inches from the centre of one ridge to the centre of the other. By this method of making the ſets fifteen ſquare inches from each other, it will take eighteen buſhels to plant an acre; and the produce, if on a good mixed loamy ſoil, will amount to three hundred buſhels. Women and children drop the ſets in the bottom of every furrow fifteen inches apart; men follow, and cover them with large hoes, a foot in width, pulling the mould down ſo as to bury the ſets five inches deep; they muſt receive two or three hand-hoeings, and be kept free from weeds; always obſerving to draw the earth as much as poſſible to the ſtems of the young plants.

"I find, by repeated trials, the firſt or ſecond week in April the moſt advantageous time for planting. In the end of September, or the beginning of October, when the haulm becomes withered, they ſhould be ploughed up with a ſtrong double-breaſted plough. The workman muſt be cautioned to ſet his plough very deep, that he may ſtrike below all the Potatoes, to avoid damaging the crop.

"The women who pick them up, if not carefully attended to, will leave many in the ground, which will prove detrimental to any ſucceeding corn, whether wheat or barley. To avoid which inconvenience, let the land be harrowed, and turn ſwine in to glean the few that may be left by their negligence.

"If the Potatoes are grown as a preparation for wheat, I prefer having the rows two feet two inches from each other, hand-hoeing only the ſpace from plant to plant in each row; then turning a ſmall furrow from the inſide of each row by a common light plough; and afterwards, with a double-breaſted plough with one horſe, ſplit the ridge formed by the firſt ploughing thoroughly to clean the intervals.

"This work ſhould not be done too deep the firſt time, to avoid burying the tender plants; but the laſt earth ſhould be ploughed as deep as poſſible; and the cloſer the mould is thrown to the ſtems of the plants, the more advantageous it will prove. Thus fifteen buſhels will plant an acre, and the produce will be about three hundred buſhels; but the land, by the ſummer ploughings, will be prepared to receive ſeed-wheat immediately, and almoſt enſure a plentiful crop.

"The potatoe ſets ſhould be cut a week before planting, with one or two eyes to each, and the pieces not very ſmall; two buſhels of freſh ſlaked lime ſhould be ſown over the ſurface of the land as ſoon as planted, which will effectually prevent the attacks of the grub. The expence attending an acre of Potatoes well cultivated in the firſt method, ſuppoſing the rent twenty ſhillings, tithe and town charges rather higher, (as in Suffolk) taking up, and every thing included, will be about ſix pounds. In the laſt method, it would be ſomewhat reduced.

"I have many years ſold the greateſt part of my crops for ſeven ſhillings per ſack of three buſhels; thus the one hundred and twenty ſacks would amount to forty-two pounds; but they are now ſo much cultivated, that to make a fair, and what may be termed a ſure eſtimate, they ſhould be valued only as applicable to the feeding and fattening of cattle. I am convinced from experience that they are worth three ſhillings per ſack for theſe purpoſes, and then the produce would amount to eighteen pounds per acre.

"They are excellent food for hogs; roaſting pork is never ſo moiſt and delicate as when fed with Potatoes, and killed from the barn-doors without any confinement. For bacon and hams, two buſhels of pea-meal ſhould be well incorporated with four buſhels of boiled Potatoes, which quantity will fat a hog of twelve ſtone, (fourteen pounds to the ſtone). Cows are particularly fond of them: half a buſhel at night, and the ſame proportion in the morning, with a ſmall quantity of hay, is ſufficient to keep three cows in full milk; they will yield as much and as ſweet butter as the beſt graſs.

"In fattening cattle, I allow them all they will eat; a beaſt of about thirty-five ſtone will require a buſhel per day, but will fatten one-third ſooner than on turnips. The Potatoes ſhould be clean waſhed, and not given until they are dry. They do not require boiling for any purpoſe but fattening hogs for bacon, or poultry; the latter eat them greedily. I prefer the champion Potatoe to any ſort I ever cultivated. They do not anſwer ſo well for horſes and colts as I expected; (at leaſt they have not with me) though ſome other gentlemen have approved of them as ſubſtitutes for oats.

"When predilections for old cuſtoms are ſubdued, I hope to ſee the Potatoe admitted in the conſtant courſe of crops, by every ſpirited huſbandman. The moſt beneficial effects will, I am certain, accrue from ſuch a ſyſtem. The advantages in my neighbourhood are apparent; I cultivated, and fed my own children upon them, and my poorer neighbours ſenſibly followed the example. A great proportion of every cottager's garden is now occupied by this root, and it forms a principal part of their diet. Potatoes are cheap and excellent ſubſtitutes for peas in ſoups and broths, allowing double the quantity."

In addition to Mr. Cloſe's excellent and inſtructive leſſon, we ſhall give Mr. Joſeph Wimpey's account of the culture of Potatoes, by the eaſieſt and moſt œconomical means, as communicated to the Secretary of the Bath Society; vide Vol. V. page 27.

Since the potatoe has been in univerſal demand for the food of cattle, as well as of families, their culture hath become an object of general attention and regard. Men of every claſs, from the princely owner of a palace to the meaneſt cottager, have exerted their ſkill in attempting to improve it both in quantity of produce and in goodneſs.

In examining ſome of thoſe accounts, the writer hath been much ſurpriſed to find their culture had been attended with ſuch enormous expence even as far, if he remembers right, as 14l. or 15l. per acre. This put him upon conſidering if a leſs operoſe and more œconomical method might not be practicable, by which, though the quantity of produce might be conſiderably inferior, yet the nett profit might be ſuperior, and that in no ſmall degree, all things conſidered.

In purſuit of theſe ideas, the writer the two laſt years adopted the following method, which fully anſwered his expectation; the particulars of which, containing an exact account of the expences, quantity of produce, the amount of the crop at a certain price per buſhel, and laſtly, the nett profit of two ſtatute acres of land ſo cultivated in the year 1788, is as follows.

"In Dec. 1787, two ſtatute acres were ploughed up and lay rough through the winter. The February following, the ground was well dragged, forty cart loads of long dung were then equally ſpread upon the ſame, and immediately ploughed in. The beginning of April, furrows were drawn the lengthway of the field with a double breaſted-plough, at about two feet eight inches diſtance one from the other, in which the potatoe ſets were dropped by hand, at the diſtance of from 12 to 14 15 inches, which were covered by ſplitting the ridges with the ſame double-breaſted plough, throwing one half of the mould to the right hand, the other half to the left, and by that means forming a ridge over each rank of ſets, and leaving a deep furrow in each interval. In this ſituation they continued till the ſets had ſhot five or ſix inches.

"By that time the weeds began to appear in great abundance. A ſmall common one-wheel plough was then ſet to work as near each ſide of each rank of potatoes as could be without damage to the plants. This operation raiſed high ridges in the intervals between the rows. In this ſtate it continued until the weeds began to advance again in their growth. The double-breaſted plough was then ſet to work again, going up the middle of one row, and down another, by which operation each ſide of the plants were completely earthed up; and before freſh weeds could vegetate, the luxuriance of the greens was ſuch as to completely cover the intervals; ſo that the whole ſurface of the field had one uniform appearance. In this ſituation they continued till about the 20th of Oct. when the greens being moſtly decayed, and the weather very fine, they were begun to be taken up in the following manner: a ſtrong plough was ſet deep enough to work below the bed of the roots, with which the ploughman goes up one row and down another

another, turning the roots up to the ſurface. Women, boys, and girls follow the plough and pick them up in baſkets as faſt as they are turned out. A pair of drags with long tines are drawn over the ground after it has been picked, by which many are brought up to the ſurface, which had eſcaped the pickers. When the whole field has been gone over in this manner, we then give it a clean ploughing and harrowing, by which means very few roots eſcape. Thus the whole operation is completely gone through, and the land left in the moſt perfect condition for the immediate reception of a crop of wheat.

"An exact account of the produce, expence, and nett profit of two ſtatute acres planted with potatoes in manner aforeſaid. Produce 750 buſhels; tithe paid in kind deducted, ſay 75 buſhels, leaves 675; which at 1s. per buſhel, or three ſhillings per ſack, amounts to . . . . . £.33 15 0

EXPENCES.

A clean ploughing in winter	0	12	0
Dragging in February	0	3	0
40 loads of long dung, and carriage . . .	4	0	0
Spurling ditto	0	2	0
Ploughing in the dung	0	12	0
Striking furrows with double-plough . .	0	6	0
Planting and cutting potatoes	0	6	0
Covering them with double-plough . . .	0	6	0
Sets 15 ſack at 3s.	2	5	0
Ploughing intervals from the rows . . .	0	6	0
Earthing up the plants	0	6	0
Taking them up, ploughing up, drawing home, ſtacking &c. 3 horſes, man, and boy 5 days	1	10	0
One man, one woman five days	0	7	6
Boys and Girls	0	5	9
A year's rent	2	0	0
	13	7	3
Nett profit on 2 acres	£.20	7	9

or 10l. 3s. 10½d. per acre.

"But to do juſtice to the experiment, the ſucceeding crop of wheat ſhould be charged with at leaſt 4l. and that ſum added to the nett profit would amount then to 12l. 3s. 10½d. per acre, for it would have coſt ſo much at leaſt to have brought the barley ſtubble into ſo perfect a tilth and fertile condition as the potatoes left it in.

"It may be very proper to obſerve, however, that the culture of potatoes for ſale, probably cannot be extended much further, in many places at leaſt, the markets being already overſtocked, and the price fallen, ſeemingly more in proportion than the increaſe in quantity. Three or four years ſince, the current price of potatoes in this neighbourhood was 6s. per ſack, and often more; ſometimes as high as 12s. Laſt year I ſold ſome for 2s. 6d. none for above 3s. and at preſent I have little proſpect of diſpoſing of what I ſhall have to ſpare of the above quantity, even at thoſe low prices.

"Hence it becomes a queſtion of very conſiderable importance, what is the real and intrinſic value of this root to the grower when applied to feeding of his own ſtock, from the time of taking it up to the time of planting, ſay from October to May following, that is, ſeven months out of the twelve? If this ſhould be found to anſwer in any deſirable degree the farmer might with ſafety cultivate as many as he could conſume with advantage, without depending upon a market, which, by means of an exceedingly extended cultivation, is become very precarious. Add to this, the potatoe in itſelf is a periſhable commodity, and whenever ſo well kept muſt be diſpoſed of in about eight months, or it will become totally uſeleſs.

"After the firſt ploughing in the winter, I think if it was to be followed by a ſecond acroſs the firſt, and the land thrown up into ſharp narrow ridges by one bout of the plough, or by the double-breaſted plough, the land would be much more effectually expoſed to the influence of the atmoſphere, and the improvement much greater in proportion, than a half ploughing would amount to, being only an addition of 6s. to the expence; the winter being the ſeaſon when the fertiliſing principles deſcend moſt copiouſly to impregnate the earth. I ſhould obſerve, in ploughing up the potatoes, we always take out the coulter, which would cut and damage a great many of them; but in this way the buſineſs is performed without the leaſt injury; as a proof of which, I did not ſee one root that was at all hurt by the plough.

"My principal object in adopting this particular method of cultivation was not obtaining the largeſt quantity of produce poſſible, but rather, the largeſt that could be got conſiſtently with cleaning, ameliorating, and improving the ſoil. This was my firſt and principal object, and perhaps a more effectual method is not eaſy to be found. Had the largeſt quantity of produce been the only thing aimed at, the number of rows might have been doubled, and inſtead of 32 inches, 16 only might have been taken. The produce in that caſe, doubtleſs would have been much more conſiderable, but then the land would have loſt all the benefit of horſe-hoeing.

"Since writing the above, I have had the pleaſure of reading the learned Dr. Anderſon's very valuable treatiſe on this article. The great accuracy and preciſion with which his experiments are conducted, are very ſingular and curious, and his ſubſequent obſervations and concluſions not leſs inſtructive and uſeful than they are ingenious and entertaining. His diſcovery, that the acreable produce is in a great meaſure in proportion to the quantity (weight) of ſets or bulbs planted, (contrary to what obtains in many other articles) is, perhaps one of the moſt important diſcoveries of the preſent age, and I muſt add, I have the ſatisfaction of ſeeing it in a great meaſure confirmed by my own practice in the foregoing account, by which it appears, that I planted fifteen ſacks of ſetts in two ſtatute acres of land; about a third more than I ever allowed before, and I believe than is commonly uſed. The increaſe of produce was not only in proportion to the increaſed quantity of ſetts by meaſure, but alſo in the ſize and fair appearance of the bulbs, which, indeed, were ſo much improved, that I could not help heſitating for a good while, if ſome miſtake had not been committed in the ſorts planted, which I could by no means account for.

"Two of the ſorts I planted were produced by a friend in London two years before, and were ſaid to be the ſorts moſt in demand in that market. One of them was the kidney ſort deſcribed by the Doctor, and I think one of the beſt kinds yet known for the table. The other was a round, white, fair potatoe, the name of which I never learnt, but it was a very good one. The firſt year of planting, the produce exactly correſponded with the ſetts, but the ſecond, that abovementioned, was ſo much improved as quite to confound my judgment. This pleaſing amendment can be imputed to nothing elſe but the weight and ſize of the ſetts planted. In this I was rather particular, ſuffering in general none to be planted leſs than a large pullet's egg; the larger ſizes were cut into two, and the largeſt into four pieces.

"For ſome three or four years paſt, I have alſo made ſome trials of raiſing potatoes from ſeed. The events of my trials differ conſiderably from thoſe of the ingenious Doctor. The firſt year I had ſome bulbs as large as a pullet's egg, but I did not then remark any variety of ſorts. The largeſt of theſe were preſerved, and planted the following April. The October following they were carefully dug up, and were as large in general as thoſe produced from old bulbs; many of them from half a pound to a pound and upwards. Among theſe, very contrary to what happened to the Doctor in his experiments, there were not leſs than five or ſix different ſpecies, moſt of them totally different, not only from the parent ſtocks, from which the ſeeds were obtained, but alſo from every other ſpecies I had ever ſeen, or have to this hour. They were of different colours, figures, and texture. Some a ſmooth yelloviſh white, ſome a duſky brown, ſome a reddiſh brown, ſome had a rough ſkin, ſome ſmooth, ſome diſtinct ſingle bulbs, of a regular ſhape, others a congeries of bulbs from 6 to 10 or 12, connected together by a kind of neck, compoſing a maſs, ſometimes nearly as big as a half-peck meaſure. But there was one ſpecies which far exceeded all the reſt in beauty, many of them were as big as a gooſe's egg, a fine clear ſmooth ſkin of a yelloviſh white, finely pounced with ſmall crimſon ſpots, the complexion beautiful, and the ſubſtance as good as ever I taſted.

"The bulbs which produced the ſeeds of which the above varieties were obtained, were of two very different ſpecies; but no more than two. One was an oblong white potatoe of no very common ſhape. Many of them were gibbous at each end, connected by a part much ſmaller in the middle, a good family potatoe. The other was of a browniſh red colour, finely marbled on the inſide with a crimſon purple; a very fine juley potatoe, much in uſe in this country for feeding hogs, but little valued for family uſe. Theſe two ſpecies are all I had at that time; from which the apples which produced the ſeeds were promiſcuouſly gathered in the ſame field, and ſown together in the ſame ſpot.

"The Doctor ſeems to doubt if the ſexual ſyſtem of Linnæus takes place in the propagation of new varieties in this uſeful plant: but it ſeems very certain from the above account, that varieties of them are attainable from ſeed, and that moſt probably by the bloſſoms of ſome plants being impregnated with the male duſt of others, ſimilar to what happens to the whole tribe of cabbages, carrots, parſnips, beets, &c. If this be not admitted, we muſt have recourſe for a ſolution to *ſeminal variations* in the primitive ſenſe of the phraſe; which is not only infinitely more improbable, but perhaps totally inadmiſſable and irreconcilable to the principles of ſound philoſophy. Nothing can be more certain than that the moſt minute variation muſt have had a pre-exiſting cauſe competent to its production; otherwiſe it unavoidably follows that an effect may be produced and exiſt without any cauſe at all, which is abſurd and impoſſible.

"What the Doctor has advanced on the diſtemper called the *curl* in potatoes, I think very juſt. That it is generally occaſioned by diſtempered ſeed, I have not the leaſt doubt. How the ſeed becomes vitiated and corrupt is another queſtion, which perhaps admits of no ſatisfactory ſolution. There are many other ways, I apprehend, by which both animals and vegetables that are robuſt and healthy during one part of their exiſtence, become diſtempered, and even their *ſtamina* vitiated, the remainder, beſides hereditary deſcents, or what they may acquire by *juxta poſition*.

"The ſmut in wheat, I have long been of opinion, is generated

by a very wet ſeaſon happening during the time of its being in bloſſom. This I eſteem the cauſe and origin of the diſeaſe; but I am well aſſured it may be, and often is propagated and continued by uſing the corn thus vitiated for ſeed. In like manner, I apprehend, the potatoe, and perhaps every other kind of vegetable, though originally of the moſt firm and perfect ſtamina, may, by an intemperate air, conſuming blights, or a combination of unſuſpected cauſes co-operating together, vitiate the original ſtamina, and induce imbecility and a diſtempered conſtitution, which may be propagated through all ſucceeding generations.

"The pureſt and beſt means of guarding againſt and preventing this evil, is to follow the advice given by the very intelligent Doctor, which is to ſelect for ſeed the largeſt, faireſt, ſoundeſt, and beſt complexioned bulbs; by which means you will moſt probably avoid thoſe that may be infected with this deſtructive malady. The Doctor hath truly obſerved, that the curled are always of an inferior ſize; to which I will add, they are alſo of ſo unpleaſing an aſpect, that an eye of modern diſcernment will eaſily diſtinguiſh them from thoſe that are ſound. Let the ſeed be judiciouſly choſen, and planted in the moſt proper ſeaſon, there will then be very little reaſon to fear a profitable crop of good ſound potatoes, of a deſirable ſize, if managed according to the directions in the former part.

"Impreſſed with gratitude for the many marks of approbation conferred on me by your very reſpectable Society, I beg leave to recommend this to their conſideration.

And am, Sir,
With great reſpect and eſteem,
North Bedlampton, Your obliged humble ſervant,
Nov. 10, 1789. JOSEPH WIMPEY."

In the above letter of Mr. Wimpey we find his ideas to be conſonant with thoſe of Dr. Anderſon, which are, that the diſeaſe called the *curl* in potatoes, ariſes from the diſtempered ſeed, that the ſtamina is vitiated in hereditary ſucceſſion, and that the ſmut in wheat is generated from the ſame cauſe. In this we muſt beg leave to differ from Mr. Wimpey and the Doctor, as the experiment of an agricultural writer, in Sect. III. clearly demonſtrates this opinion to be erroneous.

With reſpect to the curl in potatoes, the Doctor recommends the choice of good ſeeds or ſetts, as tending to prevent this evil; but experience does not prove this; though we agree with the Doctor that it is good management upon all occaſions to ſelect the beſt ſeeds or ſetts. In our opinion, however, there is no means of preventing this malady, and our ideas on this ſubject are perfectly in uniſon with thoſe of the writer above alluded to, and who accounts for this phænomenon on the moſt rational principles that can poſſibly be adduced.

In this Section we ſhall alſo introduce an account of the uſe of Potatoes in feeding cattle, by Mr. John Bywell, of Aglethorp, Yorkſhire. Vide Annals of Agriculture, Vol. I. page 402.

Uſe of Potatoes in feeding Cattle.

"Four pecks, eight quarts to the peck, are ſufficient for a large beaſt, with a little hay for 24 hours; they are ſuperior to turnips in feeding, by one third, both uſed in equal time. They are given to milch cows with great advantage, and are healthy fodder. They are very good for draught horſes, to give them half a peck a day with hay; I never had my horſes in ſo good condition as when fed with Potatoes; they are a certain remedy to a horſe with ſwelled legs, or out of condition (in other caſes and diſorders inwardly one peck a day) they are accounted good for hunters the day after they have had a ſevere run, to give them eight or ten large potatoes. The number of buſhels of potatoes grown on one acre are, upon an average, 360. I give them to cattle raw as taken out of the ground.

"J. BYWELL."

The uſe of potatoes in feeding cattle is further confirmed by John Kirby, Eſq. of Ipſwich, as appears from Mr. Young's Annals, Vol. I. page 285.

"Not having any cluſter of potatoes of my own, I bought ſome of a neighbour to try them in horſe-feeding, and from the reſult, prefer them to carrots. They were given raw, but waſhed, to ſaddle-horſes, each having a peck a day, and no oats whatever. The horſes were worked moderately, the ſame as on oats, did their work very well, and were in good order. At firſt they ſcoured, but it ſoon went off, and did no more than keep their bodies gently open.

"To aſcertain from this trial the value of the potatoes, that of oats will decide it; reckoning half a peck of oats a day to be equal feeding, and the price 16s. a quarter, the value of the potatoes will be 1s. a buſhel."

Uſe of Potatoes in Diſtillation.

Doctor JAMES ANDERSON, by his ingenious experiments, has ſucceſsfully diſtilled Potatoes, and drawn from 72 pounds weight of that root a gallon of pure ſpirit conſiderably above proof, and a quart of a weaker kind a good deal below proof. "This was," he obſerves, "the fineſt and moſt agreeable vinous ſpirit I ever ſaw. In taſte it reſembled very fine brandy, but was more mild than any brandy I ever taſted, and had a certain kind of coolneſs upon the palate peculiar to itſelf."

The following is an abridged account of the proceſs. The Potatoes were firſt boiled till they came to a pulpy ſtate, then bruiſed and made to paſs through a ſtrait riddle along with ſome freſh water; the ſkins, being by this means ſeparated, were thrown away. The pulp was then mixed with cold water, till the whole amounted to about 20 gallons; this, when in a proper heat, had ſome yeaſt put to it, as for brewing. In the ſpace of ten or twelve hours a fermentation began, which continued twelve hours, and then abated. I warmed it a little, but in vain; then ſtirred it briſkly, which had the deſired effect, as the fermentation was renewed by that means. I uſed the ſame means every day, and it fermented a fortnight, and then ſtopped. The liquors having acquired a ſlight acidity, it was put into the ſtill, and ſtirred till it boiled; the ſtill head was then put on; it was then diſtilled with due caution, and produced the valuable ſpirit beforementioned.

To make Yeaſt from Potatoes.

Boil Potatoes of the mealy ſort till they are thoroughly ſoft, ſkin and maſh them very ſmooth, and put as much hot water as will make the maſh of the conſiſtency of common beer Yeaſt, but not thicker. Add to every pound of Potatoes two ounces of coarſe ſugar or treacle, and when juſt warm ſtir in for every pound of Potatoes two ſpoonfuls of Yeaſt, keep it warm till it has done fermenting, and in 24 hours it may be uſed. A pound of Potatoes will make near a quart of Yeaſt, and when made will keep three months. Lay your bread eight hours before you bake it.

I have ſeveral times tried this receipt in a hard froſt when Yeaſt was ſcarce, and found it to anſwer the purpoſe ſo well, as not to be able to diſtinguiſh the bread made from the one or the other. This is an invention of material conſequence to thoſe who bake and brew in their own houſes, and tends to ſhew the unlimited uſe of Potatoes.

SECT. XIV. CARROTS AND THEIR CULTIVATION.

CARROTS were introduced into this kingdom by the Flemings, in the reign of queen Elizabeth, and firſt ſown about Sandwich in Kent. There are two or three ſorts of this plant cultivated for the uſe of the kitchen; and theſe are ſown at ſeveral different ſeaſons of the year, to afford a ſupply of young roots, in all ſeaſons, for the table.

The cultivation of Carrots is lately become a conſiderable branch of agriculture. For this purpoſe the ground ſhould be ploughed early, before the winter begins, that the froſt may mellow the ſoil, and well dunged. The ſeed ſhould be ſown in March or April, ſeparating it firſt by paſſing it through a fine chaff-ſieve. Four pounds of ſeed are ſufficient for an acre. In about ſeven or eight weeks they are fit for hoeing, and in a fortnight after they ſhould be harrowed, which is done without injury to the Carrot plants. Mr. Billing, an ingenious farmer in Norfolk, obtained from twenty acres and a half of land, of different ſoils, and differently prepared, five hundred and ten loads of Carrots, which, as experience led him to conclude, were equal in uſe and effect to a thouſand loads of turnips, or three hundred loads of hay. Some of them meaſured two feet long, and from twelve to fourteen inches round.

The ſeaſon for drawing Carrots is a little after Michaelmas; and the beſt method of drawing them is by breaking the ground about ſix inches deep, with a four-pronged fork; though Mr. Billing has plowed them up with a narrow ſhared wheel-plough, without injury, and the ſtock was turned into the ground to feed on them without any farther preparation. Cows, ſheep, horſes, and hogs, become, by uſe, fond of Carrots, and are greatly nouriſhed by them. See Billing's Account of the Culture of Carrots, 1775. 8vo.

In order to preſerve Carrots for uſe all winter, they are to be dug up in the beginning of November, and laid in a dry place in ſand; and theſe roots being planted again in February will ripen ſeeds in Auguſt for ſucceeding crops: the longeſt and ſtraighteſt roots are to be choſen for this purpoſe.

Carrots, as food for cattle, have been ſucceſsfully cultivated in the county of Suffolk and others adjoining. We ſhall therefore preſent the following account of the culture of Carrots as related

In a Letter to the Bath Society, by John Kirby, Eſq.

"The ſoil proper for the cultivation of this uſeful root is a ſandy loam, of about ſeven or eight ſhillings per acre; that on which I have uſually grown them is of a ſharper nature, and not ſo valuable. I have variouſly ſown them after turnips, ſummer-land barley, and peas ſet upon a rye-graſs ley; the crop upon the firſt has generally been moſt productive; next to that I ſhould prefer the latter. In the firſt inſtance we feed off the turnips by the beginning of February, and then lay the land up on ſmall balks or furrows, in which ſtate it remains until the ſecond week in March, when it is harrowed down, double-furrowed to the depth of about twelve inches, and the ſeed ſown thereon, at the rate of four pounds and an half to the acre. As ſoon as the plants appear diſtinctly, they are ſet out with a ſmall hoe, at the diſtance of ſix inches from each other; they are afterwards hoed twice more at different times, according as the crop ſeems to require it; and it is not unuſual to harrow them between the hoeings, which does no injury to the root, and frequently ſaves the expence of a third hoe-

ing;

ing: for these three hoeings, I commonly pay from fifteen to eighteen shillings per acre.

"When Carrots are intended to be sown after peas, I usually plough the stubble as soon as the harvest is over, in order that the land may purge itself of weeds: in December it is laid up in small balks to receive the benefit of the frosts: in February it is harrowed down, and manured at the rate of fifteen loads per acre; the manure is ploughed in to the depth of about four inches, and in the middle of March the land is double furrowed, and the seed sown. By pursuing this method, the manure lies in the centre of the soil, and not only affords nourishment and support to the Carrot in its perpendicular progress, but renders it easy to be turned up by a single ploughing, and greatly promotes the growth of the succeeding crop of barley. With this crop I usually lay down the land with rye-grass, in which state it remains for two years before it is again ploughed up, and sometimes longer.

"The Carrots being fit to take up, I put them out to my labourers, sometimes by the acre, and sometimes by the load, containing forty bushels; for the former, if a good crop, I pay for taking up and topping ten shillings and six-pence per acre; for the latter, from one shilling to one shilling and two pence per load, taking particular care of the tops, which are equally valuable with the roots for cows, sheep, and swine. After the Carrots are taken up, I lay them in an out-house, and cover them well with straw, to guard them against the frost, though it is not unusual for some farmers to let them continue in the ground until they are wanted, which is less expensive; and the weather must be extremely severe to injure the crown of the root, which is more hardy than either a turnip or potatoe. There is only one objection to which this practice appears to be liable, viz. that of the ground being sometimes rendered too hard by the frost to admit of their being taken up; but this may easily be obviated, by a little care and attention in the grower.

"Respecting the weight of an acre of Carrots, I confess my curiosity has not yet extended so far as to determine that point; but as to quantity, I usually grow from 200 to 500 bushels per acre, which we sell at six-pence per bushel.

JOHN KIRBY."

As a further illustration of this subject, we shall subjoin the following extract of a letter from the Bath Papers, Vol. V. page 239, on

THE ADVANTAGE OF CARROTS AS FOOD FOR CATTLE.

By Mr. Charles Onley.

"ABOUT an acre of my bean-field I have applied, as a winter vegetable, to Carrots. The product with so little ploughing and no manure, has been, on an average, only about 400 bushels per acre. I am however sensible they will amply repay every expence of the *finest* culture; and should, from their extensive utility, on sound, deep, and friable land, be every where attempted. Mine, in general, is far from being their proper soil. I sow in March, or April, hoe three times; harrow after each hoeing; have sometimes left them in the land till after Christmas, and taken them up as wanted; but lately have taken them up in October, in dry days, put them directly into small *upright* cocks of ten bushels each, *entirely* covered, with the tops cut off; they *thus* appear to dry better than in any other mode; and, with very little loss, to bear the weather. If, after being thus dried, they are carried into any barn, or shed, it will be better, if in large quantities, through the hazard of heating, not to pack them *close*, but rather throw them promiscuously into *heaps*, with a little straw over them. Some of my neighbours, who have been induced by me to try them, on *a rather larger scale*, with *finer* culture, and *fresher* soil, have raised from six to nine hundred bushels per acre, and applied them more profitably, as well as more generally, than any other winter herbage, to deer, sheep, bullocks, cows, and horses. At the lowest calculation they are, from our little trials, esteemed to exceed turnips in value one third, as to quantity of feed; but are far superior in what arises from convenience. For the stable, where to *us* they seem to be a perfect substitute of corn for all horses, at least not used in any quick work; and partially so, with corn, for those that are.

"The comparison (tilths for each alike) betwixt the produce and value of an acre of oats, and one of Carrots, one bushel of the latter presumed equal to one peck of the former; and each estimated at six-pence, will, I conjecture, stand thus:

One Acre of Oats, Dr.	£.	s.	d.
Seed, four bushels	0	8	0
Mowing	0	2	0
	0	10	0
Per Contra, Cr.	£.	s.	d.
Five quarters of oats, at 16s. per quarter, being 160 pecks, at 6d. per peck	4	0	0
Deduct	0	10	0
Nett profit	3	10	0

One Acre of Carrots, Dr.	£.	s.	d.
Seed, eight pounds	0	8	0
Hoeings thrice	1	1	0
Harrowings	0	3	0
Digging up, gathering, and cocking, at 1d. per bushel, 400 bushels	1	13	4
	£. 3	14	4
Per Contra, Cr.	£.	s.	d.
400 bushels of Carrots, at 6d. per bushel	10	0	0
Deduct	3	14	4
Nett profit	6	5	8
Nett profit oats	3	10	0
Excess on Carrots	£. 2	15	8

"When perfectly dry, no washing of the Carrots is, in general, necessary for any cattle, except horses *regularly* kept in the stable. This is undoubtedly a little additional trouble and expence. We sow in March. If the weather continue dry, it will be some weeks before this plant appears, and so *very delicate*, as to make the first hoeing, or rather weeding, which must be as early as their strength admits, extremely tedious and troublesome. In about a fortnight their root will be sufficiently fixed to bear harrowing, by which their growth will be promoted, and the land cleaned; and the treading of the horses will not hurt the plants. In about a fortnight more the second hoeing, to set them out at six inches square, will follow, and a second harrowing; the third, if at all necessary, just as the state of the soil and growth of weeds may require; for as to the Carrots, their nourishment is drawn from a bed so much deeper than that of weeds, as not to be at all injured in their progress, though disgraced, in their appearance, by such company.

"Such are my trivial attempts, on a few acres, in agriculture; to the adventurers in it, on a large scale, I look up, with somewhat of veneration, as the best subjects of the state, and the first friends of man; but which in this kingdom, as the source of all *permanent* manufacture, and *fair* commerce, instead of receiving every political encouragement, is burdened with every oppression that the spirit of monopoly can devise, the cunning of trade demand, and the interest of corruption support; and consequently the large capitals seduced into every speculation and pursuit, except that which promises an ampler and surer, though slower return, and far more congenial with that habit of patient industry, and exact œconomy, to which alone wealth should appertain, the perfect cultivation of our soil. A fourth, probably, of this island is nearly waste; wanting only an encouraged cultivation to afford employment and comfort to that numerous poor, which the manufacturer rears for the landholder, under a rate of two millions per ann. to sustain; and which remains a mark of more barbarous folly in this refined age of arts, manufactures, and commerce, than of tyranny in that gross one, when feudal dignity demanded such a range for its savage chace.

"What does a kingdom merit, that presuming to take the lead in wisdom amongst the nations of the earth, yet, for want of the most obvious exertions of benevolence, in the public encouragement of rural industry, spurns at the very means that Providence offers for its peaceable greatness—at home; and madly thinks of gaining power and commerce, and preserving its freedom, by squandering wealth and population in the acquirement of dominion, abroad; thus placing itself in a state of constant jealousy and fear with one-half of the world, and counteracting the very advantages of that commerce it would thus violently ensure, by the enormous burdens, essential at all times to guard against, and frequently to support the wars resulting necessarily from such mistaken policy?

I am, Sir,

Your obedient Servant,

Stisted-Hall, near Braintree. CHARLES ONLEY."

The soil on which Carrots grow to most advantage is a sandy loam, of considerable depth, and to plant them on soil where they cannot strike downward, form nourishment, is throwing away labour and expence to little purpose. From the collected opinions of those who have cultivated Carrots as food for cattle, they seem to possess more nutriment than any other root propagated for that purpose, particularly for horses; that 40 bushels will maintain six working horses a week, allowing them hay, and that half the quantity of hay usually given when horses are fed on oats, will be sufficient. Oxen are fed with Carrots quicker than with either turnips or potatoes; they increase milk in dairy cows, and contrary to cabbage or turnips, make butter sweet and of a fine flavour: the quantity necessary for a cow that gives milk, is half a peck at night and the same in the morning; and with this quantity of Carrots, and good fresh straw, they will be kept in better order, and produce more milk, superior in goodness to cows fed with the best hay. Sheep are likewise very fond of Carrots, for which they are esteemed a very wholesome food.

SECT. XV. ROOTS AND PLANTS NOT IN GENERAL CULTIVATION.

TURNIP CABBAGE.

THIS is a species of vegetable, as yet but little cultivated in England. It is said to have been brought by Mr. Hastings from

the Cape of Good Hope. It is a very hardy plant, enduring the winter at leaſt as well if not better than broccoli. It is found a moſt valuable acquiſition to the kitchen garden; and may be introduced with advantage by the farmer as an article of fodder for his ſtock.

We ſhall preſent our readers with the following account of the culture and management of this plant, extracted from a letter addreſſed to the Bath ſociety, by THOMAS BROUGHTON, Eſq. of Twerton.

"I have not been able to aſcertain in what country the Turnip Cabbage was firſt produced, but am informed that it is very common in Holland, and at the Cape of Good Hope. It has certainly been known in Britain many years, though not generally. MILLER does not notice it, but it is particularly mentioned in the liſt of excellent plants at the end of the octavo edition of "Every Man his own Gardener," by MAWE and others, publiſhed in 1786; and is there eſpecially diſtinguiſhed from the turnip-rooted Cabbage, to which it bears little or no reſemblance to the Cabbage tribe than to the turnip, whereas the Roota-Baga, from the ſlight acquaintance I have with it, appears to be more nearly allied to the turnip.

"The beſt ſeaſon for ſowing for the garden, appears to me to be the end of May, or beginning of June. Though ſown ever ſo early, I never ſaw one run the ſame ſummer; indeed I have ſown in Auguſt at the cauliflower ſeaſon, and the greater part have ſtood over the following ſummer, and not run till the ſecond ſpring, which is certainly a very uncommon property.

"With reſpect to the management of the plants, they require nearly the ſame treatment as broccoli, in regard to tranſplanting, diſtance, &c. They are uſually moſt eſteemed when young, and about the ſize of a moderate garden turnip; thoſe ſown in June will continue good all the winter. The bulb muſt be ſtripped very clean of its thick fibrous rind; after which it may be treated as a turnip. The ſprout or crown is very good, but eſpecially in the ſpring, when they begin to run. I ſhould imagine, from the remarkable ſweetneſs of the bulb, that it is more nutritious than the common turnip. The largeſt bulb I have meaſured was twenty-three inches in circumference.

"I took up a plant in February laſt, which was ſown the Auguſt twelve-month before; which, when deprived of its fibrous root, weighed about twelve pounds; the bulb was conſiderably elongated, and meaſured nineteen inches in circumference, and twelve from the baſe of the bulb to the top of it; it had thrown out forty-ſix lateral ſprouts.

"My plants ſtood the winter of 1788, which was a very ſevere one, when all my turnips were deſtroyed. It has been ſuſpected by farmers that the toughneſs of the rind would form an inſurmountable objection to them, as fodder for ſheep; but I have this winter had poſitive proof to the contrary. I have given many of the toughſt and oldeſt to my ſheep, which not only penetrated through the coat, but even devoured the greateſt part of it.

"I do not know where the ſeed is to be procured in any quantity. I propoſe to ſave a great deal this ſpring, if the ſeaſon ſhould be favourable.

I am, Sir,
Your very humble ſervant,
Twerton, March 19, 1790. "THOMAS BROUGHTON."

The following ſhort letter by Sir THOMAS BEEVOR, Bart. to the Secretary of the Bath Society is a further proof of the excellence of this plant.

ON THE VALUE OF TURNIP-ROOTED CABBAGE AS A SPRING CROP.

By Sir THOMAS BEEVOR, BART.

"MY Turnip-rooted Cabbages are now in high perfection. I have about three acres left, with which I am feeding 22 bullocks intended for fattening this ſummer, 17 cows, 2 bulls, 4 young cattle, and 110 ſheep, beſides 30 horſes, which partake largely of them. I hope and expect they will yet laſt near a fortnight more, by which time I doubt not but I ſhall have a full and plentiful bite of graſs for all my ſtock. In order to aſcertain, in ſome degree, the quantity of food they produced, I carefully ſelected ſome of them, and ſome of the common turnips: and have girted each of them with as much accuracy as poſſible. I found the Turnip-rooted Cabbage at the circumference of 18 inches, weighed 5lb 1, and the common turnip of the ſame circumference 3lb 1 only. I took others of different dimenſions, and found throughout, the reſult to be in that proportion: they were all without their tops; otherwiſe the exceeding of the Turnip-rooted Cabbage would have been greater, the leaves of them being remarkably buſhy. It muſt, however, be mentioned, that thoſe roots were weighed at the latter end of March: had they been weighed at Chriſtmas it is likely the difference had not been ſo great: ſtill, their late continuance for a green and moſt nouriſhing food is indiſputably a merit they muſt be allowed beyond any other known vegetable production.

"I am with regard, your's, &c.
Hethel, May 1, 1789. "THOMAS BEEVOR."

We ſhall add further remarks on the utility of this plant, by the ſame Author, From the Bath Papers. Vol: V. p. 422.

ON THE TURNIP-ROOTED CABBAGE.

By Sir THOMAS BEEVOR, BART.

"ON the 30th of May 1788, I had four acres of turnip-rooted Cabbages ſown in the random or common method of turnip-ſowing, which growing very thriftily, were hoed out the firſt time on the 1ſt of Auguſt following, and again a ſecond time on the 16th. Theſe plants endured the long and ſevere froſt of the ſucceeding winter, without the leaſt injury, though three fourths of all the common Turnips in this country were deſtroyed by it.

"On the 21ſt of April 1789, I cauſed (in order to aſcertain the quantity) twenty feet ſquare of them to be taken up from three different parts of the field, which being weighed, I found the average produce to exceed, by ſix pounds, twenty-four tons and a half per acre; though at this time their tops had not ſprouted above three inches in height; for theſe plants I was offered by ſome neighbours ten guineas per acre, but as my want of green food was great, I would not accept of it, or of any greater ſum for them.

"If farmers would obſerve, they could not but learn, from their repeated experience, the very little dependance which can be had on the ſupply of food for their cattle in the ſpring from a crop of common turnips, either after a ſevere and froſty winter, or after a very mild and warm one, (which laſt conſtantly cauſes ſo early a growth of their tops as to render both them and the roots of little or no worth) and they would then, I conceive, rarely fail to have ſuch a proportion of the turnip-rooted Cabbages growing on their lands, as would afford and enſure them a full and excellent proviſion for their cattle for about three or four weeks in the laſt part of the ſpring. A greater quantity of them I do not wiſh to recommend, as the conſumption of them, particularly when drawn, and carried from off the land, is certainly attended with rather more trouble and expence than that of common Turnips, eſpecially if the ſoil be wet and heavy; the beſt for them, and that on which mine grew, was a dry, ſound, mixed ſoil, worth 16s. per acre, at the diſtance of ſeven miles from Norwich.

Hethel, Jan. 2, 1790. "THOMAS BEEVOR."

As turnip-rooted Cabbages occupy the ground till the ſeaſon becomes too far advanced for barley ſowing, Sir Thomas Beevor, and other cultivators of the Turnip Cabbage, ſow, inſtead of barley, buck-wheat, and with it graſs ſeeds: this nouriſhes the graſs ſeeds, produces a profitable meliorating crop, and keeps the land in its proper courſe of tillage.

Turnip Cabbage, or Turnip-rooted Cabbage, ſhould be ſowed on rich good land about the time which is deemed proper to plant the common Turnip, and ſhould be hoed and managed in the ſame manner. The importance which Turnip-rooted Cabbages claims as a valuable appendage to huſbandry, is by retaining their good qualities when the common Turnip becomes of little value, and from our own experience we can recommend the culture of this valuable plant for the ſupport of almoſt all live ſtock, for the three laſt weeks in April, or the firſt in May, where the graſs ſhoots late.

MANGEL WURZEL.

MANGEL Wurzel, or Root of Scarcity, was firſt introduced into this kingdom by Sir Richard Jeb, Bart. and preſented to the Society of Arts, from whom Dr. Lettſom obtained ſome of the ſeeds, and has cultivated them, according to his account, to great advantage: and to whoſe induſtry we are indebted for the following information:

The ſeeds may be ſown as early in the ſpring as the weather will permit, on rich land well prepared, and tranſplanted from the ſeed bed, ſometimes in the month of May, on a loamy ſand, or rich hollow loam, at a diſtance of 16 or 20 inches from each other, and at a depth of 4 or 5 inches.

At the end of June, or beginning of July, when the outward leaves are become about a foot long, the firſt crop of leaves is to be gathered, breaking them off near the root, which may be done at the end of every twelve or fifteen days, and are an excellent vegetable for the table, ſuperior to ſpinach.

Advantages reſulting from the Cultivation of the Root of Scarcity, by John Coakley Lettſom, M. D.

"THE numerous experiments that I have made, eſpecially in the year 1785, relative to the culture, the produce, and the uſe of the root of Scarcity, have convinced me, that it deſerves to obtain a decided preference over all other roots, and even over turnips. Whether I am partial, or enthuſiaſtic in my attachment to it, may be determined by conſidering the reaſons which I am now about to enumerate.

1. This vegetable may be eaten by men during the whole year: it is agreeable and wholeſome, and does not cauſe flatulencies, as turnips do.

2. As it is not attacked by the caterpillar, or by any other inſect, its ſucceſs is certain every where: it ſuffers nothing from the viciſſitudes of the ſeaſons. Our own turnips do not poſſeſs theſe advantages.

3. The leaves of the root of Scarcity afford an excellent food for all kinds of cattle, during four months in the year; whilſt turnips produce leaves only once a year, and even then are tough, and injured by inſects.

4. The root of Scarcity may be well preſerved during eight months in the year, and is not ſubject to become rotten, as is the caſe

eaſe with turnips; which, from the end of the month of March, become ſtringy, tough, and ſpungy.

5. There is no kind of turnips that ever ſucceeds perfectly; they often fail entirely, eſpecially in hard lands; they require a light, good, and ſandy ſoil; but the root of Scarcity will ſucceed every where; the cultivators of different kinds of lands may be equally aſſured of ſucceſs; and farmers and labourers may therefore be greatly benefited by this reſource.

6. The milk produced by cows who have been fed for ſome days together with turnips, contracts a ſtrong, ſour, and diſagreeable tallow-taſte; but thoſe who are fed with the Root of Scarcity produce both milk and butter of an excellent quality. "The Root of Scarcity is never diſliked by cattle; they eat it always with the ſame avidity and the ſame pleaſure; and they have nothing to fear from thoſe unhappy accidents, which ſometimes reſult from the uſe of turnips.

"I ſhall eſteem myſelf happy, if the truths which I have ſtated ſhould encourage the cultivation of a Root, which may increaſe the riches of the ſtate, and contribute to the eaſe and happineſs of the people.

"After having given the public every uſeful information in my power, reſpecting the Mangel Wurzel, or *Beta Hybrida*; and after having, at much labour and expence, diſtributed many millions of ſeeds, for the purpoſe of experiment, time muſt determine how far my endeavours, directed to the good of the community, will prove ſo eventually. It remains with me, however, publicly to thank my numerous correſpondents, among whom I may include many of the firſt in national rank, who have condeſcended to favour me with their approbation.

"To thoſe invectives, which ſome of the public prints have exhibited againſt me, I make no reply. However eſtimable the regard of virtuous characters may be, he will involve himſelf in diſappointment and remorſe, who acts merely to gain the applauſe even of the good, or to deprecate the cenſure of the envious. If my conduct has acquired the former, my motives render me indifferent to the latter.

"I ſhould conclude this letter with regret, in being under the neceſſity of informing the public, that I am now exhauſted of all the ſeeds of the Mangel Wurzel which I raiſed myſelf, or procured from abroad, were it not in my power to add, that the ſeedſmen in London are now in poſſeſſion of a quantity to diſpoſe of.

"As I wiſh fully to appreciate the value of this vegetable, any future information reſpecting it will be acceptable to

JOHN COAKLEY LETTSOM."

The worthy and reſpectable Dr. LETTSOM has beſtowed much trouble and expence in the cultivation and diſtribution of this plant, and doubtleſs from the pureſt philanthropic motives: his zeal has raiſed up a hoſt of illiberal and anonymous opponents, ſome to diſplay their wit, and others their ignorance; but all have failed in their attempts to hurt the feelings or character of ſo good a man. We cannot but think the Doctor too warm in his commendations of the root of Scarcity, before he had ſufficiently made experiments; but we hope his ſanguine hopes will be gratified.

As a further account of this *Stranger*, which is ſo lately ſettled among us, we ſhall give the following Letter to the Bath Society, from

SIR THOMAS BEEVOR, BART.

"My ſeeds were ſent me very late, two months nearly after the moſt proper time of ſowing them; however I ventured to commit them to the ground, on the 13th day of June laſt; and in a few days had the ſatisfaction to find them all riſe well, and in a vigorous ſtate of growth. I have ſince gathered their leaves twice, and find their roots of ſuch ſize as to promiſe a conſiderable and profitable production. The meaſure of ſome of them is now 15 inches round; the length (of a few I pulled up on this occaſion) is 13 inches, and the weight of them on an average 4lb. The ſeeds and plants are not, I think, to be diſtinguiſhed, at their firſt growth, from ſome beets; but in order to aſcertain the difference, (if ſuch there was) I ſowed on the ſame bed of mould, on the ſame day and hour, ſome ſeeds of the real beets; and find that under the ſame management, the Roots of the Scarcity plant are four times as big, and the leaves of it much larger than thoſe of the real beets. I have offered a few of the leaves of the Scarcity plant to the cows whilſt going in exceeding good paſture in my park, which they readily ate; I did the ſame to ſome horſes which were ſtanding in a waggon in the harveſt field, who as readily ate the broad tender part of the leaves, but rejected the thick parts of the ſtalks. I have alſo had dreſſed the leaves of each of the abovementioned plants, and brought boiled to my table; and think, as did ſome other gentlemen who ate of them, that there is a manifeſt difference in their taſte; thoſe of the Scarcity plant being ſo like ſpinage, as hardly to be diſtinguiſhed from it; whilſt thoſe of the beet were both harder and drier.

"What further obſervations I ſhall be able to make upon the growth and application of this plant, in the courſe of the winter, I will tranſmit to you, as it certainly promiſes to be of the firſt importance in the article of food for cattle. In the mean while let me not omit to inform you, that I ſaw a few weeks ago, at Lord ORFORD'S place at ERISWELL, near Barton-Mills, in Suffolk, ſome of the plants, which were nearly twice as big as mine: and I have been told, that at Mr. DASHWOOD'S, of CLEY, in Norfolk, there are ſome which meaſure two feet in circumference; but the two laſt-mentioned parcels were, I am informed, ſown at leaſt ſix weeks ſooner than mine were."

We ſhall add ſome obſervations on the cultivation and uſes of the Mangel Wurzel, as communicated to the Bath Society,

BY THE REV. MR. BROMWICH.

"SIR,

"DESIROUS to try the ſucceſs of the Mangel Wurzel in our climate, and whether, with us, it might merit thoſe high encomiums it has met with abroad, I was induced to make the following experiments to aſcertain its value. If you think the obſervations I have hitherto been able to make will be of the leaſt utility in promoting the cultivation of ſo beneficial a plant, I ſhall be happy in having communicated them to you.

"In the beginning of laſt April I prepared about a quarter of an acre of light ground, by forking it over, it having been left exceedingly foul and impoveriſhed by a former tenant. I mention this, as it will, together with the dry ſeaſon, in ſome meaſure account for the ſmallneſs of the roots; the largeſt not having exceeded ſix pounds in weight. As ſoon as the land was cleaned, as well as ſo early a ſeaſon would admit of, I divided it into two equal parts; one half to be ſet with young plants from a feed-bed, and the other part with ſeeds at half a yard diſtance from each other, in order to aſcertain the beſt of theſe two methods of planting. The laſt I find is much to be preferred, as the plants that were never tranſplanted, though late ſown, ſoon outgrew the others that were.

"March 19th, the firſt ſeeds were ſown in the feed-bed, and tranſplanted into the field the 16th of May following; the roots having attained the thickneſs of a gooſe quill. April 15th, one half of the ground in the field was ſown with ſeeds, being dropped at half a yard diſtance from each other, the ſame in which they were to remain, and but about an inch deep into the ſoil. Every ſeed commonly produces more than one plant, ſometimes three or four, ſo that it is neceſſary to draw up the ſmalleſt, about ten days after they appear above the ground, when ſown in this manner.

"May 26th, the firſt crop of leaves was gathered, being then at their full growth, and more than a foot long, many meaſuring eighteen inches. A freſh crop of leaves was conſtantly collected afterwards, every ten days or a fortnight, during the ſummer and autumn until froſts ſomewhat retarded their vegetation. The laſt crop of leaves is not yet gathered. The land, being very full of weeds and couch graſs, was obliged to be hoed three times during the ſummer, notwithſtanding the amazing luxuriancy of the plants, which covered all the ground; this foulneſs of the ground, together with the dryneſs of the firſt part of the ſeaſon, prevented the roots from gaining their uſual magnitude; none of mine having exceeded ſix pounds in weight.

"The firſt attempt, in diſpoſing of the leaves, was to offer them to ſome milch cows, who fed upon them with great avidity, and even preferred them to clover, or any thing elſe that could be given them. Young calves were alſo very fond of the leaves, and would hardly touch any other food after they had eaten of them, except milk. Pigs, I believe, prefer them to any other vegetable that they are commonly fed with, and feed fatter on them than potatoes. I do not find that horſes are fond either of the leaf or root; after repeated trials they will ſometimes eat a few leaves, but ſoon leave them for other food.

"I have chiefly appropriated my crop of leaves to the feeding of pigs; and perhaps the following account of the actual profits I have made will place the utility of this plant in a more obvious point of view than by any other mode in which I could poſſibly expreſs myſelf. Two cows were fed four weeks entirely with mangel wurzel leaves, and two calves eight weeks.

"Sept. 18th, ſold four pigs at 1l. each, fed entirely with the leaves from the time they were eight weeks old. Nov. 16, ſold four pigs for 5l. 5s. fed with the leaves from the time they were weaned. Beſides the above, upwards of twenty pigs, of all ſizes, have been conſtantly fed with theſe leaves, ſince the 26th of May till the preſent time. Moreover, in a quarter of an acre of ground, there are above 2400 plants; the average, therefore, at 4lb. per root, makes 9600 pounds weight of root for winter proviſion.

CALCULATION.

Debtor.	£.	s.	d.
To forking the land	0	14	0
To hoeing	0	4	0
To gathering the leaves	1	0	0
To coſt of 8 pigs, at 8s. each	3	4	0
	£. 5	12	0

Creditor.	£.	s.	d.
By keep of 2 cows four weeks, at 1s. each	0	8	0
By ditto 2 calves 8 weeks, at 6d. each	0	8	0
By ſale of 4 pigs	4	0	0
By ditto of ditto	5	5	0
By 20 pigs, kept 28 weeks, at 4d. each	9	6	8
By 9600lb. of roots for ſtore, 6d. per 100lb.	2	8	0
	21	15	8
	5	12	0
Profit £.	16	3	8

"I hope

"I hope the rates of feeding the different kinds of ſtock will at leaſt be deemed ſufficiently low; they are much too low for theſe parts.

"However conſiderable the profit from the above calculation may appear, I am very certain the produce of the roots will be far above what I have expreſſed; I am convinced that the root will fatten any animal, that will eat it much quicker than the root of the potatoe; but which I have eſtimated far below the value of that root by weight. If ſuch be the produce of a crop, ſo poor as mine, where the average would hardly admit of four pounds per root; the advantage of a good one, where they run from ten to twenty pounds weight, muſt be far ſuperior to any other vegetable I have the leaſt idea of. I am happy to find that this plant, as the benevolent Doctor Lettſom ſuggeſts, may prove particularly uſeful to poor people; for, beſides the advantage ariſing from it for culinary purpoſes, a very ſmall bit of land will enable them to keep a cow, or at leaſt a pig all the ſummer, which now few can do without being at more expence than the animal profits them.

Cliff Houſe, near Bridgenorth, Dec. 1, 1788. BRYAN J'ANSON BROMWICH."

Further experiments on Mangel Wurzel,
BY THE REV. MR. BROMWICH.

SIR,

"As, from my former remarks on the culture and produce of the Mangel Wurzel, you wiſhed to be informed of my ſucceſs in regard to the root; I have to mention, that they remained in the ground ſo late as the 16th of December, when one part was taken up, and after having the leaves cut off, the roots were piled up in a building, and covered with ſtraw, to preſerve them from the froſt. A part was left in the ground, in order to ſee if they would endure the ſeverity of our winters equally with the turnip; but as the froſt was ſo very intenſe ſubſequent to the 16th, it was impoſſible to aſcertain that point, as both equally periſhed.

"The greater part of the roots, when cut in pieces, was given to milch cows? and the butter at that time was eſteemed equal to the beſt, when produced from graſs. From this trifling experiment I could eaſily perceive two advantages this root has over the turnip; it feeds cattle much quicker, and communicates no offenſive taſte to the milk. The remainder of the roots were given to pigs; two were entirely fatted by them, and weighed about 260 pounds each when killed.

I am, Sir,
Your obedient ſervant.

Cliff Houſe, May 25, 1789. BRYAN J'ANSON BROMWICH."

The ſeverity of the froſt in the winter of 1788 was uncommonly ſevere, therefore it cannot be ſurpriſing that the roots of this luxuriant vegetable ſhould periſh in common with the turnip; but from other accounts which we have received, we may conceive a hope that the Mangel Wurzel, in a dry and healthy ſoil, is capable of reſiſting the influence of common degrees of froſt, and that though the accounts of its excellence, as food for cattle in general, are not numerous, it will yet be found valuable for that purpoſe in many ſituations. If the plant in queſtion ſhall be found but half as profitable in general for feeding pigs as it appears to have been in the inſtance related by the Rev. Mr. Bromwich, it will ultimately rank among crops of conſequence to the farmer.

Sir Thomas Beevor, Bart. in the Bath Papers, Vol. V. page 149, obſerves that ſome perſons who have offered this root to horſes which refuſed to eat it, entertain doubts if horſes could ever be brought to eat it; but no one ought in a caſe of this kind to be deterred by a ſingle trial. It often happens that a particular animal, or indeed many individuals, will refuſe to eat a particular food they have not been accuſtomed to, which is well known to be both wholeſome and palatable to that claſs of animals in general. "I have ſeen many cattle that were, with difficulty, brought to eat turnips, and ſome that never would take to that feeding kindly, ſo as to fatten upon it. I have alſo been informed, upon authority I could not doubt, that ſome ſheep have actually died before they could be brought to taſte that root. By a little attention, however, cattle may in general be brought to reliſh any ſucculent root of the nature of this in queſtion, and horſes alſo. My horſes that are employed in taking turnips from the field, in general, learn in time of themſelves to eat turnips, though horſes in general do not take this food at firſt. I ſaw a letter laſt year from a gentleman who had been at pains to train his horſes to eat turnips, and he found it to put them into good condition, and gave them a fine coat. He therefore thinks that young horſes might be reared upon this root with advantage."

As we have enumerated the many advantages which may ariſe from the cultivation of this *ſtranger* amongſt us, we think it incumbent on us to ſtate ſome obſervations rather unfavourable to its culture, as related in the Bath papers, Vol. V. page 147,

BY SIR THOMAS BEEVOR.

"The ſeeds I had from a common ſeed-ſhop, therefore it is poſſible they were not of the true ſort; but the plants were ſo much like thoſe of the true ſort that have been deſcribed by others, that I think it extremely probable they were genuine.

"It is plainly a variety of the beet. The roots were of various colours, white, yellow, and red; the difference in the intenſity of each of theſe tints was very great. The root is thick and fleſhy, more reſembling the beetrave, or red beet, than the common beet; the leaves large and ſucculent, more reſembling thoſe of the green beet than the beetrave. The ribs of the leaves are always of the ſame tint with the root. The fleſh of the root is coloured the ſame as the ſkin. Its taſte a maukiſh ſweet, that is reliſhed by very few of the perſons who ate of it.

"I ſowed part of the ſeed on a light ſandy ſoil, and part on a rich light loam. The plants on the laſt proſpered much better than the other; it ſeemed to me that the ſand was too poor a ſoil to rear this plant to its full ſize, though carrots, turnips, cabbages, and potatoes, were all reared upon it at the ſame time in the higheſt perfection. The ſeeds were ſown about the beginning of April. This ſeemed to be too early, as many of the plants ran up to flower during the ſummer, which greatly diminiſhed the crop, as they had been properly thinned before they began to run. Part of them were ſown where they were to remain, and part of them were tranſplanted. Thoſe that were not tranſplanted proſpered the beſt.

"During the ſummer the leaves were tolerably abundant, but nothing like ſo luxuriant as I had been made to expect. I cauſed ſome of the blades to be gathered, but this ſeemed rather to retard the growth of the root. Indeed the quantity that could be procured did not ſeem to be at that ſeaſon of the year worth the trouble of gathering. A much greater quantity of uſeleſs blades I think could be obtained from an equal extent of ground in cabbages. I am alſo inclined to think, that on the ſame ſoil, with an equal care in the culture, as great a weight of carrots or parſnips may be obtained; and that there can be little doubt but a greater weight of turnips may be got; and that this laſt could be reared on many ſoils to great perfection where the root of ſcarcity could hardly be made to grow at all. I did not obſerve the ſmalleſt mark of any puncture from inſects on its leaves during the whole period of its growth. In this reſpect it ſeems to reſemble the mulberry. It is rather more hardy during the winter than moſt kinds of turnips, particularly its leaves, though they do not perfectly reſiſt our winters: I even obſerved, that ſeveral of my plants were killed by the froſt during this winter. Upon a careful examination of theſe, however, I think, that all thoſe that have been killed, diſcovered ſome tendency to be about to ſhoot up into flower-ſtems towards the end of autumn.

"I was anxious to know whether it continued late in the ſeaſon before it began to run to ſeed in the ſpring, as I was in hopes that if it ſhould be ſo, it would have ſome chance of proving a valuable addition to our catalogue of uſeful plants: but here alſo I have been diſappointed. The ſeaſon had been backward, and turnips were only on the 23d of March beginning to ſhew their flower-ſtems. The root of ſcarcity was alſo faſt advancing to the ſame ſtage of its growth, ſo that it will probably fail about the ſame time with the turnip crop.

"The root is reliſhed very well by cattle, and my horſes eat it; but I fear it is of a nature rather too ſucculent to be a very proper food for horſes. I have no doubt but that cattle would thrive upon it very well, though the quantity I had was too ſmall to enable me to ſpeak experimentally to that point. On the whole, though it is perhaps poſſible, that in certain circumſtances this plant may be cultivated with profit; yet if my ſeeds were of the genuine ſort, it will not be found to be in general of equal value to the farmer as ſeveral plants with which we have been long acquainted. Independent of every other conſideration, it appeared to me that the expence of taking up and cleaning this root, ſo as to make it fit to be given to the cattle, would be ſuch as for ever to prevent it from coming into general uſe; for the fibres that ſpring out of it are ſo numerous and ſtrong, as to entangle a great deal of earth among them, from which, if the earth has the ſmalleſt tendency to adheſiveneſs, it is a matter of great difficulty to diſengage it. During wet weather in winter I do not ſee how it would be poſſible to get this root taken up, and made fit food for cattle at any thing like a bearable expence, eſpecially that which has been tranſplanted."

Sir Thomas, in farther remarks which he makes on this plant in the ſame vols. page 417, ſays, "The few plants of it which I cultivated laſt year afforded me no opportunity or ground whereby I could judge of their effect upon the cattle which fed on them. I could therefore only try whether they would be eaten or rejected by cows, bullocks, and ſheep, and whether, in caſe they were left in the ground, they would ſo well endure the viciſſitudes of froſt and thaw, through the winter, as to furniſh the farmer with a certain and plentiful ſupply of food in the ſpring. With reſpect to the firſt object of my trials, the report I have to make is, that I found all my cows, bullocks, and ſheep, would, after two or three days, feed as readily upon them as on turnips or any other food; but with regard to the latter object, I cannot ſay the reſult was ſo favourable as I could have wiſhed, and did expect; for, notwithſtanding the mildneſs of the weather through the whole of the laſt year (1787) and the different means I uſed for the preſervation of the roots, by covering ſome of them lightly with earth, others with ſtraw, and leaving others in the ſtate in which they had grown, I did not find half of them found or fit for uſe in the month of

of March. Now if this ſhould have been the caſe with other crops, and they be not found able to reſiſt the power of the froſt, whilſt ſtanding in the field, I apprehend they will never anſwer the farmer's purpoſe as a winter food for cattle upon any large ſcale, ſince there could be very few men found who could ſpare time to pull up the product of from twenty to one, two, or three hundred acres of theſe roots before winter; and when pulled, I conceive there would be ſtill fewer found who could contrive in what manner and place they might be put, ſo as to be ſecure from froſt, and convenient for daily uſe; but perhaps the evil I mention may not have generally exiſted, and may have been owing to ſome particular unheeded cauſe."

SWEEDISH TURNIPS, OR ROOTA-BAGA.

As a confirmation of the great utility of this root, we ſhall ſubjoin the following extract of a letter to the Secretary of the Bath Society, as appears in the Bath papers, Vol. V. page 425, from

SIR THOMAS BREVOR, BART.

"The Roota-Baga plants are very promiſing; their growth is quick, and their roots very much exceed in ſize all thoſe of the turnip rooted cabbages growing in the ſame field, and on preciſely the ſame ſoil. They are firm, ſweet, and particularly grateful to all cattle; unfortunately they had been ſo much ſo to hares, pheaſants and wood-pigeons, as to have obliged me, in order to preſerve ſome of the few plants I have raiſed, to tranſplant the chief of them into my garden, whereby I might ſecure a ſufficiency of ſeed from them to ſow in the enſuing ſeaſon. Several of thoſe in the field are very much eaten, whilſt neither a turnip-rooted cabbage, a mowing cabbage, a common turnip, or a Scotch cabbage, all ſtanding in the ſame field, are yet touched. They are, when dreſſed for the table, in the manner of other Turnips, univerſally preferred to them."

We cannot but obſerve, the Roota-Baga is a plant from which great expectations are formed, both as a vegetable for the table, (in which reſpect Sir Thomas's opinion is generally agreed in) and an article of food for cattle. Little doubt can be formed of its being hardier than the turnip; and its greater ſweetneſs and ſolidity muſt give it a preference in the eſteem of many perſons.

We ſhall give the following extract on the cultivation and uſes of the Roota Baga, from the Leiceſter Herald; as related by a Correſpondent.

[*Vide Leiceſter Herald of May* 2, 1792.

"The introduction of any ſort of Turnip, which will ſtand through the winter, cannot fail to be of great utility. The Sweediſh Turnip, or Roota-Baga, defies the hardeſt winters of this country, even as far north as Edinburgh, as appears by an experiment made by John Anſtruther, Eſq. who reſides north of that city, and near the ſea.

"In April the ſeed was ſown on a hot-bed, but hot-beds are found to be quite unneceſſary. The ground was ploughed and dunged in the uſual manner as for other turnips. The beginning of June they were planted out in rows three feet aſunder, and the turnips at nine inches diſtance, and not one failed taking root. In the beginning of July they were horſe-hoed, and afterwards hand-hoed.

"In winter a few were taken up for the table, they were moſtly in figure reſembling a quart bottle, but longer than the common turnip, and ſo much ſuperior in flavor that none of the family would taſte the other ſorts; they were alſo twice as heavy as a turnip of the ſame ſize. Both cows and fattening oxen ate them as readily as the common turnip.

"To try how they would keep, they were pulled up in November; ſome were put in ſand in a barn, and the reſt laid upon a graſs walk in the garden. They lay there, entirely expoſed to the weather, until April, when they were juſt as good, and the cattle eat them as well as if they had been freſh; thoſe in the Barn were the ſame, and at table both ſorts were as good as thoſe gathered in November. This trial proved their hardineſs, as from March to the end of April, there were ſevere ſtorms of froſt and ſnow, with little or no intermiſſion.

"As tranſplanting was troubleſome, and it being conceived that they would grow larger if ſown on the ſame place, where they were to ſtand; the firſt week in June 1791, ſome were ſown in drills three feet aſunder, and hoed as other turnips: the event anſwered the expectation: the roots were conſiderably larger, though ſown on much worſe ground. Except what were uſed for the table, the whole were pulled up about the 20th of March, and laid in heaps in the barn-yard, entirely uncovered from the weather, and were given to the fattening oxen, after all the other turnips were gone. This proved of the greateſt advantage, for the mildneſs of the weather cauſed all the others to run to ſeed, and having no graſs, the cattle were ſtarving."

Mr. J. Freeman, of Fuſton, in the county of Leiceſter, informs us that he has grown this valuable plant, and that it is proof againſt the ſharpeſt froſt: he has tried it in the laſt two winters with great ſucceſs, and certainly thinks it will be of great utility to this country, as it is ſweeter and firmer than any other ſort, and ſheep and beaſt are very fond of them. The bottoms weigh from about 4lb. to 7lb. each. It is an amazing hardy plant, grows exceeding well on being tranſplanted about 12 or 14 inches from each other. Time of ſowing for tranſplanting, in May; and to ſow, to ſtand for a crop, June is ſoon enough. A quarter of a pound of ſeed will plant an acre over.

As ſome of our ſubſcribers may wiſh to be poſſeſſed of a ſeed which is ſo likely to be beneficial to graziers, farmers, and the public in general, we think it neceſſary to inform them that Mr. Freeman has a ſmall quantity of this ſeed to diſpoſe of. It may be had of him, at Fuſton, Leiceſterſhire, or at the Saracen's Head, Leiceſter.

CHICORIUM INTYBUS, OR CHICORIE SAUVAGE, OTHERWISE CALLED WILD ENDIVE.

The Chicorie Sauvage is a plant very little known in England, but bids fair to become an acquiſition of great conſequence to the *rural œconomics* of this country. The Rev. Mr. COOKE, Inventor of the well-known Patent Drilling Machine, has favoured Mr. C. Cooke, the publiſher of this work, with the following valuable information reſpecting the plant now under conſideration.

"SIR,

"In my tour through Normandy, Picardy, and the Iſle of France, in October, 1787, I had an eye to the reſpective Syſtems of Agriculture, as practiſed in thoſe parts of the country, and was ſurpriſed to find the conſtruction of the implements in huſbandry, as well as the methods of cultivating the ſoil, rotation of crops, &c. &c. ſo much behind the common practical Syſtem of Agriculture in Great Britain. I think I could with ſafety pronounce them two hundred years behind us, both in theory and practice. I was alſo ſurpriſed, but very agreeably, at the ſight of ſeveral acres of land, covered with a ſucculent luxuriant herbage for cattle, of the plant called CHICORIE SAUVAGE, or Wild Endive, belonging to Mr. CRETE, of *Dugney*, near St. *Denis*, about 7 miles from *Paris*; eſpecially when I was informed, that upwards of forty tons, the produce of one ſeaſon, had been cut as green herbage for cattle, from one Engliſh acre, previous to my ſeeing it in the above flouriſhing ſtate in October.

"I was alſo informed, that the herbage of this plant, (which is perennial,) withſtood a moderate froſt in the beginning of winter, and that it began to vegetate early in the ſpring. That this plant flouriſhed upon a dry, thirſty, gravelly ſoil, was ſelf-evident to me; it alſo ſtruck me very forcibly, that if this plant would flouriſh equally in our climate, the introduction of it might prove an acquiſition to this country. On which account I was induced to requeſt of Mr. Crete a little ſeed, which requeſt was very liberally complied with.

"This ſeed I brought to England, and diſtributed it in ſmall portions to a number of my agricultural friends and correſpondents, ſuch as I apprehended would give it a fair trial upon different ſoils; and I have the ſatisfaction to ſay, that as far as I have ſeen of the cultivation of this plant upon a very ſmall ſcale, and heard of from others, its luxuriancy appears to equal, if not ſurpaſs, that which I ſaw at Mr. Crete's; particular information of which I have already had from WM. WHITMORE, Eſq. of Dudmaſton, near Bridgnorth, in Shropſhire, from Mr. CROOK, of Tytherton, near Chippenham, in Wiltſhire, and from Mr. MAY, of Pendis, near Ipſwich, in Suffolk. It is well known, that the ſoil of Mr. MAY's farm is a poor light unproductive ſand, not worth 4s. per acre; and if one-half, nay, if a fourth part of Mr. CRETE's produce can be obtained from the ſoils in this iſland, ſimilar to Mr. MAY's, the cultivation of this plant may be truly ſaid to be an acquiſition to this country, and worthy of every attention. In the preſent infant ſtate of the cultivation of this EXOTIC, I have only to obſerve, that if it really begins to vegetate luxuriantly in the month of March, as I have been informed it does, the advantages to the farmer will be ineſtimable; in the time of ſcarcity of food for cattle, in the ſpring, when hay, turnips, cabbages, &c. are expended, and common graſſes not yet begun to vegetate, he will have a plentiful ſupply; in which caſe, the formidable month of April, and the beginning of May, will ceaſe to be any longer dreaded by the huſbandman.

"I have thus briefly communicated to you the information I have received of the plant called CHICORIE SAUVAGE, in hopes of inducing cultivators of different ſoils to give it a fair trial.

And am,

Your moſt humble ſervant,

JAMES COOKE."

The great ſervices this gentleman has already rendered to the Agriculture of this kingdom, by his ingenious and uſeful inventions, are conſiderably increaſed by his introducing this promiſing and uſeful plant; and his making us the happy inſtruments of firſt communicating this acquiſition to the public, is a diſtinction we are not a little proud of. From the ſame ſource, we likewiſe learn the following particulars: That the proper time to ſow it is early in the ſpring, broad-caſt with corn, as you do other graſs ſeeds, or plant it in rows with a drill, twelve or fifteen inches diſtant from each other; that broad-caſt, one buſhel and half is ſufficient to ſeed an acre, and drilled, half the quantity. In France it may be cut as green food four times in a year, and all kinds of cattle eat it readily; it grows with a tap root, and ſtrikes a conſiderable

siderable depth into the earth; of course it should be planted on a soil capable of giving it admission.

Whatever tends to improve poor land is of the most material importance to Agriculture: of that description the *Chicorie Sauvage* bids fair to stand foremost, and we make no doubt but in a few years its cultivation will become widely extended in this kingdom.

We shall add some farther observations on the cultivation and uses of this new plant, as introduced in page 202 of the Annals of Agriculture, by

ARTHUR YOUNG, ESQ. ON CHICORIUM INTYBUS.

"SOIL, a wet sandy friable loam, on a clay marle bottom; hollow drained; level; worth 14s. an acre. March 20, 1790, sewed oats on a cabbage preparation, on 16 square perch lying circularly, for the convenience of ploughing, and, at the same time, with the oats the following seeds on each perch.

No.	Seeds.	Proportion per acre.
1,	Burnet	20lb.
2,	Alopecurus pratensis,	5 bu.
	White clover,	10lb.
	Rib grass,	10
3,	Poa pratensis,	20
	White clover,	10
	Rib grass,	10
4,	Timothy grass,	20
	White clover,	10
	Rib grass,	10
5,	Chicory,	10
	Rib grass,	10
	Trefoil,	10
6,	Chicory,	10
7,	Chicory,	20
8,	Chicory,	5
	Burnet,	10
	Trefoil,	5
	White clover,	5
9,	Chicory,	10lb.
	Alopec pratensis,	2½ bu.
	Rib grass,	5 lb.
10,	Chicory,	10
	Timothy,	10
	Rib,	5
11,	Chicory,	10
	Poa trivialis,	10
	Rib,	5
12,	Chicory,	10
	Poa Pratensis,	10
	Rib,	5
13,	Lucerne,	20
14,	Ditto alone, no oats,	20
15,	Avena elatior,	5 bu.
	White clover,	10 lb.
	Rib,	10
16,	Poa Pratensis,	10
	Poa trivialis,	10
	Avena elatior	10
	Timothy,	10

"The oats were mown at harvest, without account being taken of their produce, as they were not in contemplation further than being the means of laying down.

"May 26, 1791, some gentlemen, correspondents of this work, favoured me with their company, and assisted at mowing and weighing the crops.

Produce weight green.

No. 1,	=	86 lb.	No. 9,	=	71 lb.
2,	=	69	10,	=	78
3,	=	73	11,	=	111
4,	=	67	12,	=	125
5,	=	81	13,	grass and weeds	
6,	=	88	14,		
7,	=	87	15,	=	113
8,	=	86	16,	=	102

Viewed them June 1st, not a drop of rain having fallen since the last cutting; numbers 2 and 9 were shot out most, that is the two numbers of the alopecurus. No rain till July 11 and 12th, when much fell. The 14th, cut the chicory numbers again, the rest had nothing worth mowing.

Produce.

No. 5,	=	56 lb.	No. 9,	=	47 lb.
6,	=	74	10,	=	65
7,	=	65	11,	=	75
8,	=	53	12,	=	90

August 17, cut all again.

No. 1,	=	25½ lb.	No. 9,	=	23 lb.
2,	=	24½ lb.	10,	=	27
3,	=	23½ lb.	11,	=	32
4,	=	30	12,	=	38
5,	=	25	13,	of no account	
6,	=	30	14,		
7,	=	34	15,	=	31
8,	=	25	16,	=	26½

The after-grass was inconsiderable, except of the chicory, which might have been weighed, but I did not think such minutiæ useful.

Total Produce.

	Produce. lb.	Produce per Acre. Ton. Cwt. lb.
No. 1,	111½	7 19 32
2,	93½	6 13 64
3,	96½	6 17 96
4,	97	6 18 64
5,	162	11 11 48
6,	192	13 14 32
7,	186	13 6 22
8,	164	11 14 32
9,	141	10 1 48
10,	170	12 2 96
11,	218	14 11 48
12,	253	18 1 48
13,	144	10 5 80
16,	128½	9 3 64

"I do not attribute the greater produce of numbers 11 and 12 to the addition of the plants sown with chicory, for appearances would not allow that supposition; but to some accidental variety in the soil, or preceding culture; and the principal circumstance to be attended to, is the superiority of chicory in general to the other plants in general, which is remarkably great.

"The reader will of course bear in recollection the circumstance of the season being an uncommon drought, so that all crops of grasses, both natural and artificial, were as scanty as ever known. These crops of chicory amount, in this unfavourable season, from three to four tons of hay per acre, allowing it to lose three-fourths in drying; not that the plant is perfectly adapted to making hay, but merely to mark the produce. I however made about half an acre this year into hay, the crop good, the hay, in so dry a season, made as well as any other, and is eaten by all live stock as readily. One cannot but remark the enormous difference between this plant and lucerne; while chicory yields from ten to eighteen tons per acre, the lucerne is such a poor, puny, sickly thing, as not to pay for mowing the weeds, which its weakness allows to vegetate.

Experiment.

"The trial upon this plant, already registered in this work (vol. xv. p. 395), during three years, was this year cut, June 14th, produce 44lb. and August 18th, 28lb.—In all 72lb. or per acre, 23 tons 6 cwt. 80lb. a very considerable produce; the extreme drought considered, much more than might have been expected. In four years, the acreable produce has been 119 tons, or very near 30 tons per acre per annum! one of those years that of sowing, and another an extreme drought.

"A general observation I shall make, which may be worth the attention of those who cultivate this excellent plant, which is, that it seems to flourish remarkably where it has most room and air; the plants along the edge of paths, &c. are vastly superior; from this I should imagine, the drill husbandry would be the best for it; but to mow it in that case four times a year. I design drilling a field of it the ensuing spring. A. Y."

SECT. XVI. HOPS AND THEIR CULTIVATION.

HOPS, from their appearance in hedges, in a wild and uncultivated state, are probably natives of this island; they naturally twine themselves round whatever support presents itself, and without such assistance will not flourish. It is something remarkable that the Hop and the scarlet kidney, or French beans, entwine round their supporters in opposite directions, notwithstanding every effort to direct them contrary. The use of Hops are absolutely essential in England, as they constitute a very material part of the liquor which is the general drink of the inhabitants; this makes their cultivation very extensive.

The Hop-planters business is very precarious, sometimes the profits are immense, and at others, a great loss for several successive years; as an instance of the first, we have known a Worcestershire farmer make 1200l. profit from 20 acres of Hop ground in one year; the expence of tillage being very heavy, a failure of the crop for several successive years occasions a very great annual loss.

Hops cannot be cultivated to advantage, except on strong rich land of considerable depth of soil, which must be constantly manured, otherwise little advantage is to be expected. Land fresh broke up from pasture is preferable for Hops; if they are planted on ground previously in tillage, it should be as well cleaned, and in as high condition as it is possible to bring it in by labour and manure.

Hops are planted early in spring, sometimes in rows, of seven or eight feet distance from each other, the intervals of which are occasionally ploughed, to pulverize the soil and destroy weeds; this causes the expence to be smaller; but planting them in hills is by all means to be recommended to those who wish to cultivate them to advantage.

If you brake up a pasture, the turf should be first pared thinly off by a paring plough, and then followed and buried by the furrow-plough, at least ten inches deep; if arable, the ridges on which the Hops are to be planted should be double ploughed, or trenched with the spade; the latter method, though most expensive, is certainly the best. This should be done early in the winter, about which time the ground should be marked out on which the hills are to be formed, and on these spaces a thin coat of well mellowed dung should be laid to remain the winter. The vacant paces have no need of dung, nor should any be used but such as is well rotted.

As soon after a hard frost as the earth becomes dry and mellow, plough into a three-bout ridge the lands on which your setts are to be planted, leaving the intermediate spaces unploughed. But before this is done, measure out your ground and square it, leaving the inequalities at the sides or ends to be managed as hereafter directed. By squaring it, I do not mean that all the sides should be equal, only that they be straight in order to add neatness and beauty to your plantation. The three-bout ridge should measure four feet nearly, and by leaving an interval of seven feet in breadth, you will so manage, that your hills will all fall on the tops of the ridges, which will be of great advantage to your plants.

The ground being thus prepared and harrowed down ſmooth, your next care is to mark out your hills. The readieſt way of doing this, is, to have four painted ſticks about ſix or ſeven feet long; two of which ſhould be ſet upright with a plummet at each end, exactly at the diſtance you intend your alleys to be. Two men ſhould be employed in this operation, each with an eight feet ſtick (for that is the diſtance I would adviſe your hills to be placed) and a ſpade. Suppoſing the men to be at the oppoſite ends, they begin one from one pole, and the other from the other pole; and each directing his eye to the pole that is exactly oppoſite to that at which he began, with his ſtick and his ſpade, he meaſures the ſpace from hill to hill, and throws up a ſpadeful of earth at each for a mark. In this manner both working alike, by meeting and croſſing one another, they arrive at oppoſite ends nearly at the ſame time; and then meaſuring and moving their poles, they proceed again in the ſame manner, and ſo continue to do till the whole plantation is marked. In forming your alleys eleven feet will be found a due proportion.

This operation completed, let them next begin to prepare the mould for the hills, which I would adviſe to be ſkimmed lightly from the ſurface of the intervals, or once ploughed lands, taking that only which is perfectly fine, and gathering it into heaps; theſe ſhould lie juſt oppoſite the holes out of which the ſpadefuls were thrown, and thoſe ſpadefuls ſhould be turned up and laid upon the oppoſite ſides of the holes to where they lay when firſt thrown up. If froſt or ſnow ſhould intervene before the time of planting, ſtir the mould again, and throw it up nearer to the place where the plants are to be ſet.

Thus every thing being in readineſs before the month of March, eſpecial care ſhould be taken to provide a ſufficient number of good ſetts, for which the younger planter muſt rely on the fidelity of ſome friend, as he cannot himſelf be a competent judge by any directions that can be given him on paper. The number of ſetts that will be neceſſary for an acre, according to the method here directed, is 4200, that is five plants to a hill, and about 800 hills to an acre: according, therefore, to the number of acres you intend to begin with, muſt be the number of plants you provide.

March, the proper month for planting, being come, the plants prepared, the ground moiſt, and the weather favourable, begin by filling up the marking holes, and juſt chopping the ground round them to looſen it, and then proceed to make up your hills with the fine mould already mentioned. This done, let the planter with his dibble make five holes in this manner; : : each about twelve inches a-part from the other, and rather inclining outwards towards the baſe of the hill than quite down-right, into which let him place his ſetts, which then will all point towards one another a-top, the uſe of which will more clearly appear hereafter; this done, let him with his hand hollow the hill like a diſh a-top, preſſing the earth cloſe to each plant with his dibble, and leaving the hole open for the reception of the firſt rain that falls. This done, let the two men proceed, one making up the hills, and the other planting till the whole plantation is completed.

Thus having completed your plantation, you have little elſe to do till the weeds begin to appear, and then inſtead of hoeing, dig up your once ploughed intervals, and throw the earth out equally on both ſides, ſo as to cover the ridge on which the Hops are planted, and ſmother the riſing weeds; this will add to the natural warmth of the ſoil, and help to enrich it; and when this is done, weed your hills, and, if the mould is fallen down, new dreſs them.

It is now the univerſal practice in Kent to pole the Hops, the firſt year with poles about 12 or 14 feet high. Theſe poles are either aſh, willow, poplar, maple, or aſp: the young planter muſt content himſelf with ſuch as the country he lives in affords; the poplar and willow are the ſooneſt raiſed; in Kent, poles for the firſt year coſt about 10l. per thouſand: but poles twenty feet high for the ſucceeding years, ſometimes coſt double. The common practice is polling as ſoon as the vines begin to riſe and bend; nature directs that they ſhould ſeek for help as ſoon as they begin to creep, and there ſeems to be a reciprocal attraction between the plant and pole, which it were in vain to attempt to explain, though daily experience confirms its exiſtence. This, however, will want the aſſiſtance of art to direct it properly, and the ſhoots muſt be led to the poles to which they ſeem moſt inclined, and lightly tied to them, to prevent their ſtraying. Three poles are uſually ſet to a hill; they are firmly fixed in the ground by means of an iron crow made for that purpoſe: the willow and poplar will frequently take root, if not well ſeaſoned before uſing, for which reaſon they are generally cut early in the winter, and expoſed to the air to harden, it not being found ſo proper to let them put forth leaves. In placing them they contrive to ſpread them a little a-top, as well for the convenience of air, as for preventing the vines from intermixing, which, without this precaution, they moſt certainly will do. No more than two vines are ever ſuffered to riſe upon a pole, the reſt are carefully trimmed from the ſtocks, and either uſed for raiſing new plantations or converted into dung. After the firſt year, however, I would adviſe the followers of theſe inſtructions to add one pole more to a hill, and let two vines approach every pole. The ground, managed as before directed, will nouriſh them, and by parting the poles properly at ſtaking them, they will want neither ſun nor air to ripen them to perfection. Great care, however, is neceſſary, after poling, to watch the ſtraggling vines, to rectify the poles, and to replace whatever may by accident be thrown into diſorder. It is likewiſe uſual about Midſummer to top the vines upon the poles, that is, to pinch off the buds, in order to check their upright growth, and to promote their branching. This is done by means of a ladder, ſuch as gardeners uſe to cut trees.

Hop grounds ſhould be always kept clean from weeds, and the earth in fine tillage; to fix ſtated periods for labour to be performed would be impoſſible, and he who does not know when ſoil ſtands in need of ploughing or digging is unfit to be a farmer. About the beginning of Auguſt, Hops are in bloſſom, after that the leafy ſubſtance forms itſelf, which is called the Hop. The general ſymptoms of their ripening are, a change of colour from a pale green to a yelloviſh hue, after this they ſmell fragrant and ſtrong, and the ſeeds will on examination be turned brown and begin to ripen; the ſmall leaves which compoſe the Hop ſeparate and open; this is a ſure criterion that the crop is fit to gather, which ſhould be immediately attended to, as delays are dangerous.

The methods of picking varies in different counties in England; in Kent they are picked in baſkets at a certain price per meaſure. In Worceſterſhire and Herefordſhire the gatherers work at a price per day and their maintenance.

A ſpace is formed in the Hop ground, and a moveable article, called a crib, conſtructed ſomething reſembling in ſhape a hamper or crate, ſuch as glaſs is uſually packed in, but a great deal larger, being fixed, the inſide covered with a cloth, it is the buſineſs of a man to cut the Hop wires near the ground, pull up the poles, and bring them with the wires upon them to the crib; the pickers ſtanding all round, pull off the Hops into the cloth before deſcribed, which when full is carried to the kiln to be dried, and another put in its place for the like purpoſe.

Hops are dried on kilns built for the purpoſe, and muſt be carefully attended during the drying, particularly that the fire is not too ſtrong, and that they are duly turned. Hops are dried with coal made into charcoal, generally called coke. After Hops are dried, they ſhould be laid together in a room to cool; if they are bagged hot from the kiln, the operation of bagging reduces them to powder.

SECT. XVII. FLAX AND HEMP, WITH THEIR CULTIVATION.

FLAX.

THIS plant is cultivated to great advantage on rich land, and all attempts to plant it on foul, not of that deſcription, ſeldom turn out profitable. The plant has a beautiful appearance, growing with a ſlender upright ſtalk, ſmall leaves, and a blue bloſſom; on a minute examination each flower appears to ſtand in a ſmall green cup, compoſed of five pointed leaves; the flower in like manner conſiſts of five leaves, the whole of which reſembles the ſhape of a bell.

Freſh broke up paſtures are frequently appropriated to the growth of Flax, and which it is neceſſary to pulverize and reduce very fine; a crop of beans, previouſly taken, are by no means improper, and ſerve to pay rent and labour.

The month of April is the proper time to ſow Flax, the ſoil being dry and in fine tillage; from two to three buſhels are uſually ſowed upon an acre: and drilled, a buſhel or 5 pecks; much depends upon the goodneſs of the ſeed: drilling in rows 10 or 12 inches diſtant is preferable.

Linſeed is eſteemed good when it is large, oily, heavy, and of a bright brown colour; to know whether it be oily, a few grains are thrown into a red hot fire ſhovel, and if they are good they crackle almoſt inſtantly, and blaze briſkly. If it be ſufficiently heavy, it will ſink to the bottom of the water; and to judge whether it be new, a number of ſeeds exactly counted ſhould be ſown on the end of a hot bed, and notice taken whether they all grow or not.

Flax is valuable for the ſeed, as well as for the product of the ſtalk, which by a proceſs is converted to linen. Flax ſeed is well known for making oil, and its uſe as food for cattle is equal, if not ſuperior, to any ſeed that grows: from a pint to a quart of linſeed infuſed in two quarts of water, and given daily to a feeding ox or cow, will bring them forward very expeditiouſly, and is much more nutritious than barley meal. When the ſeed of Flax is ripe, the ſtalk is paſt its perfection; it is therefore commonly pulled before the ſeeds become quite ripe, when the head begins to droop and change colour; this ſhould be particularly attended to: the future proceſs belongs to the manufacture of Flax.

HEMP.

Hemp, like flax, muſt be cultivated on rich land; its appearance, while growing, very much reſembles the common nettle, and the part manufactured for cloth, cordage, &c. inſtead of being incloſed in the middle of the ſtalk, like flax, forms the outward covering or peeling.

Hemp is ſowed about the ſame time as directed for flax; ſowed, about three buſhels to the acre, and drilled in rows 12 or 14 inches diſtant

diſtant, one buſhel, or one buſhel and an half to the acre: drilling is certainly the moſt eligible method, as, without the land is in fine tilth, it is by no means proper to plant hemp.

Particular care ſhould be taken to procure freſh, bright, and heavy ſeed, and it ſhould be planted ſhallow in the ſoil: it ſhould be carefully weeded, or if drilled, the intervals between the rows ſhould be hoed three or four times in the ſeaſon.

Hemp is of different kinds, male and female, and ripens one before the other, the male firſt, which is known by the leaves changing colour and falling, and the ſtalk alſo becoming whitiſh. The female plant produces the ſeed, and ripens later than the male, which renders it proper management to pull them at different periods; this makes drilling more eſſential, as one ſpecies may be collected without injuring the other. When pulled, care is taken to dry the ſtalks, which are generally tied in bundles. Neither Hemp, or flax, will anſwer any profitable purpoſe, except on good land, which they very much exhauſt.

SECT. XVIII. MADDER AND WOAD, WITH THEIR CULTIVATION.

MADDER.

THIS is a plant cultivated for its root, which is uſed by dyers; ſome ſmall quantity is alſo ſold as a drug. It appears an inſignificant running plant; the root being the object, the ſoil ſhould be rich and deep, by no means of a ſtiff, clayey nature.

The ſoil on which Madder is intended to be planted ſhould be ploughed deep, and laid perfectly dry in autumn; and after ſufficient ſpring ploughing and harrowing, the time to plant it is in April; the ſets are procured from an old plantation, and taken off when they are about two inches above the ſurface; they ſhould be ſlipped from the plant at as great a depth as you can, as they will then have the better chance to grow; and as ſoon as they are taken off, it is proper to throw them into water to keep them freſh.

The method of planting them, as generally practiſed, is in equi-diſtant rows, two feet four inches diſtant from each other: women or children drop the ſets, and men immediately follow after and depoſit them in the earth. If planted in the month of April, there is little danger of their growing, eſpecially if the land is well prepared, and watering them will ſeldom be found neceſſary. Great care is to be taken in weeding and hoeing, both to keep down the weeds, and pulverize the ſoil. The root is not to be taken up for ſale till the autumn after planting, twelve months; as before that time they are not grown of a ſufficient ſize. When the roots are taken up they ſhould be gently dried upon a kiln, or other place adapted for the purpoſe; after which they are marketable. The intervals between the rows are planted the next year, and managed in the ſame manner as the preceding.

WOAD.

Woad is a plant uſed by dyers, the leaves of which are valuable, and in colour of a blueiſh green: a rich dry ſoil ſuits it, and on no other ſhould it be planted: the roots likewiſe ſtrike deep, and ſhould be accommodated with a ſufficient depth of good ſoil. All thoſe plants which require a fertile ſoil, require alſo much ploughing and harrowing to prepare the land before ſeed time.

Woad is ſometimes ſowed in February or March; but the moſt proper ſeaſon is Auguſt: four quarts will ſow an acre broad-caſt, and drilled, half the quantity.

When the plants are two or three inches high, they ſhould be hoed from weeds, and left ſtanding about one foot diſtance from each other, and ſo remain during the winter, except the crop was drilled, in which caſe horſe-hoeing may be performed. When the leaves take their firſt ſhoot in ſpring, the intervals between each plant ſhould be well cleaned, and ſtirred as much as poſſible, as it will cauſe them to ſhoot more vigorouſly. The leaves of Woad are gathered when they are full grown, and continued from time to time during the ſummer, picking thoſe leaves only which are plump and juicy, and of a fine ſage green colour. As ſoon as they are gathered, they are ſent to the mill, which is a branch of the manufactury. Keeping the earth mellow by frequent hoeings greatly aſſiſts the growth of this plant, as well in its quality as quantity.

SECT. XIX. OVERFLOWING, DRAINING, AND CLEANSING MEADOW AND PASTURE LAND.

MEADOW and Paſture are generally applied as ſynonimous terms, and, in ſome reſpects, they are ſo. All kinds of Meadow land may, with the greateſt propriety, be called Paſture, but all kinds of Paſture cannot, with equal propriety, be deemed Meadow. By Meadow, we mean ſuch graſs land as lies level, or nearly ſo, and on which the traces, or appearance of the plough, are not viſible. Paſture is graſs land ſituate on the ſides or tops of hills and in vallies, always appropriated either to the purpoſes of growing hay, or depaſturing cattle; but which bears evident marks of cultivation.

Theſe we conceive to be the definite meanings of Meadow and Paſture, by which it muſt be underſtood, that Meadow, by being converted to tillage, and afterwards laid down graſs, becomes Paſture; but Paſture cannot be re-inſtated in its priſtine condition of Meadow. This we muſt confeſs ſavours ſomething of ſyloglſtic argument, not tending to eſtabliſh any uſeful criterion by which the huſbandman can be benefited; but having made uſe of the terms Meadow and Paſture, we could not delineate the ſubject without making ſome remarks upon the outlines.

Meadow land frequently lies contiguous to rivers or brooks, and is liable, in wet ſeaſons, or by art, to be overflowed: this Mr. Young, and ſeveral of his correſpondents, calls irrigation, the word being of a curious dictionary conſtruction, and as Mr. Young, and ſome of his facetious correſpondents, laugh at the farmers when they are "puzzled and ſcratch their heads," we mention this for the benefit of thoſe who may not have had an opportunity of conſulting Dr. JOHNSON, previous to their attending the *Agricultural Society*, or the *Farmers' Club*: for our parts we ſhall content ourſelves with uſing the familiar appellations of flooding, overflowing, or watering,

OVERFLOWING.

The farmers of England, having long obſerved how great an advantage it was to meadow and paſture land to be ſometimes *over-flowed* by the ſudden riſe of brooks, rivers, or the like, which brings the ſoil of the uplands upon them, and makes them need no other mending or manuring, though conſtantly mowed; have found an artificial method of working the ſame end, and by it producing the ſame good effect in many of their grounds without any ill one. The benefit of the natural *over-flowings* of meadow lands, which lie in the way of floods, is in ſome ſort taken off, by their being ſubject alſo to theſe inundations at improper times; as when a winter flood has cauſed a fine crop of graſs, a ſummer flood ſometimes comes and deſtroys it all before the hay-making ſeaſon.

There are ſome lands ſo advantageouſly ſituated, that with the aſſiſtance of art they may be laid under water or left dry, at the pleaſure of the farmer. Theſe are the moſt valuable of all graſs-lands, and it is upon theſe that the farmer practiſes his artificial *over-flowings*; improving them in winter by letting in the floods to have their ſoil for manure upon them, and keeping them dry in ſummer when the graſs is long.

The time for *over-flowing* of land is uſually from November to the end of April; but though this is the general practice, yet Miller ſays he cannot approve of it for many reaſons. The firſt is, that by the wet lying continually on the ground in winter, the roots of the finer ſort of graſs are rotted and deſtroyed; and by letting on the water at the ſeaſon when the ſeeds of docks, and other bad weeds, which commonly grow by river ſides, are falling, theſe ſeeds are carried upon the land, where they remain and grow and fill the ground with bad weeds, which is commonly the caſe with moſt of the water-meadows in England, the graſs in general being deſtroyed; ſo that ruſhes, docks, and other trumpery, make up the burden of theſe lands; but if theſe meadows were judiciouſly managed, and never floated till March or April, the quantity of ſweet good graſs would be thereby greatly increaſed, and the beautiful verdure of the meadows preſerved.

Some farmers graze their lands till Chriſtmas, and ſome longer; but as ſoon as ſed bare, from Allhallows till ſpring, that the graſs is not too high, is the propereſt time of *over-flowing*, except that it prove a dry time in April or May. If this happen, *over-flowing* the lands at this time will be of ſingular advantage; for the graſs will grow three times as faſt after it, in hot weather, as it would in cold. Land floods are the beſt to *over-flow* with in winter, and warm fattening ſprings in ſummer; only it muſt be obſerved, that the water of one operation is dried in before any more is let on. It is always beſt alſo to do it at night, that the moiſture may be ſoaked into the ground before the heat of the day; for otherwiſe the land is often burnt. The waſhings of towns and of public highway is of great improvement to lands, as is alſo the waſhings of lands where ſheep feed.

All waters are not proper for this purpoſe of *over-flowing* of lands to enrich them: the waters of coal mines, and other places where there is any ſulphureous mineral mixed among them, being apt to deſtroy and kill the graſs wherever they come. Theſe waters are eaſily known from the healthful ſpring, by their leaving a reddiſh mud or ſediment behind them wherever they have paſſed, but it is poſſible that even theſe may have their uſe when properly applied. They ſeem to contain a vaſt quantity of ſalt of ſome kind, and we known that urine, dung, and many other things that are moſt fit of all others to enrich land, will burn up and deſtroy plants, if improperly laid on in large quantities: the caſe may be the ſame in theſe, and very probably theſe waters abounding in ſalt would do great good if they were properly blended with common water, and let in upon the lands with floods of ſweet water. The farmers have gone ſo far towards proving the truth of this, that they have found ſome of theſe ſprings, when more diſtant from their ſource, not only more innocent than before, but alſo beneficial. Cold clay lands and other ſtrong lands that lie flat, will only be improved by overflowing them with land floods, and that only in ſummer, when the ſeaſon is very dry. Theſe lands will not bear water in ſuch quantity at any other time, becauſe

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cause it will not soak into them easily, and it is for the contrary reason, that the light and spungy lands are always most improved by *over-flowing*.

As the watering or overflowing of Meadow and Pasture land is of the utmost importance to Agriculture, the improvement being generally great, and the expence often trivial, we here present our readers with certain abstracts transmitted to the Bath Society, which cannot fail of instructing those who attentively peruse them.

Water running from a spring, or out of a rock, is often preferred for the purpose of overflowing, to water from a river that has passed some way. I apprehend, however, that this is not always the case; but sometimes quite the reverse. Springs coming immediately from a rock, or from the earth, are, I apprehend, of very different qualities. A spring coming from a limestone rock, I should think by much the best for watering meadows, which is the case at Orcheston in Wilts, where that famous grass grows, which produces an amazing crop in those seasons when the meadow can be watered with the springs gushing out of the lime-stone rocks. At other times, when the springs are low, the land does not produce more than a third of the quantity.

It is understood by the farmers here, that water is very much impoverished by watering a great many meadows on the same stream; and that those meadows at the head of the stream are much the best on that account, except where there are a great number of farm yards draining into it; which, in my opinion, makes up in part at least for the deficiency.

"Water seldom, if ever, promotes vegetation, unless it be in a mixed or heterogeneous state. It is therefore necessary, previous to the overflowing of Meadows, to examine of what nature and quality your water is. All water that passes through beds or veins of minerals, or which contain calcareous nitre, copperas, allum, &c. is highly prejudicial to grass lands. But water that issues from chalk cliffs, or lime stone rocks, or sand and gravel, is in general friendly. The best test is its softness, which may easily be known.

"The quantity of water that is let over the land should be in proportion to the nature of the soil, and the heat of the season. If the soil be sandy, gravelly, or chalky, and the declivity considerable, the more water is wanted, and it should remain the longer, especially if the weather be warm, and it be a south aspect.

"If your water has run a long course above ground, the foulest is the best; but that coming immediately from chalk or lime rocks is warmest, and much to be preferred to foul muddy water in general. I must however observe, that water in a state of putrefaction is poison to vegetables, and therefore ought never to be used for this purpose.

"Water, when carried over meadow lands, after heavy rains, deposits a fertilizing sediment, which enriches the soil, and turns the mould blackish. It also promotes the speedy putrefaction of every vegetable and animal substance found in the earth, and thereby contributes to the melioration of the soil under the sward or turf.

"Care should, however, be taken, that the quantity of water brought on the land be only enough to give vigour to the plants, without overcharging their vessels. Never water your lands in the heat of the day, for when the vessels of the plants are filled by means of the heat, a sudden cold will greatly injure the herbage.

"If the spring proves dry, pastures may be watered as soon as the frosty season is over. But if the winter has been severe, and the earth remains moist, no current of water should be admitted till the earth is settled, and the surface becomes dry; for the gentlest stream would carry off the fine mould loosened by the frost. After the grass shoots, and the season becomes mild, water sparingly. In the summer, never water but in great drought.

"I consulted my Meadow-floaters, who are unanimously of opinion, that the sooner the water is thrown over the Meadows after it arises out of the springs, the more effectual it will be. We have no springs on the hills in this part of the country, as in the neighbourhood of Bath; but our meads are full of them, and we apply the water issuing therefrom as soon as possible to the lands. We find spring water is better for this purpose than river water, on account of its being warmer in winter, and cooler in summer.

"I have a range of meads lying nearly on a level by the side of a little river, which runs near thirty miles before it reaches my lands. And in the upper part of my meadows a spring rises of very clear soft water. Being desirous of proving which would be most beneficial to the land, I have divers times, in different years, tried both.

"In a wet winter I can easily, at flood time, when the river is very foul and muddy, float all my meads by opening the bank by the river side. This I have done several times, and a great deal of sediment has been left behind on the retiring of the water. In this case, I have generally had a large crop of grass the succeeding summer, but I have always found it more rank, and the hay less sweet than at other times.

"When I have turned the water of my spring over the land, I have found the produce equally great, and the hay much finer and sweeter than in the other instance. I have also observed, that those meads which first received the water from the spring, were most luxuriant; and those which it ran over last were the least so. I am therefore of opinion, that the best and most fertilizing water for Meadow land is that which issues immediately from warm soft springs.

"I formerly occupied some water-meadow not many miles distant from this place, where there is a great deal of land watered from the Kennet, a very considerable river which rises at a village of that name not far from Marlborough. The occupiers of those lands are uniformly of opinion, that the more thick, turbid, and feculent, the water is, the greater will be the benefit to be derived from the use of it: and the opinion is certainly well supported both by reason and experience. Hasty showers, and very heavy rains, dilute the manure, and wash away the fine pulverized earth from the adjacent lands for many miles round; so that as the waters increase, and become more rapid, they also become more replete with fertilizing matter, as is visible to the eye by the quantity of scum, mud, and fine earth, remaining on the surface when the water is drawn off. The benefit derived from flooding may in general then be computed, *cæteris paribus*, from the quantity of feculent matter deposited by the water, for it is, I believe, invariably found to be in proportion thereto.

"The effects of the water of land-springs must depend upon the nature of the strata through which it passes, and may be beneficial or otherwise to vegetation, as that might be if applied in substance. Calcareous earths, in general, are friendly and conducive to vegetation; and from thence it seems probable, that water issuing from limestone rocks would promote the growth of vegetables in proportion to its impregnation by the calcareous matter.

"The effects of limestone water have never fallen within my observation: but from what I have observed of land springs, I have often thought the benefit from them was nothing more than from the simple fluid as a constituent part necessary to the accretion of all bodies, abstracted from every principle of nutriment but what is contained in water as such only. However, there cannot be a doubt, but different springs are impregnated with different qualities, the particulars of which cannot be known but from observations of their effects."

As the use of clear spring and river water is greatly neglected by numbers who have it in their power to improve their pasture at an inconsiderable expence, the foregoing observations being the opinions of various ingenious gentlemen, will, we hope, be regarded with that attention such rational ideas deserve. There is a material advantage in those meadows which are liable to accidental overflowings, and those which are capable of being overflowed at pleasure, and are at all times out of danger. In the first the water may come at a wrong season, and often does, to the entire loss of a crop; but in the latter it never can come, but when the husbandman thinks proper.

Water running in a brisk manner over pasture in the winter, enriches it materially; but standing water, which does not run off till dispersed by the warm dry weather in the spring, does great injury. The methods of overflowing, practised in Gloucestershire and Wiltshire, are very curious; large flood-gates, or weirs, are erected on the rivers, and channels cut to introduce the water over the land, which are contrived in a manner capable of flooding or laying dry any part thought proper.

DRAINING.

The draining of pasture land is also another great improvement to it; for though meadows and pastures, which are capable of being overflowed, produce a greater quantity of herbage than dry land, yet where the wet lies too long upon the ground, the grass will be sour and extremely coarse: and when there is not care taken in time to drain this land, it will produce little grass, and soon be over-run with rushes and flags, so as to be of small value.

The draining of lands which lie with a proper descent, is very easily effected; we mean by Draining, such Drains as are covered; for digging a ditch and letting it remain uncovered is not a subject worth mentioning; nor does it deserve to be ranked with improvements.

Hollow or Under-Draining is generally attended with a great expence, and if well performed the improvement is permanent; for this reason, it should by no means be done at the expence of a tenant; indeed, no gentleman possessing a particle of generosity, would permit his tenant to throw away his property on so uncertain and precarious a foundation. When a swampy, or boggy place, is situate in the midst of a field, the cause may justly be attributed to a spring in the upper part of such wet place; the first circumstance to be considered is to fix on a place for the drain to empty itself; this being done, begin there, and work up to the spot you purpose Draining.

Springs usually lie on a bed of clay, for which reason it will be necessary to dig the drain of a sufficient depth. Various methods are used in constructing the Drains; wood tied up in small bundles is sometimes placed at the bottom of the Drain, sometimes stones are thrown promiscuously together at the bottom; it is to be observed, that in both those methods the Drains are brought to a

point

point at the bottom, the ſides forming an acute angle; in either of thoſe inſtances, when the wood or ſtones are placed at the bottom, the turf which was taken from the ſurface is placed upon them with the graſs downwards.

The uſual method of making theſe drains is to dig trenches, and fill the bottoms with ſtones, bricks, ruſhes, or buſhes, which are covered over with the earth which was dug out of the trenches; but this is not the beſt method, becauſe the water has not a free paſſage through theſe drains; ſo that whenever there is a flood, they are often ſtopped by the ſoil which the water frequently brings down with it. The beſt method yet found to make theſe drains is to dig trenches to a proper depth for carrying off the water, which for the principal drains ſhould be two feet wide at their top, and ſloped down for two feet in depth, where there ſhould be a ſmall bank left on each ſide, upon which the croſs ſtakes or bearers ſhould be laid, and below theſe banks there ſhould be an open drain left, at leaſt one foot deep, and nine or ten inches wide, that there may be room for the water to paſs through: the larger Drains ſhould be at convenient diſtances, and ſmaller Drains of about ſix or ſeven inches wide, and the hollow under the buſhes eight or nine inches deep, ſhould be cut acroſs the ground, which ſhould diſcharge the water into theſe larger Drains. The number and ſituation of them muſt be in proportion to the wetneſs of the land; and the depth of earth above the buſhes muſt alſo be proportioned to the intended uſe of the land; for if it is arable land to be ploughed, it muſt not be ſhallower than a foot or fourteen inches, that there may be ſufficient depth for the plough, without diſturbing the buſhes, but for paſture land nine inches will be full enough; for when the buſhes lie too deep in ſtrong land, they will have little effect, the ground above will bind ſo hard, as to detain the wet on the ſurface. When the drains are dug, there ſhould be prepared a quantity of good bruſh-wood, the larger ſticks ſhould be cut out to lengths of about ſixteen or eighteen inches, which ſhould be laid acroſs upon the two ſide-banks of the drain, at about four inches diſtance; then cover theſe ſticks with the ſmaller bruſh-wood, furze, broom, heath, or any other kind of bruſh, laying it lengthways pretty cloſe; on the top of theſe may be laid ruſhes, flags, &c. and then the earth laid on to cover the whole. This ſort of Drains will continue good for a great number of years, and are never liable to the inconveniences of the other; for the water will find an eaſy paſſage through them under the buſhes; and where there is plenty of bruſh-wood, they are made at an eaſy expence; but in places where wood is ſcarce, it would be chargeable to make them: however, in this caſe, it would be a great advantage to theſe lands to plant a ſufficient number of cuttings of willow, or the black poplar, on ſome of the moiſt places, which would furniſh bruſhwood for theſe purpoſes in four or five years; and as the expence of planting theſe cuttings is trifling, there cannot be a greater advantage to an eſtate which wants draining, than to practice this method, which is in every perſon's power, ſince there is little expence attending it.

In countries where there is plenty of ſtone, that is the beſt material for making theſe under-ground Drains; for when theſe are properly made, they will never want repairing. It may be neceſſary, in many caſes, and has proved very uſeful, to flag the bottom, and to line the ſides of the Drains with tiles, brick, or ſtone, to keep the earth from falling in, and to preſerve a free paſſage for the water.

When the ground in which the ſprings are, lies on a gentle declivity, plough it in an horizontal direction, by which means each furrow carries off the water, which would otherwiſe ſink into the next ridge

The beſt time of the year for making theſe Drains is about Michaelmas, before the heavy rains of autumn fall, becauſe at this ſeaſon the land is uſually dry, ſo that the drains may be dug to a proper depth; for when the ground is wet, it will be very difficult to dig to any depth, becauſe the water will drain in, wherever there is an opening in the ground.

For further information, we inſert from Mr. YOUNG's Annals, Vol. III. p. 378, the following obſervations on Draining.

By R. H. CLARKE Esq. of BRIDWELL, near CULLOMPTON, DEVON.

"No branch of huſbandry is attended with greater ſucceſs, in ſoils naturally wet and ſubject to ſprings, than under-ground drains, which are called with us, French gutters; the uſual method of making them, is with ſtone, but where there is a ſcarcity of that material, alder poles are ſubſtituted; and where wood is ſcarce, that method alſo becomes expenſive. I have a farm ſubject to all three of the above inconveniences, and my tenant was adviſed to the following mode, viz. when the line is marked out where the Drain is to be cut (which muſt be directly through the ſpot where the ſpring riſes, and fully at the head of it) with a ſpade of 12 inches wide, take the turf carefully up in ſquares, with conſiderable ſubſtance of earth to it, and lay it by on one ſide of the intended Drain; then cut the Drain of the ſame breadth, three feet deep; take the earth out clean, leaving the bottom ſmooth; then, with a ſpade, three inches wide, cut a channel in the middle of the bottom part, ſix inches deeper; when that is done, lay the turf in flat, with the graſſey ſide downwards, that will have a bearing of four inches and a half on each ſide, and leave a clear Drain of three inches by ſix, to carry off the water; then fill the Drain to the ſurface with the earth that remains, and at the mouth, or where it is deſigned to diſcharge the water, ſecure it with a few bricks, or ſtones. You will pleaſe to obſerve, that the depth prevents their being injured from any ſuperficial preſſure, and the only objection I have ever made to the plan, is, that they may be liable to be choaked by the moles; but I believe they ſeldom or ever work at that depth."

Drains, in the fen-countries, are large cuts, or ditches, of twenty, thirty, nay ſometimes forty feet wide, carried through the marſhy ground to ſome river, or other place capable of diſcharging the water they carry out of the fen-lands. Moſt of theſe Drains are made in our fen-countries by a body of men called the undertakers, whoſe reward is one third of the ground they drain. They alſo erect ſluices at a great expence, often not leſs than two thouſand pounds each. Yet theſe, with all the care they employ in erecting them, are ſubject to be blown up by the vaſt weight of water that lies upon them when the lands are overflown. Some of theſe ſluices have two or more pair of doors, of ſix, eight, or ten feet high, which ſhut when the water in the river is higher than in the Drains, by the weight and force of it; and ſo *e contra*, throw out a body of eight feet ſquare of water for about ſix or ſeven hours during the ebb. The real uſe of theſe Drains is very evident from the preſent ſtate of the land where they are cut, and that of it before. In Camden's time all this was bog, and now it is all firm land. The country about Crowland was in that author's time ſo ſoft, that it was not paſſable by carriages; and thus grew a wittieiſm upon it, that all the carts that entered this town were eaſed on the wheels with ſilver; but this is now ſuch firm ground, that carriages of any kind paſs over it. The duck-ponds uſed to be called the fen corn-fields, and they now are ſuch in reality, their bottoms being dry, and producing oats, and rape-ſeed, or cole ſeed, with great increaſe.

CLEANSING PASTURE.

Paſture ground, of an inferior quality, is ſubject to become moſſy, ſometimes to a degree which renders it of little value; various methods have been deviſed to deſtroy moſs on Paſture. Scarrifying it in ſpring with a ſtrong harrow made on purpoſe has been practiſed, and ſtrongly recommended; but we by no means think it conſiſtent; it is true if a dreſſing of coal-aſhes, lime compoſt, ſoapers aſhes, or other ſuitable manure, has been freſh laid on, harrowing with heavy harrows may be uſeful, but without manure it cannot.

Paring, burning, and ſpreading the aſhes on greenſward, overrun with moſs, is good management, but particular care ſhould be taken to pare the turf extremely thin, otherwiſe the paſture is a long time before it recovers itſelf. A light dreſſing of mud, or loamy mould, is very ſerviceable to ſpread over the land at the time you ſpread the aſhes; they ſhould be well harrowed with a thorn buſh, loaded with ſtones, or a harrow with ſhort tines or teeth. The proper time to pare and burn moſſy and coarſe greenſward, is as early in the ſpring as poſſible.

Cleanſing Paſture ground from anthills is certainly good huſbandry, although numbers object to the practice, and will tell you they know the injury attendant on the ſyſtem from experience; and with them we readily agree, provided the buſineſs is badly managed. We have ſeen great benefit from digging away anthills in the following manner: as ſoon in autumn, as you can poſſibly ſpare time, dig up the anthills rather deeper than the ſurrounding ſurface, and having a cart ready, throw them into it, and immediately carry them off to a convenient place to make the compoſt heap; as ſoon as poſſible after, get if you can about one load of lime freſh from the kiln, to every five loads of the anthills, and mix it well together; if it has been properly mixed, the compoſt will be in condition to ſpread on the land the next ſpring; by this means the inſects will be all killed, and the land will be benefited.

If the lime cannot be procured, ſoot, ſoapers aſhes, or animal manure, ſhould ſupply the place, obſerving to throw ſome of the compoſt on the bare places which were made by removing the hillocks. The ground ſhould be harrowed as ſoon as the dreſſing is put on the land, and is in a condition to break to pieces.

SECT. XX. HAY AND ITS MANAGEMENT.

THE making and management of Hay has been learnedly diſcuſſed by many able theoriſts, ſome of them, in order to preſerve its virtues, diſapprove of expoſing it to the ſun; and we rather wonder that we have never ſeen it recommended in print to the farmer, to take his Hay home and dry it the chimney corner.

The editors of the SCOTCH ENCYCLOPÆDIA ſay, the beſt method of haymaking ſeems to be that recommended by their own countryman, Dr. ANDERSON, as follows.

"Let the haymakers follow the mowers, and make the graſs into cocks about three feet high, giving each of them a ſlight kind of thatching, by drawing a few handfuls of the Hay from the bottom, laying them lightly upon the top, with the ends hanging downwards."

Had the learned Doctor and the Editors of the ENCYCLOPÆDIA been Iriſhmen, the reader would have jocoſely called this method of haymaking a BULL; but as thoſe gentlemen are natives of a country, whoſe inhabitants are famous for their ſcientific learning, and accurate mode of expreſſing themſelves, we muſt content ourſelves with charitably ſuppoſing the Doctor meant to give a receipt for making dung inſtead of Hay, and hope no one will be credulous enough to try the experiment.

Hay made from clover, ſaintfoin, or other graſſes of the ſame kind, ſhould be treated in a different manner from natural or meadow graſs; but to preclude it from the influence of the ſun, is not the proper method to make good Hay. The firſt object is the proper ſeaſon to mow graſs for the purpoſe of making Hay, and when that period arrives depends more on the practical judgment of the farmer, than any theoretic deſcription can convey.

Graſſes of all kinds are in their higheſt perfection juſt before they bloſſom, and that is the criſis which ſhould be the huſbandman's guide in mowing; a perſon who has a great deal of buſineſs, which will neceſſarily take up three weeks or a month, be the weather ever ſo fine, ſhould begin what he intends to mow firſt earlier than we have directed.

Graſs grown old in the field is of little more nouriſhment to cattle than ſtraw; and the land is materially exhauſted by bearing the crop till its virtues are evaporated. From cutting graſs of all ſorts early, every advantage which can accrue, from good Hay, ſtrong and luxuriant aftermath, the ſoil not impoveriſhed, and every other good circumſtance that can be wiſhed, may be expected. With reſpect to making Hay, graſs cut young, and with its juices in perfection, requires much more making than that which is overgrown before it is mowed.

Saintfoin, clover, and other artificial graſſes of the like kind, ſhould be once turned in the ſwath, and as ſoon as poſſible made into very ſmall cocks, the ſmaller the better, and from time to time turned till they are fit to be put together in rows for the purpoſe of carting to the ſtack or rick.

Natural meadow and paſture graſs, being mowed in its proper ſeaſon, ſhould be ſpread in the morning, and before the evening raked in ſmall rows, and thoſe rows made into ſmall cocks: they cannot be made too ſmall, provided they are put together in a round ſnug manner: on the morrow the cocks ſhould be throwed and ſpread in rows, and turned and raked together as may ſeem neceſſary, and in the evening made into larger cocks than thoſe the preceding day: thus the proceſs ſhould be continued till the Hay becomes fit to carry together, which may be known by its handling light; and by twiſting a ſmall wiſp as hard as you can with both hands, obſerve that no moiſture appears, or the hay is not ſufficiently dry to put together in a rick.

It is a cuſtom to make Hay into ſmall ſtacks of about a ton each, and letting them ſtand in that condition till the field, or the quantity deſigned to make the rick, is made ready, and then the rick or ſtack is made without intermiſſion. This prevents Hay heating immoderately; and if judiciouſly conducted, anſwers many convenient and good purpoſes.

SECT. XXI. INCLOSING, WITH THE MANAGEMENT OF FENCES.

INCLOSING.

DIVIDING and Incloſing, with the planting and management of Fences, are circumſtances of the moſt important conſequence to the flouriſhing and improved ſtate of agriculture in this kingdom.

Incloſing of lands, and dividing the ſame into ſeveral fields for paſture and tillage, is one of the principal means of improvement; firſt, by aſcertaining to every man his juſt property, and thereby preventing an infinity of treſpaſſes and injuries that lands in common are ſubject unto; beſide the diſadvantage of being obliged to keep the ſame ſeaſons with other people who have land in the ſame field; ſo that the ſowing, fallowing, and tilling the ground muſt be equally performed by all the landholders; and when there happens a ſlothful negligent perſon, who has land intermixed with others, it is one of the greateſt nuiſances imaginable. Secondly, where land is properly incloſed, and the hedge-rows planted with timber trees, &c. it preſerves the land warm, and defends and ſhelters it from the violent cold nipping winds, which, in ſevere winters, deſtroy much of the corn, pulſe, or whatever grows on the grounds; and where it is laid down for paſture, it yields much more graſs than the open fields, and the graſs will begin to grow much ſooner in the ſpring. The hedges and trees alſo afford ſhelter for the cattle from the cold winds in winter, and ſhade for them in the great heats of ſummer. Theſe hedges alſo afford the diligent huſbandman plently of fuel, as alſo plough boot, cart boot, &c. And where they are carefully planted and preſerved, furniſh him with maſt for his ſwine; or where the hedge-rows are planted with fruit trees, there will be a ſupply of fruit for cyder, perry, &c. which in moſt parts of England are of no ſmall advantage to the huſbandman. By this method of incloſing, there is alſo much more employment for the poor, and it is therefore a good remedy againſt beggary; for in thoſe open countries, where there are great downs, commons, heath and waſtes, there is nothing but poverty and idleneſs to be ſeen amongſt the generality of their inhabitants.

It muſt be acknowledged, that incloſures of waſte lands and commons would be uſeful, if they were divided into ſmall parcels, and given up to be occupied at moderate rents by the poor. But if beſides leſſening the produce of fine wool, they bear hard on the poor, by depriving them of a part of their ſubſiſtance, and only ſerve to increaſe farms already too large, which is commonly the caſe, the advantages attending them may not much exceed the diſadvantages. With reſpect to incloſures of open fields and lands, the advocates for incloſing are ready to own, that theſe diminiſh tillage, increaſe the monopolies of farms, raiſe the prices of proviſions, and produce depopulation. Such incloſures, therefore, however gainful they may be at preſent to a few individuals, are undoubtedly pernicious. It is a known fact, that in Northamptonſhire and Leiceſterſhire, where incloſing has greatly prevailed, moſt of the incloſed Lordſhips are converted into paſturage; in conſequence of which many Lordſhips have not now fifty acres ploughed yearly, in which fifteen hundred, or at leaſt a thouſand, were ploughed formerly; and ſcarce an ear of corn is to be ſeen in ſome that bore hundreds of quarters: the effect of which has been, that the price of wheat and malt is greatly increaſed, and that the inhabitants in almoſt all the incloſed villages, where they have no conſiderable manufacture, are very ſenſibly diminiſhed; inſomuch that a hundred houſes and families have in ſome places dwindled into eight or ten; and the landholders, in moſt pariſhes that have been incloſed only fifteen or twenty years, are very few in compariſon of the numbers who occupied them in their open field-ſtate. It is no uncommon thing to ſee four or five wealthy graziers engroſſing a large incloſed Lordſhip, which was before in the hands of twenty or thirty farmers, and as many ſmaller tenants or proprietors. All theſe are hereby thrown out of their livings, with their families, and many other families which were employed and ſupported by them.

The ſtate of Norfolk is in ſome reſpects ſimilar to this. Incloſures, ſays the celebrated Lord Bacon, in his Hiſtory of the Reign of Henry VII. (ſee his works, vol. iii. p. 431) began in 1489 to be more frequent, whereby arable land was turned into paſture, which was eaſily managed by a few herdſmen. This occaſioned a decay of people. In remedying this inconvenience, the king's wiſdom and the parliament's was admirable. Incloſures they would not forbid, and tillage they would not compel; but they took a courſe to take away depopulating incloſures, and depopulating paſturage by conſequence. The ordinance was, that all houſes of huſbandry, with twenty acres of ground to them, ſhould be kept up for ever, together with a competent proportion of land to be occupied with them, and in no wiſe to be ſevered from them. By theſe means, the houſes being kept up, did, of neceſſity, enforce a dweller, and the proportion of land for occupation being alſo kept up, did, of neceſſity, enforce that dweller not to be a beggar. This ſtatute was renewed in King Henry the Eighth's time; and every perſon who converted tillage into paſture was ſubject to a forfeiture of half the land, till the offence was removed. In a law of the twenty-ninth of the ſame reign, it is ſet forth, that many farms, and great plenty of cattle, particularly ſheep, had been gathered into few hands, whereby the rents of lands had been increaſed, and tillage very much decayed; churches and towns pulled down; the price of proviſions greatly enhanced, and a prodigious number of people rendered incapable of maintaining themſelves and families; and, therefore, it was enacted, that no perſon ſhould keep above two thouſand ſheep, nor hold more than two farms. In the third of Edward VI. a bill was brought in for the benefit of the poor, for rebuilding decayed farm-houſes, and maintaining tillage againſt too much Incloſing. In the year 1638, there was a ſpecial commiſſion from Charles I. for enforcing the ſtatute of the 30th of Elizabeth, by which no cottage was allowed in any country place, without at leaſt four acres of land to it, to prevent the increaſe of the poor, by ſecuring to them a maintenance; nor were any inmates allowed in any cottage, to ſecure the full cultivation of the land, by diffuſing the people more over it. And by an act in Cromwell's time, no new houſe was to be built within ten miles of London, unleſs there were four acres of land occupied by the tenant. Thus did the policy of our anceſtors diſcourage incloſing and engroſſing, upon the ſame general view of their depopulating tendency; and though the increaſe of trade and manufactures in more modern times has produced a conſiderable alteration in the ſtate of our country, and may require ſome change in our internal policy, yet it is eaſy to foreſee, becauſe facts juſtify the apprehenſion, that incloſing and engroſſing to the degree in which they have lately prevailed, will annihilate the ſmall occupiers of land, and reduce the inhabitants of the kingdom to two claſſes, viz. gentry and beggars, or grandees and ſlaves.

As in former times the number of occupiers of land was greater, and all had more opportunities of working for themſelves, it is reaſonable to conclude, that the number of people willing to work for others muſt have been ſmaller, and the price of day-

The BINDER *is deſired to obſerve that this* Sheet (D d 1) *is to be placed before* Sheet (D d 2) *in this Number, it being an* Additional Sheet *to the* SECOND *Edition of this Work.*

abour higher. The nominal price of day-labour is at preſent not more than about four times, or at moſt five times higher than it was in the year 1514. But the price of corn is ſeven times, and of fleſh-meat and raiment about fifteen times higher; therefore the price of labour has been ſo far from advancing in proportion to the increaſe in the expences of living, that it does not appear to bear now half the proportion to theſe expences that it did formerly. See on this ſubject Price's Obſervations on Reverſionary Payments, Supplement, p. 388, &c. Appeal to the Public on the Subject of the National Debt. p. 93, &c.

In incloſing of land, regard ſhould be had to the nature of the ſoil, and what it is intended for; becauſe corn-land ſhould not be divided into ſmall fields; for beſides the loſs of ground in hedges, &c. the corn doth ſeldom thrive ſo well in ſmall incloſures, as in more open land, eſpecially where the trees are large in the hedge-rows. The graſs alſo in paſtures is not ſo ſweet near hedges, or under the drip of trees, as in an open expoſure; ſo that where the incloſures are made too ſmall, or the land overplanted with trees, the herbage will not be near ſo good, nor in ſo great plenty, as in larger fields; therefore, before a perſon begins to incloſe, he ſhould well conſider how he may do it to the greateſt advantage: as, for inſtance, it is always neceſſary to have ſome ſmaller incloſures near the habitation, for the ſhelter of cattle, and the conveniency of ſhifting them from one field to another, as the ſeaſon of the year may require; and thereby the habitation, barns, ſtables, and out-houſes will be better defended from ſtrong winds, which often do great damage to thoſe that are expoſed to their fury. Theſe ſmall incloſures may be of ſeveral dimenſions, ſome of them three, four, ſix or eight acres in extent; but the larger diviſions for corn ſhould not contain leſs than twenty or thirty acres, or more, according to the ſize of the farm.

The moſt common incloſure is by a ditch and bank raiſed by its ſide with quick: this takes place in almoſt any ground; but as it is expenſive, and ſtone or water more plentiful, they are uſed in its ſtead. In marſhy lands they only cut ditches, by way of fence between ground and ground; and theſe, when wide and deep enough, are a very good fence in all places where there is water to keep them full. In Cornwall and Devonſhire, and ſome other of the Weſtern counties, they uſe a ſtone fence, which is the beſt kind both for the lands and for the cattle. Flat ſtones are very plentiful in theſe counties, and may be had at a trifling expence. With theſe ſtones they build round the land that is to be incloſed two walls near one another, laying the ſtones upon one another, firſt two and two, then one, all the way up; and as they riſe, they fill up the ſpace with earth; and ſo they continue the ſtone-work, filling it to what height and breadth they pleaſe, and beating the ſtones in flat to the ſides, which makes the whole firm. On the top of theſe walls they plant quick, and even timber-trees, which thrive extremely well. In the northern counties of England, and ſome others, where there is plenty of ſtone of a large and rough kind, they make their fences with the rough and unhewn ſtones, piling them up into a wall with no ſort of cement or mortar, only laying on large ones at the top in a bed of clay, which keep all the reſt together. They make theſe walls about five feet high.

MANAGEMENT OF FENCES.

The white thorn is the beſt of all trees to plant for a fence, being a tolerably quick grower, and laſting a long time, and making a very handſome fence. It will ſucceed on any ſoil where a ditch and new bank are made, except it be wholly of gravel or ſand, and even in this caſe it will thrive, if there happen a rainy ſeaſon after the planting of it. Some raiſe it by ſeeds, and others by young plants; the latter is the moſt expeditious way, for the ſeeds lie two years in the ground before they ſhoot, but they grow very faſt after two or three years. Some prepare the haws, or fruit of the white thorn, by tying them up in a hair bag, and ſoaking them all winter; after this, if they are ſown in February or March, they will come up the firſt year, and grow better than any other way.

Where ſets are ſcarce, it is a good way when the underwoods are felled, or rather the year before, to ſow haws and ſloes in them, and they will furniſh a ſupply of young plants for hedges, without doing the woods any harm, becauſe they may be drawn before they come to be too large. The white thorn is alſo of conſiderable value in ſome ſort of works; its root becomes very beautifully veined when old, and elegant boxes and combs are made of it. It is uſed by ſome alſo in the buſineſs of inlaying, and would be more ſo, if its beauty were more known. The crab and the ſloe-tree, or black thorn, comes next in value to the white thorn, for quicks for fences.

The crabs are to be ſown by kernels, pulp and all, and they will come up the firſt year; and a ſet of young crabs planted thick enough, make an excellent fence. The black thorn is not ſo much approved, becauſe it is not ſo ſure of growing, and if it does, its roots ſpread, and it is apt to run in too much upon the land. The buſhes of black-thorn are however the beſt of any for dead hedges, and for mending of gaps; and they have another advantage over the white thorne, which is, that cattle are not ſo apt to crop them. The black thorn will grow on any ſoil where the white grows, but the richer the mould is, the better it will thrive.

Holly is another excellent ſhrub for a fence; it is indeed much the beſt of all the fence buſhes; but it grows ſo ſlow, and is ſo uncertain, that the farmers are afraid of waiting for it or of truſting to it; but where it ſucceeds, it makes amends for the delay in its thickneſs, height, and ſtrength. It is to be raiſed like the white thorn, either by ſets or berries, and the berries in the ſame manner lie two years in the ground before they come up. It will grow on any ſoil, even on the drieſt gravel, or among ſtones and rocks. It delights moſt in light grounds. If it be raiſed in plants, they ſhould be about the thickneſs of a man's thumb, and planted in a moiſt ſeaſon, either in ſpring or autumn; they muſt be ſhaded well with ſtraw or haulm after they are ſet, and muſt be carefully watered, as ſoon as they begin to ſhoot, otherwiſe they will all periſh.

If any of them ſeem to periſh, they muſt be cut off cloſe at the roots, and they will often ſprout out vigorouſly thence again. The ground muſt be dug up about them at times, which very greatly promotes their growth; and the farmer muſt keep his ſheep from them, for they are very fond of cropping the young ſprouts. Field-mice are apt to gnaw the roots of holly in hard winters; and many of theſe trees are ſuppoſed to be killed by the froſt, when the teeth of theſe little vermin have really done the miſchief.

The beſt way of raiſing a fence of theſe trees, is to plant them with the quick or white thorn, four plants of that to one of holly; theſe will thrive very well together; and while the white thorn grows very ſpeedily, the holly will take its time: as this grows large, the white thorn may be pulled up by degrees, till at length there is only the holly left; and if this is found not thick enough, the boughs of it which grow neareſt the ground may be laid down and covered with earth, and they will ſend up innumerable ſuckers, which will fill up all the gaps.

Beſide theſe there are very good fences made of furze, or alder, and even of elder, in ſome places, on proper ſoils. Elder ſticks, or truncheons, ten or twelve feet long, are to be cut and ſtuck in the bank ſlope-wiſe each way, ſo as to make a chequer-work. This makes the ſpeedieſt ſhelter of any. When the trees grow old, they are alſo ſtill of value; their wood is a very fine one for turning, and is at leaſt equal to box, if not ſurpaſſing it. The elder-tree makes an extremely good fence in watery places: and when planted on the banks of rivers, is of great uſe in preventing them from being undermined by the current; the roots being very numerous, ſtrong, and compact. It is always ſending ſuckers alſo from its loweſt roots, which makes it very uſeful where ſtreams wear away their banks, and are widening their courſe.

The furze buſh, though an irregular grower, makes an excellent fence on dry banks, where nothing elſe will grow. It may be raiſed either by ſeeds, or by ſets; but the ſeeds are the beſt, eſpecially thoſe of the French furze, which grows to the height of fifteen or ſixteen feet, and is not ſubject to ſpread with its root, and get into the good ground, as our common heath-furze will always do. This has the advantage of being a very ſpeedy grower. It will make a very good hedge in three years, if taken care of. It muſt be kept well weeded while young; and the ſheep muſt be kept away from it; for they are very fond of its young ſhoots. But it only requires this care for a little while; for when grown up to any conſiderable height, nothing can hurt it. If a furze-hedge be clipped, it will grow large and thick; but if left to itſelf, it will run up to a conſiderable height, and afford good ſhelter, and yield an excellent fuel. They ſow much of the poor land in Devonſhire with furze, and make a very conſiderable advantage of it.

SECT. XXII. HORSES AND OXEN AS USED IN AGRICULTURE.

ARTHUR YOUNG, Eſq; has collected, from various quarters, the expence of keeping horſes for the purpoſes of Agriculture, and on an average, finds about 16l. the expence of keeping a farmer's horſe one year, half the year in the ſtable with hay and corn, and the other half with green food, or turned to graſs.

Theſe calculations, or accounts, which may be ſeen in the Annals of Agriculture, Vol. IV. p. 134, not meeting with the ideas and practice of Mr. WILLIAM PITT, of Pendeford in Staffordſhire, he writes the following on the ſubject, Vol. IV. page 423, Annals, &c.

ON THE EXPENCE OF KEEPING HORSES, AND COMPARISON OF HORSES AND OXEN,

In anſwer to Obſervations made by Arthur Young, Eſq.

By Mr. PITT.

SIR,

"I make the following remarks on your expence of keeping horſes, as alſo on the compariſon betwixt horſes and oxen, which if you think worth attention, may ſerve to fill a corner of your Annals.

"Firſt, it appears to me that you charge the full market price for hay conſumed at home, which is not fair: hay, if even ſold to be

be conſumed on the farm, by no means deſerves the ſame price, as if carried clean off; the dung of cattle, or horſes, which eat ſuch hay, and manure raiſed thereby, is a very material object: It is not eaſy to find data from which to calculate this difference of value; but from ſeveral correſponding circumſtances I conjecture, that Hay conſumed at home ought not to be charged at more than half the price of Hay delivered at market; more eſpecially if carriage out be taken into the account; if this point be admitted, it makes a very conſiderable deduction from our eſtimate. Upon the average of nine years the value of Hay conſumed per horſe in your eſtimate is 6l. 2s. If one half be taken off for the advantage of home conſumption, it makes a deduction per horſe per annum of 3l. 1s. for Hay only.

"Secondly, allowance of oats being ſo various is a proof at leaſt, that leſs than the largeſt allowance will ſuffice: I find the average (beans included) equal to 23 quarters per annum for four horſes, or 46 buſhels each horſe, and average price 2s. 3d. per buſhel.

"I have converſed with ſome very liberal horſe-keepers, who allow three quarters of a peck per day each horſe, when they bait at noon, and go out again at ſix at night; two quarters per day when they go out but once, and lay in the ſtable at nights; and one quarter per day at graſs: ſuppoſing theſe intervals of equal length, each one third of a year, it gives 45 buſhels and an half each horſe per annum, which very nearly equals your average. I allow leſs, viz. one buſhel per horſe per week in ſpring and autumn ſeed time: half a buſhel per horſe per week at other times, when they lay in the ſtable; and only half the latter quantity at graſs, but always mixed with plenty of chaff, or cut ſtraw; the above intervals are 16 weeks, and 20 weeks reſpectively, which makes only 29 buſhels per annum each horſe.

"Upon the other articles of expence I remark as follows: chaff cutting charged 1d per buſhel, the price here a half-penny and an allowance of beer; ſhoeing very high, the average being double the price of this country; a common price here for ſhoeing huſbandry horſes, is 7s. 6d. and 8s. per head per annum; I paid for ſeveral for ſome years 9s. per head per annum, on account of working them cloſer than other people; I am in doubt whether wheat-chaff ought to be charged, as being in few places a marketable article; and the extreme ill-luck in 1768 is ſuch as I think ought not to join the general account.

"The following is the calculation of the expence of keeping eight horſes, upon an average of the laſt three years; which have generally been healthy, and equal to their buſineſs:

	£.	s.	d.
16 acres of clover mown for hay, at 1l. 15s. per acre, the rent of land and tythes being the half, viz. 17s. 6d. per acre	28	0	0
Oats 240 buſhels. at 2s.	24	0	0
20 weeks ſummer food, from the beginning of June to about the middle of October, at 1s. 6d. per horſe per week	12	0	0
Shoeing 9s. per head	3	12	0
Decline of value at 1l. per horſe per annum	8	0	0
	75	12	0

"Chaff and farrier may bring it up to 10l. a Horſe per annum; and I am of opinion, that by œconomy and good management, Horſes for Agriculture buſineſs may be, and are, kept in many places fit for conſtant work, without exceeding that ſum, upon the general average of many years. A breeding mare in a team of 7 or 8, may and does frequently prevent decline of this valuation from being at all felt.

"The ſuperiority, or even equality of Oxen to Horſes, is, I think, by no means aſcertained; Oxen were, half a century ago, much more in uſe in this country than at preſent. As an improved agriculture, and more extenſive cultivation took place, they by degrees gave way to Horſes; I have no doubt but Horſes thus gradually eſtabliſhed themſelves in conſequence of a decided ſuperiority, both with reſpect to docility and diſpatch; and be it ever remembered, that Oxen are by no means capable of thoſe quick exertions, ſo naturally and advantageouſly made by Horſes in critical times of ſowing and harveſt.

"Seven draught Horſes I look upon as a very complete ſet; they keep on three carts in carrying either dung or marl; they make occaſionally a waggon team and a plough team; are ſufficient for two plough teams in the ſtrongeſt work, and will occaſionally make three in barley or turnip ſeed time, or keep on a plough and two pair of harrows for ſowing at the ſame time; this number will do a vaſt deal of work, and will never want more attendance than a man and two boys, whoſe wages ſhall not exceed five ſhillings per week with their board; I am perſuaded the ſame work cannot be done by any number of Oxen whatever, with the ſame attendance; nor probably without an extra man, whoſe wages and board will in its turn, "prove a moſt heavy burden." In a caſe where, by the uſe of Horſes, it might have been diſpenſed with.

"I have never yet ſeen Oxen docile enough to be managed at the plough by one perſon; a holder and a driver, as far as I have obſerved, always attended them; on the contrary, three Horſes at a wheel plough require only a boy of twelve or fourteen, and will undoubtedly do more work.

"WILLIAM PITT."

As this gentleman, in his correſpondence with Mr. Young, ſeems to acquit himſelf in an ingenious and practical manner, we have given his letter at large, but do not in every reſpect agree with him.

Horſes are alſo adapted for all kinds of buſineſs, in a manner that oxen are not: theſe circumſtances make it neceſſary that every farmer ſhould keep a team of Horſes; but thoſe who have a great deal of ploughing, and other buſineſs requiring either Horſes or Oxen, will find it greatly to their advantage to keep Oxen to perform part of the buſineſs.

Oxen are kept at much leſs expence than Horſes, are bought at half the value, ſubject to fewer accidents, and, properly managed, will do nearly as much work. The cuſtom of drawing Oxen in the old method, with bows and yokes, is nearly exploded: the prevailing method at this time is to harneſs them as you do Horſes; the collar being cut open at one end in order to put it on their necks: Oxen uſed in this manner are of great ſervice to cultivators in general; and in particular to thoſe whoſe buſineſs for the plough is on a large ſcale. We ſhall finiſh this ſubject with the following letter to the Bath Society, which does the writer the greateſt credit.

ON THE COMPARATIVE UTILITY OF OXEN AND HORSES IN HUSBANDRY.

By Mr. R. Keddington.

"About five years ago, I took ſome land into my occupation, and having found the expence of Horſes very great, I determined, ſomewhat more than two years ago, to make trial of Oxen, and bought one pair. At that time, I am almoſt certain, there was not an Ox worked in this country; on which account my workmen added much to the trouble of breaking them, by their obſtinate prejudices againſt the uſe of them.

"At laſt I was fortunate enough to ſelect a labourer, who, though totally unuſed to them, was willing to take proper pains to break them. By his good treatment and temper, they ſoon became tractable, and as handy both at ploughing and carting as any Horſes. Being well ſatisfied with their performance, I reſolved to diſpoſe of all my draft Horſes, and ſubſtitute Oxen in their ſtead.

"I have now compleated my plan, and have not a ſingle cart-horſe; but the work of my farm (which conſiſts of upwards of one hundred acres of arable land, and ſixty of paſture and wood) is performed with eaſe by ſix Oxen; together with my ſtatute-duty on the highways, timber and corn, carting, harrowing, rolling, and every part of rural buſineſs. They are ſhoed conſtantly: their harneſs is exactly the ſame as that of Horſes, excepting the neceſſary alterations for difference of ſize and ſhape, they are drove with bridles, and bits in their mouths, and anſwer to the ſame words of the ploughman or carter, as Horſes, and as readily. A ſingle man holds the plough, and drives a pair of Oxen with reins; they will regularly plough an acre of land, every day, and in leſs than eight hours time; I believe they will do it in ſeven, but I would not aſſert more than I know they perform. I have a ſmall plantation, in which the trees are planted in rows ten feet aſunder; the intervals are ploughed by a ſingle Ox with a light plough, and he is drove by the man who holds it. I mention this as an inſtance of their great docility.

"My Oxen go in a cart ſingle, or two, three, or more, in proportion to the load. Four Oxen will draw eighty buſhels of barly, or oats, in a waggon, with eaſe; and if they are good in their kind, will travel nearly as faſt as Horſes with the ſame load. I frequently ſend out eighty buſhels of oats with only three Oxen, and one Ox with forty buſhels in a light cart, which I think of all others the beſt method of carriage. My workmen are now perfectly reconciled to the uſe of oxen; and the following reaſons determine me to prefer them greatly to Horſes:

"1ſt. They are kept at much leſs expence. Mine never eat corn or meal of any ſort. During the winter, they are kept in good order for work upon ſtraw, with turnips, carrots, or cabbages; for want of either of the three latter, I allow one peck of bran a day to each Ox, whilſt in conſtant work. When my ſtraw is finiſhed, and the ſpring advances, they eat hay; and if they work harder than common in the ſeed-time, they have bran beſide. When the vetches are fit to mow and give them in the ſtable, they have nothing elſe. After the day's work in the ſummer, they have a ſmall bundle of hay to eat, and ſtand in the ſtable till they are cool, and are then turned into the paſture. I am of opinion, that the annual difference of expence in keeping a Horſe and an Ox, each in condition for the ſame conſtant work, is at leaſt four pounds.

"2dly. The value of a Horſe declines every year after he is ſeven years old; he is of little uſe if blind, incurably lame, or very old. But if an Ox is in any of thoſe ſituations, he may be fatted, and ſold for much more than the firſt purchaſe; and will always fatten ſooner after work than before.

"3dly. They are not ſo liable to illneſs as Horſes. I have never had one indiſpoſed.

"4thly

" 4thly. Horſes (eſpecially thoſe belonging to gentlemen) are frequently rode by ſervants without their maſter's knowledge, and often injured by it. Oxen are in no danger of this kind.

" 5thly. A general uſe of Oxen would make beef, and conſequently all other meat, more plentiful; which I think would be a national benefit.

" That it may not be thought, that a pair of Oxen will plough an acre of land in a day only upon a very light ſoil, I muſt add, that the greater part of my arable land is too heavy to grow turnips to advantage. When my lighter lands are in fine tilth, I make uſe of a double plough; a ſingle man holds it, and drives one pair of Oxen, and will plough two acres a day. I am well aware, that the method of working Oxen with a yoke ſpares a conſiderable expence in the article of harneſs; but they move ſo much more freely with collars, and can be uſed with ſo much more advantage ſingly by the latter method, that I think it far preferable.

" After experience has inclined me to give the preference to Oxen, I will not omit in my account the only material inconvenience I have found in working them; which is, they are troubleſome in ſhoeing, at leaſt I have found them ſo in this county; and, I believe, chiefly becauſe my ſmith never ſhoed any before. I have them confined in a pound whilſt they are ſhoed, and a man attends the ſmith. However, I think this advantage amply recompenſed by more material advantages; and can with great truth affirm, that the longer I have worked Oxen, the better I have been ſatisfied with their utility.

I am, with great reſpect, Gentlemen,
Your moſt obedient ſervant,
R. KEDINGTON."

SECT. XXIII. COWS AND DAIRY.

THIS ſection we have appropriated to the articles Cows and Dairy. By Cows we mean all of the ſpecies of the Cow kind; and with reſpect to Dairy, we intend to treat of it here no farther than we think it is connected with the labours of the field, conſidering the making of butter and cheeſe as an independent article.

Almoſt every county in this kingdom has its reſpective breeds of cattle, of that ſpecies called the Cow kind: the diſtinction is generally to be obſerved in the length or ſhape of the horn, except in one kind which are without horns. The juſt proportion and due ſymmetry of make, in horned cattle, is in truth confined to a few ſimple obſervations, which we ſhall attempt to deſcribe.

In the firſt place, a round, tight carcaſe, wide in the hips and ſtrait in the back, filled up level behind the ſhoulders, the neck long and fine without any protuberant ſkin underneath, or what is commonly called throaty, the horns long, ſmall and taper, bending downwards, the head fine and ſmooth, long and yet ſmall, legs ſhort, ſtanding wide and firm, the tail fixed neither too high or too low, but growing in a right line with the back bone, the ribs formed in a regular convexity, particularly that called by the graziers the firſt rib, but which in fact may with propriety be called the laſt, it being the hindmoſt.

This is an outline of what the curious in cattle call a good beaſt; and we by no means think ſuch a Bull or Cow undeſerving the appellation; at the ſame time time we would wiſh to be underſtood that there are good beaſts which do not tally with the above deſcription; ſome with ſhort horns, and others without any, are qualified to rank with the greateſt favourites belonging to either the Leiceſterſhire Mr. BAKEWELL, or the Oxfordſhire Mr. FOWLER. Theſe celebrated breeders have carried the improvement of live ſtock to the greateſt perfection.

Mr. Bakewell, for all kinds of cattle, ſtands highly exalted; his name is doubtleſs foremoſt on the liſt. But with reſpect to Horned Cattle, we can venture to pronounce Mr. Fowler, of Little Rollright, in the county of Oxford, proprietor of the fineſt breeding ſtock of beaſts that are in the poſſeſſion of any individual in this kingdom: to effect this has been a work of time and great expence.

It has always been thought neceſſary to mix and change the breed of Cattle, at leaſt ſo far as related to blood or conſanguinity; but the gentlemen we have juſt noticed have ideas totally oppoſite to thoſe old-faſhioned prejudices: they without ſcruple permit the dam, or ſire, and its offſpring, to breed together, holding it an invariable maxim, that a complete Bull, and a Cow equally ſo, ſtand the faireſt chance to propagate a perfect Calf. This has been the practice of thoſe we have been ſpeaking of for a number of years, and the reſult has anſwered their moſt ſanguine expectations.

With theſe celebrated improvers of live ſtock, two or three hundred guineas is not deemed an uncommon price for a Bull or a Ram: this is certainly improving at an immoderate expence, and tends to ſhew the world that there are *connoiſſeurs* and *virtuoſi* beſides thoſe who deal in pictures, medals, or other ancient relics.

There is undoubtedly truth in the notion that an Ox or Cow will feed more readily and with leſs expence, when they are kind and pleaſant in their nature and touch, or handle with a mellow ſoftneſs: it is not the grazier only will be benefitted by purchaſing cattle of this deſcription; but the butcher, and even the perſon who eats the beef, will receive every advantage that can be deſired.

In buying cattle either for the purpoſes of the Dairy, or Oxen to work or feed, it is of material conſequence to purchaſe thoſe which bid fair to turn out uſeful; ſome ſorts may be more ſo than others; there is no particular kind but what are liable to objections in ſome reſpects: beaſt bred on a farm generally are more healthy, and are ſubject to fewer caſualties than thoſe of another kind brought from a different ſoil.

As the weaning or rearing of calves for the uſe of the Dairy, or other purpoſes, is a particular and expenſive branch of Huſbandry, we preſent the following letter to our readers, written by the illuſtrious DUKE of NORTHUMBERLAND; alſo with Mr. Young's Obſervations. Annals, Vol. I. p. 293.

METHOD OF REARING CALVES.

BY HIS GRACE THE DUKE OF NORTHUMBERLAND.

SIR,

" I AM to acknowledge the receipt of your letter on the ſubject of rearing Calves in a leſs expenſive manner than has hitherto been practiſed, and, in anſwer to it, I muſt deſire to acquaint you, that I have for ſome time entertained an idea that ſkimmed milk might be prepared with proper ingredients effectually to anſwer that purpoſe, at about a third of the expence of feeding Calves with new milk; the articles to be added to the blue or ſkimmed milk, are treacle and the common linſeed-oil cake, ground very fine, almoſt to an impalpable powder, and the quantities ſo ſmall, that to make 32 gallons would coſt no more excluſive of the milk, than about ſixpence. It mixes very readily, and almoſt intimately with the milk, making it more rich and mucilaginous, without giving it any diſagreeable taſte.

" I have ſent you the receipt for making the *linſeed-milk*, which may be varied at diſcretion; and, though I have not yet had much experience of its good effects, I am inclined to believe, that under your care and direction there is a very great probability of its ſucceſs; it will afford me great pleaſure if the hint I have here given ſhould be found any way uſeful in promoting your laudable wiſhes to ſerve the public; and be aſſured I ſhall find great ſatisfaction, on all occaſions, in teſtifying the great regard and eſteem, with which I am, SIR,

Your moſt obedient,
And moſt humble ſervant,
NORTHUMBERLAND."

" Take one gallon of ſkimmed milk, and in about a pint of it add half an ounce of common treacle, ſtirring it until it is well mixed; then take one ounce of linſeed-oil-cake finely pulverized, and with the hand let it fall gradually, in very ſmall quantities, into the milk, ſtirring it in the mean time with a ſpoon or ladle, until it be thoroughly incorporated; then let the mixture be put into the other part of the milk, and the whole be made nearly warm as new milk when it is firſt taken from the cow, and in that ſtate it is fit for uſe.

" N. B. The quantity of the oil-cake powder may, from time to time, be increaſed as occaſion may require, and as the Calf becomes inured to the flavour of it."

OBSERVATIONS ON THE SAME SUBJECT.

BY A. YOUNG, ESQ.

" There are two objects in rearing Calves, each of which is of the greateſt importance: *firſt*, to effect it without the aſſiſtance of any milk at all; and *ſecond*, to improve ſkim-milk in ſuch a manner as to render it more nutritious, it being well known that there is a prodigious difference in the growth and thriving of the animal when fed with *new* or *ſkimmed* milk. The Society of Arts at London offered for ſome years premiums for the firſt of theſe objects, and rewarded an account from Mr. Budd, of Wandborough, in Surry: his method was to feed them with a gruel made of ground barley and oats, the particulars of which are to be ſeen in the third volume of *Doſſie's Memoires of Agriculture*. On this method I ſhall only obſerve, that I followed it with the greateſt exactneſs laſt year with two Calves, both of which, ſo far from being reared, were ſo reduced, that, though I changed their diet to milk upon finding it would not do, yet I was too late with the change and they both died. I will not generally condemn the method from one experiment, but I muſt own, I have many doubts of its ever proving a *real* and entire ſubſtitution for milk.

" During my reſidence in Ireland, I had the opportunity of buying calves at three days old for the price of 20d. to 3s. which induced me to make many experiments in this enquiry. Knowing before I went the cheapneſs of Calves, I had recollected various receipts for weaning them, among others hay-tea; bean-meal mixed with wheat-flour; barley and oats ground, nearly, but not exactly, in Mr. Budd's proportion; but principally flax-ſeed boiled to a jelly and mixed with warm water: this being recommended more than the reſt, I tried it on more Calves. The reſult of the experiments on above thirty Calves was regiſtered regularly, but the minutes loſt, with other papers, in packing up and moving from one kingdom to another: the general reſult, however, I well remember. In above thirty Calves, I reared not above three or four, and I was convinced as ſtrongly as the experience of one ſeaſon could convince

vince me, that none of the methods tried deserved reliance. Barley and oat-meal, with a very small quantity of flax-jelly, reared the few that escaped, except one, on which a trial was made at the suggestion of my coachman, who had reared many Calves. He desired to mix two thirds skim-milk, and one-third water with a small addition of flax-jelly well dissolved; that Calf recovered quickly from the low condition it had been reduced to, and afterwards throve well.

"Upon the whole, I have no slight reason to think, that this first object remains nearly in as great state of uncertainty as ever: I am far from pronouncing that it cannot be done, and intend multiplying my experiments in the enquiry as often as I am able; all I can assert is, that I have hitherto had no success.

"I now come to the second object, that of improving skim-milk, a desideratum as much to be desired as the former.

"The moment I received the above very satisfactory communication from that great patron of every patriotic endeavour to serve the public, THE DUKE OF NORTHUMBERLAND, I tried it exactly according to the receipt, and at the same time, recommended it to two farmers in different parts of the kingdom, who I knew were solicitous for discoveries of this kind. It answered with me as well as I could wish the first season, and has stood a second test; the farmers to whom I communicated it, report also favourably of it: in all cases it has appeared to do better than skim-milk alone. Thus one material point is gained; not the complete establishment of the method, which can only follow multiplied and varied experiments; but a proof that it may very safely be recommended to those who are the most cautious, and the most fearful of incurring expence.

"Being able to declare thus much in its favour, I lately wrote to His Grace, informing him of the success, and requesting his permission to publish it, which, by another letter conceived in the handsomest terms, he allowed me to do. I can only add, that such a liberality of sentiment gives a lustre to exalted rank; sets an example of attention to the welfare of the lowest classes; and connects greatness with its right basis, THE PEOPLE'S GOOD.

A. Y."

As rearing Calves without milk must be admitted a very important consideration to farmers in general, we shall introduce the following method, as communicated to the secretary of the Bath Society,

By Mr. THOMAS CROOK, OF TYTHERTON

"SIR,

"The following is as near a calculation of the expences of rearing my Calves without milk, as I can at present assert. In the year 1787 I weaned seventeen Calves, in 1788 twenty-three, and in 1789 fifteen. I bought, in 1787, three sacks of lindseed; I put one quart of the seed to six quarts of water, which, by boiling ten minutes, became a good jelly? this jelly was mixed with a small quantity of the tea of the best hay steeped in boiling water.

"Having my Calves drop at different times, I did not make an exact calculation of the expence of this hay-tea, but out of my three sacks of seed I had better than two bushels left at last. I gave them the jelly and hay-tea three times a day; to the boy who looked after them 6d. per day; the price of the lindseed was 4s. 6d. per bushel; the whole three years feed 2l. 5s. My Calves are kept in a good growing state, and are much better at this time than those of my neighbours that are reared by milk; they do not fall off so much when they come to grass.

"I am, your obedient servant,

Tytherton, Dec. 8, 1789. "THOMAS CROOK."

The foregoing is a succinct but useful account of a method of rearing Calves, which has often been suggested, and deemed practicable, but which the Society had never before known so fully proved. Mr. CROOK, of whose judgment in cattle the public is well informed, undertook this business with a zeal which does him credit, and after a small testimony of approbation by presenting him with a piece of plate, the Society declare themselves happy in recommending a practice, the value of which Mr. CROOK has so well experienced.

SECT. XXIV. SHEEP.

SHEEP, like cattle of the neat kind, are of different sorts, generally adapted in their size to the poverty or richness of the pasture on which they feed. Small Sheep yield the best mutton and the best wool, but there are advantages which arise from a breed of large Sheep which makes the scale preponderate entirely in their favour. On extensive commons the Sheep are generally small, and of little value; on those places Seep are liable to a number of casualties which those in inclosures are easily defended from.

The best sort of Sheep for fine wool are those bred in Herefordshire, Devonshire, and Worcestershire; but they are small, and black faced, and bear but a small quantity.

The marshes of Lincolnshire breed a very large kind of Sheep, but their wool is not good, unless the breed be mended by bringing in Sheep of other counties among them, which is a scheme of late very profitably followed there. In this county, it is no uncommon thing to give fifty guineas for a ram, and a guinea for the admission of an ewe to one of these valuable males, or twenty guineas for the use of it for a certain number of ewes during one season. Suffolk, also, breeds a very valuable kind of Sheep.

The northern counties in general breed Sheep with long, but hairy wool; however the wool which is taken from the neck and shoulders of the Yorkshire Sheep, is used for mixing with Spanish wool, in some of their finest cloths.

To known whether they are sound or not, the farmers should examine the wool that none of it be wanting, and see that the gums be red, the teeth white and even, and the brisket skin red, the wool firm, the breath sweet, and the feet not hot. Two years old is the best time for beginning to breed, and their first lambs should not be kept too long, to weaken them by suckling, but be sold as soon as convenience will admit. They will breed advantageously till they are seven years old.

The difference of land makes a very great difference in the Sheep. The fat pastures breed straight tall Sheep, and the barren hills and downs breed square short ones; woods and mountains breed tall and slender Sheep, but the best of all are those bred upon new ploughed land, and dry gounds. On the contrary, all wet and moist lands are bad for Sheep, especially such as are subject to be overflowed, and to have sand and dirt left on them.

The great improvement which has been made in this kingdom in the breed of Sheep must be attributed to inclosures; by inclosing every person becomes independent of his neighbour, as far as respects his business, and if a spirit for improvement is his wish, he can exercise his will uninterrupted.

A few years past a committee of tradesmen of the City of London met to enquire into the causes of the high price of provisions, and to petition and request parliament to pass some act to redress the grievance. This wise-experienced committee attributed every thing to the numerous inclosures which had recently taken place; their Secretary, Mr. Deputy Leekey, was desired to write to Arthur Young, Esq. to procure his opinion, which Mr. Young very politely complied with; and as we think it does the greatest credit to the author's heart and understanding, we present it to our readers as a master-piece of the kind; and the high price of mutton being the principal thing complained of, it appears with propriety in this place.

On the high Price of Provisions,

In a Letter to Mr. DEPUTY LEEKEY,

By ARTHUR YOUNG, ESQ.

"SIR,

"I have attended for more than twenty years to various complaints in and out of parliament, which have been made on *high* prices of provisions, as they have been called; but I never saw the least good result from any such measures, though seemingly no more than enquiries; and when laws have been made in consequence, they have always done mischief. There is no inconsiderable reason for believing that whatever *is* the price, *ought to be* the price; since price can be formed by nothing but quantity, demand, and competition. If quantity does not exist, no one I suppose can expect cheapness. If demand does not exist, the farmers can never expect a good price; and if competition does not take place, trade cannot be free, or the price fair. The last is the only point on which laws or regulations can bear to prevent monopolies: but if by provisions you mean bread and meat, a little reflection will prove how impossible monopolies are. What capital does it take to set up a butcher or a baker? at ready money prices an hundred pounds will do either. How then can profits rise too high when competition so easily takes place? and when do you hear of enormous fortunes made by butchers and bakers? I am rather inclined to think them among the poorest of the classes; certainly the bakers; and when butchers are in good circumstances, it arises generally from a very fair interest on some tolerably good capitals. The misfortune of these enquires is, that if you mistake the cause, and instead of attributing it to want of quantity, think it owing to a want of competition, and in consequence of that idea take measures to establish it—mischief is sure to result; of which we have formerly seen various instances in laws against forestallers, regrators, &c. all which raised prices instead of sinking them. Perfect freedom of trade is the only means of securing the necessary competition. If the corporation of London give certain privileges to a butchers' company—if there are laws that enforce long apprenticeships that are unnecessary, whatever regulations you may have of this sort among yourselves, they all tend to restrain and regulate what should be as free as air, and as far as such regulations take place, must certainly have ill effects; for there can be no doubt but all corporations and all companies are mounds raised against freedom of trade, and consequently public nuisances.

"But give me leave to ask what reason any person can have to expect cheap provisions at present, if by that term *meat* is understood? Last winter, hay, straw, and fodder of all kinds, were scarcer and dearer than ever known in this kingdom. Severe frosts destroyed the turnips; cattle of all kinds, and sheep suffered dreadfully; many died, and the rest were in ill plight to fatten early in this summer; would you, in such a case, have had meat cheap? that is only asking whether you would have those farmers starve, whose wealth alone can feed you: you might as well burn all the ploughs to make corn cheap.

Such

"Such, Sir, are my ideas on the preſent enquiry; they call for no exertions, becauſe the leſs that is attempted the better; and *doing nothing*, in this caſe, as in many others, is the beſt policy.

"I am,

"Your obedient and devoted Servant,

"ARTHUR YOUNG."

Sheep, which at this time go under the denomination of Leiceſterſhire Sheep, are unqueſtionably the moſt profitable of any breed that are known; they grow to a large ſize, and will live nearly as hard as ſome others which do not weigh more they two-thirds of their weight; if the fleece is not worth ſo much per pound, its weight makes it of three times the value; and as to the mutton which epicures think inferior, we defy them to diſcover any difference, provided they do not ſee the ſize of the joint from whence it was taken. We think ourſelves juſtified in the prediction, that, in a few years, there will be ten Leiceſterſhire Sheep kept in this kingdom to one of any other kind.

The profits on a flock of Sheep have lately been a matter of contention between Mr. MACRO, of Barrow, in Suffolk, a gentleman farmer, and his Grace the DUKE OF GRAFTON. We have given in this ſyſtem ſeveral extracts from the productions of Mr. Macro, and regret that we cannot on the preſent occaſion, the ſubject being inveſtigated by him in ſo copious a manner. But when a nobleman of ſuch political conſequence and poliſhed manners as the Duke of Grafton condeſcends to correſpond with a plain ſenſible Farmer, the public muſt anxiouſly wiſh to ſee the ſentiments of ſo high a character, on ſo humble a purſuit as that of Agriculture; we therefore lay the Duke's excellent letter before the public.

ACCOUNT OF A FLOCK OF SHEEP.

BY HIS GRACE THE DUKE OF GRAFTON.

"The account, given by M. Macro, of HIS Flock of Sheep, is, as juſtly obſerved, ſo very complete on that point, that I have waited in expectation of ſeeing ſo good an example, (which has been given by my neighbour) taken up by others of intelligence and experience, and that we ſhould have been furniſhed with the means, before this time, of weighing, on juſt and ſatisfactory grounds, what are the benefits, or diſadvantages ariſing from Sheep, on each ſeparate kind of land, and to which particular breed of Sheep, the preference ought to be given in every different county.

"Though Mr. Macro has deſired that it may be obſerved, this account is confined to *his own* farm, to breeding from *ſtout* ewes, on *that* farm, *great* lambs; he, at the ſame time, has fairly intimated, that, on a farm different in nature, and on land lower rented than his own, the advantage and profit may conſiderably increaſe; yet, notwithſtanding this candid and reaſonable declaration from him, many perſons, who have either haſtily caſt their eyes over his account, or, who have heard it ſtill more indiſtinctly related by others, have run away with the notion, that Mr. Macro has proved, that no farmer could ever find his account in having a large flock, indeed any flock of Sheep; and that Sheep were unneceſſary in farming moſt lands, if neceſſary on any. As an article of the firſt neceſſity, and as a moſt beneficial one to the nation, as well as to individuals, in trade and manufactures, we are all concerned to prove the fallacy of ſuch an opinion. And here we may always rely on one excellent ſecurity againſt this and moſt other wild projects, which is, the private intereſts of individuals, among a people ſo active and induſtrious as we are; for, I will venture to aſſert, that the very attempt to lower the quantity of Sheep in the iſland, or even, that the expectation alone of ſuch a ſtep, would at once raiſe the price of the article, and quickly call back the grazier and farmer from ſuch a deſign. On the ſame ground of reaſoning, I have always made myſelf eaſy on the conſideration of the poſſible conſequences that might ariſe from the incloſure of ſo many common fields; conſequences, which, at firſt ſight, I acknowledge, were alarming, but which experience has ſhewn to have been more frightful at a diſtance than they have proved to be ſo in the event. It may be depended upon, as a maxim in agriculture, as in trade, whenever any article becomes, by accident, or by the nature of it, to bear a higher price, that more induſtry will be uſed inſtantly to provide you with that commodity. Butter, corn, cattle, &c. all ſtand on the ſame ground, and, in proportion as one gains upon the other, or becomes more ſought after than the others, ſo will it be found, that more land will be turned to the produce of that article, which is moſt demanded.

"Theſe ideas alſo, relative to Sheep, I am ſatisfied will ſpread but little; they can have no weight with thoſe who are well informed: but ſtill there are certain objects ſo neceſſary, and of ſuch conſequence to the community, that I am always ſorry to hear ſuch ſubjects looſely diſcuſſed; and I cannot think it politic or wiſe ever to bring it in doubt, whether Sheep are, or are not, a beneficial part of farming. They underſtand Mr. Macro very ill who draw this inference; ſo far from ſaying ſo, I am perſuaded, that, if the queſtion was put to him, he would readily anſwer, that, if he had even found the balance of the account much againſt him; yet, "he conſidered the advantage the farm received from the flock was ſuch, that, on that very farm, he could not go on, nor pay his rent, withoout his Sheep, although he ſhould be a loſer by that article, taken ſeparately." If ſo, they become upon *his* farm as neceſſary an article as any utenſil belonging to it.

"Another opinion, I underſtand, is now much propagated, and it is, as I hear, with the authority of a gentleman, whoſe merits, as a breeder alone, call for the general thanks of the nation, beſides the good qualities, and knowledge, which render his character ſo reſpectable. This opinion is ſo readily and eaſily confuted, if wrong, that I am not much alarmed for any bad conſequence that may happen from the notion, "that Sheep, by being folded regularly, are of no more advantage, or leſs, than if the ſame were on the grounds, or lands, at liberty without folding." I own that this poſition is, or may be more problematical than the other; and though I differ extremely in opinion from the gentleman alluded to, I would wiſh to refer any perſon to the moſt experienced, and who are the moſt thriving in their neighbourhoods, and to aſk fairly from ſuch farmers, whether they could have gained what they were poſſeſſed of, without having folded their Sheep on the lands, which were preparing for a crop; and to deſire them likewiſe to make enquiry within their reach, whether the moſt thrifty amongſt theſe farmers were not preciſely thoſe, who had the beſt opportunity of folding, and had practiſed it the moſt. If he ſhould receive for anſwer, contrary to my expectation, that ſuch farmer preferred other means, and had not followed this method; may I, without preſumption, ſay, that I conceive that ſuch an anſwer can only come from one, who has carried on farming near a capital town, or within reach of ſome adventitious manure; or elſe from one, who has farmed on a bargain, where the arable has borne no proportion to the paſture, or meadow; and where the ſtock fed upon the latter two produced all the manure he could want for his crops of grain? But, if the report of ſuch men as theſe ſhould ſtill not ſatisfy, I think, that it would be no difficult matter to prove the fallacy of ſuch an idea, by argument firſt, and if that failed, by fair experiment. However, my buſineſs at preſent only relates to the profit of a flock of Sheep kept on a farm, differing in ſoil, &c. from Mr. Macro's; and confining myſelf to the account of this ſingle flock, and that my own, I ſhall give it to you to diſpoſe of as you may judge beſt, to render the communication of public ſervice. I had been deferring, from time to time, (on account of one avocation or another,) to make out an accurate account, *debtor* and *creditor*, of this flock; and I do not know but the ſame cauſe might have kept me much longer, if ſome very peculiar avocations, for a few days, had not rouſed me to undertake it. The materials were all at hand, and capable of being referred to, in the moſt accurate manner: the heat of the weather made in door amuſements very deſirable, and I ſat down heartily to the buſineſs, which took up a good part of one day, and ſeveral hours of the next.

"It is a conſtant, and juſt remark, that the numerous publications, on the various branches of Agriculture, contribute but little to the improvement of that ſtudy; that but few of the experiments though delivered therein, almoſt under the colour of demonſtration, are brought into uſe or common practice, to which end all ſuch writings ought to direct. To what is this to be imputed? though of theſe many may be given to the world, and certainly are, without ſufficient conſideration; yet among the number of writers, whoſe zeal calls them forth on theſe occaſions, there muſt alſo be many, who are very able, undoubtedly, to give the beſt leſſons on the ſubject they treat, and to juſtify them by experiments of their own. However, too often it happens, that the particular deſcription of the lands, and ſoil, as well as of the general nature of the farms on which theſe have been tried, are omitted; and this is ſo material a point, that no one muſt expect to be followed without it; or elſe the writer, captivated with his own ſucceſs on a ſingle ſpot, gives it to the kingdom in general, hoping to ſee it adopted, when probably, it was calculated only for that ground on which the experiment was made, and might become of no uſe, if tried on the other ſide of the next hedge. Agriculture, I believe, admits of deciding rules leſs than any other purſuit; for almoſt each piece of land requires ſome one particular rule to itſelf. Let all experiment, and even precepts, be deſcribed as exactly as poſſible, with every dependent circumſtance; and then, I am perſuaded, the rational ones will never want curious perſons to give them a ſufficient and candid trial.

"In order that I may not fall into the ſame error, from which I have preſumed to warn others, I muſt ſtate, that my farm is chiefly on that ſort of ſandy ſoil, which is to be found in the neighbourhood of Thetford, and reſembles moſt of the farms thereabout, in the nature of the land, as well as in the Sheep walk and heath: in many or moſt parts of which chalk lies at no great depth; and in a few ſpots a good loam appears ſurrounded by theſe light ſands. The more valuable and fruitful parts have been made ſo at the expence of a thorough coat of clay, found in many places on it. Theſe lands, thus improved, are moſtly incloſed with good quicks, and admit

of the three ſhift huſbandry; while the reſt is quite open, and lies four or five years, before it comes again under the plough. Beſides the turnips allotted to the Flock, about ſixty or ſeventy acres more grown annually for the fattening Scotch baſts, and for the cows alſo at particular times."

We ſhall here preſent ſome obſervations on

SHEEP IMPROVEMENTS IN SCOTLAND,

By Sir John Sinclair, Bart. M. P.

In a Letter to Arthur Young, *Eſq.*

"Dear Sir,

"I am glad to find the ſpirit for the improvement of Sheep and wool continues undiminiſhed. My ſentiments on the ſubject you will ſee from the incloſed. I am now perfectly ſatisfied, that three diſtinct breeds of Sheep ſhould be reared in this country; the Leiceſterſhire in the plains; the Cheviot croſſed by the Spaniſh in the hills: and the Shetland breed in ſmall iſlands, or along the coaſt where the graſs is ſhort and kindly from the ſea ſpray.

"I went two days ago to ſee the flock belonging to the Society; they are kept four miles from Edinburgh, and are thriving to our wiſh; we ſhall be able to produce as fine wool of the growth of Scotland (particularly from M. d'Aubenton's ewes), as perhaps ever came from Spain. One experiment has anſwered beyond all expectation: a lamb of above a year old, a croſs between one of Lord Sheffield's Spaniards and a Cheviot ewe, was clipped and clothed on the 3d of October laſt; its fleece has ſince grown about an inch, and for ſoftneſs, fineneſs, and colour, exceeds almoſt any thing you ever ſaw, and the animal itſelf is in the beſt order of any in the whole flock.

"We have juſt been making up a ſtate of our operations for the year 1791, during which period the Society have purchaſed in all about 800 ſheep, 550 of which they have reſold, and diſperſed all over Scotland, in the hands of above 100 different individuals, for the purpoſe of giving them new ideas upon the ſubject, and of exciting a ſpirit of experiment.

"I remain, with eſteem, Sir,

"Your very obedient humble ſervant,

Edinburgh, Jan. 16, 1792. "JOHN SINCLAIR."

We cannot but conſider the communications of this gentleman as highly beneficial, and that the public are much indebted to the zeal and activity of a character of ſuch exalted rank.

As the ſcab in Sheep is a diſorder very common as well as fatal, we ſhall preſent a valuable recipe for the cure, from the Annals of Agriculture, Vol. V. page 12.

ON THE SCAB IN SHEEP.

By Paul Treby Treby, Esq. of Plympton, Devonshire.

"SIR,

"I ſend you the following recipe for the ſcab in Sheep, which I have found infallible.

3 gallons of brine,	¼ lb. ſtone brimſtone,
3 gallons of urine,	¼ lb. leaf tobacco,
1 lb. ſulphur vivum,	handful of fox glove leaves,
¼ lb. white copperas,	ditto of broom twigs.
¼ lb. roch allum,	

"Theſe ingredients to be boiled until reduced to 2 gallons, and then corked.

"The wool ſhould be parted on the buds of ſcabs, and a ſmall quantity of the mixture poured on them, this ſhould be repeated three or four times, and well rubbed in; I ſcarcely ever knew this application fail the firſt time. My Sheep running on a common, where this diſorder prevailed very much, when firſt I kept them, I found it very troubleſome; but I have now the pleaſure, with this recipe, not only to find my own Sheep quite clear of it, but thoſe of my neighbours.

"I uſe as much ſublimate as will lay on a ſhilling (I forget the weight), to a quart of warm water, in which I ſometimes put a wine glaſs of ſpirits of turpentine, for the worms in Sheep; my ſervant ſays this is too ſtrong, and that he often repleniſhes his bottle with urine, which anſwers completely. I have always experienced that camphire alone expelled bugs. The mixture ſhould ſurround the part affected with the ſcab.

"I am, Sir,

"Your devoted ſervant,

Plympton, Nov. 2, 1791. "PAUL T. TREBY."

SECT. XXV. PIGS.

PIGS, either wild or domeſtic, are animals more univerſally exiſting in all parts of the globe, than any other kind whatever; in their wild ſtate they are found in moſt parts of Europe, except the Britiſh iſles, and the countries north of the Baltic; in Aſia, from Syria to the borders of the lake Barkal; in Africa, on the coaſt of Barbary; and in the foreſt of South America.

Tame hogs are found univerſally, except in the frigid zone and Kamtſkatka, and ſuch places where the cold is very ſevere. The Chineſe hog is only a variety of the common hog; its belly hangs almoſt to the ground, its legs are ſhort, its tail reaches to the heels, and the body is generally bare: it is a much cleaner animal than ours. Although ſo conſiderable a part of the inhabitants of the earth are, from religious motives, forbid taſting their fleſh, in our country they are in great eſtimation, as they yield the food on which huſbandmen chiefly ſubſiſt; they are very prolific in their nature, as a Sow generally produces from ſix to twelve Pigs at a litter. Theſe animals are very profitable to the owner, being kept at a ſmall expence, feeding on things that would be otherwiſe thrown away, and producing a very large increaſe. Leiceſterſhire, Northamptonſhire, and Hampſhire, are famous for theſe animals, which ſeems owing to their being clayey countries, and that more peas and beans are ſown there, than in other places. The breed of pigs have been greatly improved, both in the hardneſs of their nature, and the goodneſs of their fleſh, by the introduction of thoſe commonly called the Chineſe, or Touquin.

The wild kind never grow ſo large as the tame, but they are much better taſted. The keepers of Hogs ſhould always chuſe ſuch boars for the purpoſe of breeding as are long-bodied, and have deep bellies and ſides, ſhort noſes, thick thighs, ſhort legs, high claws, a thick neck, and a thick chine, well ſet with large briſtles. The Chineſe being put to breed with the large long-legged, large eared kind of our own country, have produced, in all reſpects, a great improvement. It is not proper to keep too many breeding ſows, for they will produce ſo many young at a time, and this three times a year, that they will not find food enough. They uſually bring thirteen or fourteen young ones in a litter, ſometimes more, but they can bring up no more than they have teats to ſuckle. Young ſhoots, as they are called, that is, ſwine of three quarters of a year old, are beſt for pork, and thoſe of a year and a half for bacon. Moiſt and ſedgy grounds are good for ſwine, for they eat the roots of many of the plants that grow there; and the fruit of the beech, cheſnut, and hedge buſhes, fatten them well, and make their fleſh much better taſted than when bred entirely in the ſtye. In various parts of the kingdom young growing Pigs are put to feed on clover, during the ſpring and ſummer, a method very profitable, and deſerving of general practice; it ſhould be rememberd a few beans or peas ſhould be given in the morning, to keep them healthy; but an inconſiderable quantity will be ſufficient.

Mr. Young obſerves, that Hogs may be kept in ſummer, with great advantage to the farmer, in clover-fields; and that lucerne is ſuperior to clover for this purpoſe, and that ſaintfoin is very good, but that burnet is very bad. In winter they may be well maintained with carrots, parſnips, beets, and potatoes. The dairy ſhould be appropriated to rearing Pigs and feeding Sows that have young. It appears, from other experiments of this writer on the fattening quality of ſeveral ſorts of food for Hogs, that pollard alone is a cheaper feed than peas alone; that boiled carrots are much the moſt profitable; that buck-wheat is more profitable than peas; that ſeveral kinds of food mixed are better than any given alone; that the meal of any one, or various kinds of grain, is better and more profitable than the whole grain mixed or alone; and that peas and barley are much ſweeter food than beans.

SECT. XXVI. PLOUGHING AND CLEANING LAND.

PLOUGHING, Harrowing and Pulverizing the Soil in a proper manner, are circumſtances which conſtitute an eſſential portion of the knowledge of a good huſbandman. It is deemed an error to plough land in very wet weather, and we think no emergency whatever ſhould induce a farmer to purſue a method ſo contrary to reaſon and experience. Stiff loams and clay cannot be laid too rough, nor expoſed too much to the froſt and ſun during the time they are under a courſe of ploughing, in order to be cleaned from weeds, and mellorated either by the intenſe heat of the ſummer's ſun, or the no leſs fertilizing influence of the winter's froſt. The more the land is ſtirred by different inſtruments, the better will the parts be ſeparated and pulveriſed. The method, as practiſed by ſome farmers, when they fallow their land, is far from anſwering their intentions, for they plough up the ground, leaving it in great clods for ſome months, and frequently, during this time, thiſtles and all bad weeds are ſuffered to grow upon the land, and exhauſt the goodneſs of it; and perhaps, juſt before ſeeds are ſown, they give it two more ploughings. This is what the farmers call good huſbandry: but if, inſtead of this method, they would labour the ground often with the plough, a harrow, and heavy roller, to break and ſeparate the parts, and never ſuffer any weeds to grow upon the land during its lying fallow, they would find their account in it; firſt by the growth and increaſe of their crops, and afterwards by a ſaving in the weeding, for if no weeds are ſuffered to grow to ſhed their ſeeds, during the time of fallowing the land, there will but few come up when the ground is ſown.

Ploughing in ridges is very proper for removing wetneſs, in which caſe every furrow becomes a drain; and alſo for enlarging the ſurface of the ſoil, expoſed to the air, and employed in vegetation. In order to obtain theſe purpoſes, the ridges ſhould be narrow; though ſoils in different ſituations will require being

laid

laid out in different kinds of ridges: they ought alſo to be ſtraight in their direction, and equal to one another in ſize, each ridge being alſo equally broad in all its parts.

There are three different ways of ploughing ridges, viz. *gathering*, *caſting*, and *cleaving*.

Gathering keeps the crown and furrows of the ridge in the ſame place in which they were before. The plough begins in the crown, and ploughs out the ridge, turning the earth towards the crown: by this method of ploughing, the earth on each ſide is turned upon the crown, and thrown up out of the furrows, ſo that the ridge is raiſed.

Caſting likewiſe keeps the crowns and furrows in the ſame place, the ridges are ploughed in pairs, and they are kept of the ſame height in the crown, and one of the furrows made a little higher, and the other a little lower than before; the earth being taken out of one furrow and thrown into the other.

Cleaving is the reverſe of gathering: the plough enters the furrow on the right ſide of the ridge, turns to the furrow on the left ſide, and ploughs out the ridge, turning the earth from the crown towards the furrow. In this caſe the furrows are made higher, and the crown lower.

There is another method of ploughing, called *ribbing*, which is performed by making furrows about two feet diſtant from each other: one half of the ſurface is untouched by the plough, and the other half, which the plough turns up, in making the furrows, is thrown on the top of what remains fall. This kind of ploughing is ſeldom practiſed, but in the beginning of winter, and upon land to be ſown with barley, after two more clean ploughings. It is much condemned by the modern improvers of agriculture, though in ſome caſes it has its uſes. *Bouting* is another kind of ploughing, performed by throwing the earth of two furrows towards each other, upon ſome faſt land; this is an improvement on ribbing and better ſerves the ſame purpoſes. Sand, and looſe gravelly loam, require but little ploughing; too much generates weeds, particularly thiſtles of various kinds.

As a particular deſcription of the various ſorts of thiſtles, with obſervations on their nature, and the methods of extirpating them, will doubtleſs prove agreeable to our Agricultural readers, we preſent them with the following

Obſervations on Thiſtles injurious in Agriculture, more particularly the Seratula Arvenſis of Linæus.

By Mr. William Curtis, of Lambeth Marsh.

"There are no plants over which the œconomical farmer ought to keep a more watchful eye than the Thiſtle tribe. He is ſenſible that they are not only uſeleſs, as reſiſting the bite of moſt animals, the hardy aſs excepted, but that they occupy much ground; and, being furniſhed with downy ſeeds, are capable of being multiplied to almoſt any diſtance. Hence, in many parts of the kingdom, the farmers whoſe lands are contiguous, unite in preventing the increaſe, by cutting them down before they ſeed; but this operation, though deſtructive to ſome ſpecies, will only palliate the bad effects of others.

"To be acquainted with the qualities of each kind, we muſt obſerve them with much attention, and view them in a botanical and philoſophical light: this alone will enable us to judge with certainty how far and by what means their deſtruction may be effected.

"The Engliſh Thiſtles meriting notice, as more or leſs noxious, are,

1.	The Carduus Lanceolatus,	or, Spear Thiſtle
2.	Carduus Nutans,	Muſk Thiſtle
3.	Carduus Paluſtris,	Marſh Thiſtle
4.	Carduus Marianus,	Milk Thiſtle
5.	Carduus Acantholides,	Welted Thiſtle
6.	Carduus Criſpus	Curled Thiſtle
7.	Onoperdum Acanthium,	Cotton Thiſtle
8.	Seratula Arvenſis,	Curſed Thiſtle.

"The Spear Thiſtle is a ſtrong plant, about four feet high, the extremity of each leaf running out into a long point; its heads are large, and it grows very commonly by the ſides of roads, near dunghills, and not unfrequently in fields and paſtures.

"The Muſk Thiſtle grows to the height of 2 or 3 feet, the heads hang down, and the flowers ſmell ſomewhat like Muſk; it is often found occupying whole fields, particularly on chalky or barren land.

"The Marſh Thiſtle is very tall and prickly; its heads are numerous, ſmall, and of a red colour; it grows abundantly in wet meadows, alſo in woods.

"The Milk Thiſtle has very large leaves, which are moſt commonly beautifully marbled with white. Near London it appears frequently on banks by road ſides: in which ſituation we alſo meet with

"The Curled and Welted Thiſtle. Theſe three ſeldom intrude into fields and paſtures.

"The Cotton Thiſtle is diſtinguiſhed by its ſize, (being, perhaps, the largeſt of the Britiſh herbaceous plants) and its white woolly leaves. It grows in the ſame ſituation as the three laſt-mentioned.

"The Curſed Thiſtle is more general in its growth than any of the others, being found not only by the ſides of the roads univerſally, but alſo in arable land, and is not uncommon in meadows, even in ſuch as are yearly mown. It is remarkably prickly, grows about three feet high; its heads are ſmall, the flowers purple, and frequently white. The ſcales of the heads are ſmooth, and may in a particular manner be diſtinguiſhed from all the others before-mentioned, by having a perennial root, about the ſize of a gooſe-quill, which runs deep into the earth, and afterwards creeps along horizontally.

"Of theſe Thiſtles, all except the laſt are either *annual* or *biennial*, that is, remain in the ground not more than one or two years, unleſs renewed by ſeed. The laſt, having a perennial root, continues in the earth, increaſing, and throwing up new ſhoots every year.

"Hence it will appear obvious, that if the firſt ſeven ſpecies of Thiſtles are cut down, before they perfect their ſeed, the ground will be entirely cleared of them; and that the laſt-mentioned can no otherwiſe be deſtroyed, than by rooting it out; a proceſs which the following experiments will forrowfully convince the rural œconomiſt to be impracticable in large fields, and ſcarce to be performed even in an enclоſed garden.

Experiment Firſt. To aſcertain the effects of mowing the Seratula Arvenſis.

"The Hon. Daines Barrington, who is ever anxious to promote uſeful enquiries, deſired me to try whether this kind of Thiſtle could not be deſtroyed by mowing. A ſmall batch of them, about two feet ſquare, was accordingly planted in a good garden, in the year 1777. In the courſe of the ſummer they were mown three ſeveral times, but without any other good effect than that of preventing their ſeeding; for, inſtead of being deſtroyed, the next ſpring they came up vigorouſly, not only on the bed where they were firſt planted, but all around it to the diſtance of ſix feet.

Experiment Second. To aſcertain the annual Increaſe of the Root of the Seratula Arvenſis.

"April, 1778, I planted in a garden a piece of the root of this thiſtle, about the ſize of a gooſe quill, and two inches long, with a ſmall head of leaves, cut off from the main root, juſt as it was ſpringing out of the ground. By the 2d of November, 1778, this ſmall root had thrown out ſhoots, ſeveral of which had extended themſelves to the diſtance of eight feet; ſome had even thrown up leaves ſix feet from the original root. Moſt of theſe ſhoots which had thus far extended themſelves were about ſix inches under ground, others had penetrated to the depth of two feet and a half; the whole together, when dug up and waſhed from the earth, weighed four pounds.

"In the ſpring of 1779, contrary to my expectation, this thiſtle again made its appearance, on and about the ſpot where the ſmall piece was originally planted. There were between fifty and ſixty young heads, which muſt have ſprung from thoſe roots which had penetrated deeper than the gardener was aware of, although he was particularly careful in extracting them. From theſe experiments it appears deducible, that no plants are more eaſily deſtroyed than the generality of thiſtles, or with more difficulty than this one; there being no ſoil, however poor, in which it will not vegetate, nor earth ſo ſtiff but it will penetrate; in proportion, however, as the ſoil is rich, will be its increaſe.

"It were much to be wiſhed, that an inveſtigation of this evil had afforded a remedy: at preſent, none appears. It is, therefore, to be feared, that ſpudding or cutting them down cloſe to the ground, once or twice in the ſpring, is the only operation the farmer can perform to prevent their bad effects in deſtroying his crops on arable land, and rendering his paſtures unſeemly. As nature in the preſervation of this plant ſeems to have exerted her greateſt powers, it is poſſible that in ſome future period, uſes may be diſcovered to which it has not yet been applied.

"To the aſs it is the higheſt treat; and I have been credibly informed, that in ſome parts of Scotland, it is cut down as food for horſes. It would be well, if a plant ſo noxious in ſome reſpects could be rendered beneficial in others."

Some kinds of ſoil require deep ploughing, and others light; we have heard huſbandmen aſſert, that on all ſoils they were friends in every reſpect to light or ſhallow ploughing; and others profeſs themſelves advocates to a deep furrow, where the rock is no impediment: theſe are aſſertions without reaſon; for where the ſoil or ſurface-earth is of a conſiderable depth, it may undoubtedly be an improvement ſometimes to fetch up freſh mould.

ON DEEP PLOUGHING.

By Mr. N. Bartley, *near Briſtol.*

"From the experiments and reaſoning of Monſ. Chateauvieux, Du Hamel, and others, I was determined to try the effects of Deep Ploughing; for this purpoſe I provided myſelf with a very ſtout plough, and began with a piece of land of about five acres on Bridlington Common, to which my experiments have been moſtly confined. The ſoil a rich loamy ſand, the colour that of a hazel-nut when fully ripe; the upper ſtratum of a pretty uniform quality, to the depth of from 2½ to 4 feet. In the firſt place, I had to contend with the prejudice of the ploughman, who,

who, for what reaſon he knew not, very ſtrongly objected to deep ploughing: however, I ſoon brought him to ſubmiſſion; and, not without much labour, he performed the buſineſs to my entire ſatisfaction: the general depth was about nine inches. During the operation, the ground was viſited by moſt of the farmers in the neighbourhood, and the method univerſally exploded. By ſome it was ſaid I ſhould not plough for them, though I would do it for nothing; by others, that it would not recover for ſeven years; and again, that it would be quite ruined. From all this I was not diſcouraged; and, after giving the land two other ploughings, which were performed with eaſe and pleaſure to the ploughman, it was cropped with Jammas wheat, and the produce was eſtimated, by ſome of theſe very farmers, at forty buſhels per acre. The next year it was manured with twenty cart-loads of a compoſition of half hog dung, and half virgin earth, part of the ſame field, and planted with potatoes. This crop was kept free from weeds, well hoed, and earthed up; the produce not leſs than 148 ſacks, or 360 Winchester buſhels, per acre. Next it was ſown with flax-ſeed, and produced two packs per acre, the pack 240lb. After this two ſucceeding crops of hoar-wheat, both good; ſay about thirty buſhels each crop per acre. The laſt ſeaſon it was ſown with black oats, and laid down with clover and rye-graſs ſeed. The oats I eſtimate at 64 buſhels per acre, which will appear moderate in compariſon of an experiment upon that grain. I attribute greatly to deep and frequent ploughing the ſucceſs of theſe crops, and I perſiſt in the ſame method. It is probable, however, that ſome degree of caution may be neceſſary on particular ſoils."

CLEANING.

Lands which lie level, have evidently the advantage of thoſe which are in high ridges, with reſpect to cleaning. Croſs ploughing is impracticable on high ridged lands, without which ſtiff ſoils cannot be ſufficiently pulled to pieces. The old cuſtom of throwing land of a wet nature into very high ridges, was certainly an error, particularly on the ſides of hills, or where there was a proper deſcent to admit of draining.

In grounds that require ridging, an error prevails, that ridges cannot be raiſed too high. High ridges labour under ſeveral diſadvantages; the ſoil is heaped upon the crown, leaving the furrows bare; the crown is too dry, and the furrows too wet: the crop, which is always beſt on the crown, is more readily ſhaken with the wind, than where the whole crop is of an equal height; the half of the ridge is always covered from the ſun, a diſadvantage which is far from being ſlight in a cold climate. High ridges labour under another diſadvantage in ground that has no more level than barely ſufficient to carry off water; they ſink the furrows below the level of the ground, and conſequently retain water at the end of every ridge. The furrows ought never to be ſunk below the level of the ground. Water will more effectually be carried off by leſſening the ridges both in height and breadth; a narrow ridge, the crown of which is but 18 inches higher than the furrow, has a greater ſlope than a very broad ridge, where the difference is three or four feet.

To attempt to level land, that has lain in high ridges a long time, on a ſudden, is by no means judicious; as experience ſufficiently ſhows, that even the beſt vegetable mould, if buried, for any length of time, ſo far beneath the ſurface as to be deprived of the benign influences of the atmoſphere, becomes an inert, lifeleſs maſs, little fitted for nouriſhing vegetables, and conſtitutes a ſoil very improper for the purpoſes of the farmer. It therefore behoves him to preſerve, on every part of his fields, an equal covering of that vegetable mould that has long been uppermoſt, and rendered fertile by the meliorating influence of the atmoſphere. But if he ſuddenly levels his high ridges by any mechanical contrivances, he of neceſſity buries all the good mould that was on the top of the ridges in the old furrows; by which he greatly impoveriſhes one part of his field, without rendering ſervice to the other; inſomuch, that it is a matter of great difficulty, for many years after, to get the field brought to an equal degree of fertility in different places, which makes it impoſſible to get an equal crop over the whole of his field by any management whatever. We have frequently ſeen fields, that have been thus levelled, in which, after thirty years of continued culture and good management, the marks of the old ridges could be diſtinctly traced when the corn was growing, although the ſurface was to level that no traces of them could be perceived when the corn was off the ground.

With carefully caſting the furrow, high ridges may, in the courſe of ſix or ſeven years cultivation, be brought almoſt on a level, and without a material injury, by impoveriſhing the top or convex point of the lands. Large ragged ſtones are frequently a great impediment to the plough; oftentimes people plough ſhallow, purpoſely to keep clear of them, and by that means are precluded from the benefits which deeper tillage would produce. Stones above the ſurface may be avoided by the ploughman, though not without loſs of ground; but ſtones below the ſurface are commonly not diſcovered till the plough is ſhattered to pieces, and perhaps a day's work loſt; the clearing land of ſtones is therefore neceſſary to prevent miſchief; and as the blowing them up, when gunpowder is furniſhed, does not exceed a halfpenny for each inch that is bored, theſe ſtones come generally cheaper than to dig as many out of the quarry, for repairing roads, and other purpoſes. In the next place, as the ſoil round a large ſtone is commonly the beſt in the field, it is purchaſed at a low rate by taking out the ſtone. Nor is this a trifle; for not only is the ground loſt that is occupied by a large ſtone, but alſo a conſiderable ſpace round it, to which the plough has not acceſs without danger. A third advantage is greater than all the reſt; which is, that the ploughing can be carried on with much expedition when there is no apprehenſion of ſtones: in ſtony land, the plough muſt proceed ſo ſlow as not to perform half of its work. To clear land of ſtones, is, in many inſtances, an undertaking too expenſive for a tenant, and requires the aſſiſtance of the proprietor.

In cleaning land from weeds, particularly couch graſs, ploughing is neceſſary as ſoon as harveſt is over, and another croſs ways before the ſeverities of winter commence; taking care to drain off water: it lying in this ſituation till ſpring, a heavy harrow, or drag, ſhould be drawn over the land, to pull it to pieces; the weight of the implement, and other circumſtances, according to the ſtrength of the ſoil.

It is a prevailing practice in the weſtern and midland parts of this country, to breaſt-plough the ſurface of the ſtubbles, and let them lie in that condition during the winter: this certainly anſwers a good purpoſe, as what was pared off becomes rotten, and mixes with the ſoil when the land is ploughed for oats or peas in ſpring. The expence attending this paring, or breaſt-ploughing, is generally about five ſhillings per acre. Was a good horſe-plough uſed for the purpoſe, it would not be half ſo much: we know of no plough ſo well adapted for the purpoſe as one made by Mr. WINLAW, of Margaret-ſtreet.

The preſent altercation amongſt thoſe who mix philoſophy with ploughing and ſowing, reſpecting fallows, is, in moſt reſpects, ridiculous: no man, in his ſenſes, would wilfully ſuffer his land to be at reſt, and under expenſive ploughings, and other management, if it was in a condition to produce a crop. the anti-fallowiſts have entered their proteſt againſt the enriching influence of the ſolar rays, and declare that ſoil derives more fertility and vigour from being covered with ſucculent vegetables, than from the moſt judicious and beſt conducted ſummer fallow. If that is the caſe, why do thoſe who purſue the horſe-hoeing ſyſtem place ſuch confidence in ploughing between the rows of corn in ſummer, in lieu of manure? Moſt kinds of ſoil, if the ſpring happens to be dry, may be cleaned before the proper time to ſow turnips arrives, or in time to plant late cabbage. This method renders fallowing for wheat unneceſſary; and the turnips or cabbages may be conſumed on paſture or arable land, where they will be of great ſervice. When land becomes full of couch graſs, and other weeds, there is as much neceſſity for time and labour to clean it, as there is for water to waſh a garment when it is dirty: whether winter and ſpring ploughings will effect it, or a ſummer fallow is neceſſary, we muſt leave to the diſcretion of thoſe who chooſe to try the experiment.

SECTION XXVII.

SOWING, DRILLING, AND OTHER MEANS OF DEPOSITING SEED IN THE EARTH.

SOWING is the operation of diſtributing ſeed on the earth, from a veſſel or meaſure of a diſtorted oval conſtruction, adapted in ſhape to the ſide of the ſower, and called a ſeed-lip, or ſeed-lip, which, in all probability, owes its derivation to the ancient method of carrying the ſeed in an apron, or a lappet of the ſower's garment. The general practice is to deliver each caſt of ſeed from the hand of the ſower, at the time he advances his left leg as in the action of walking, and to proportion the diſtance he ſteps, and the quantity of ſeed he throws each time, to the width of the land he is ſeeding. This is the mode called broad-caſt, the ſeedſman going twice over the ſame ground. Thoſe who are dexterous ſow both right hand and left, which is a practice very convenient, and to be recommended to every young perſon's notice, as it is acquired with eaſe if practiſed early in life. On ſtubbles and fallows, when they are in a mellow, friable condition, all kinds of grain ſhould be ſowed under furrow, that is, before the land is ploughed, and ſo turned in with the furrow. It is a practice very cuſtomary to ſow one caſt before ploughing, and another after; but we cannot think it eligible, as the advantage, if any, muſt belong to one mode independent of the other, conſequently none can derive benefit from uſing both. On land freſh broke up from graſs, and commonly called a ley, corn is generally ſowed after ploughing, and harrowed in; except beans or peas, which are not eaſily buried, and for that reaſon commonly ſowed under furrow. The quantity of ſeed neceſſary to ſow an acre of land, is generally more or leſs, according to the quality of the ſoil: the richer the ſoil, the leſs ſeed; and the poorer, the greater the quantity. This is a maxim generally attended to, and by multitudes invariably purſued, but certainly liable to exceptions, if not totally founded in error. No perſon ſhould invariably adhere to preſcribed rules, but deviate, by making ſmall experiments,

periments, and taking notice of the result; this only can correct error, and lay a good foundation for improvement.

THOMAS LE BLANC, Esq. of Cavesham, in Suffolk, relates, in Mr. Young's Annals, Vol. I. p. 111. the following

EXPERIMENTS ON THE SEEDING OF SAND LAND.

"1. On one acre of poor sand, worth about 3s. 6d. an acre, were sown two bushels of barley. 2. On the next adjoining acre three bushels. 3. On the next four bushels. The result was, that the crop was best from two bushels, next best from three, and the worst from four.

"The experiment was afterwards repeated on sand worth 7s. an acre, in which two bushels produced four quarters; three bushels produced four quarters, two bushels; and four bushels produced three quarters, seven bushels.

"It is the observation of the farmers in the neighbourhood on the same land, that, where the chalk lies very near the surface, there the quantity of seed must be increased."

"As we have given these interesting experiments on a poor sandy soil, we shall add the following on a COLD CLAY: Annals, Vol. VII. p. 28.

EXPERIMENTS ON THE QUANTITY OF SEED ON COLD CLAY LAND.

By Mr. SOLOMON NORMAN, of CLEVELAND, YORKSHIRE.

"I HAVE been a seedman many years. The first oats that I sowed, broad-cast, was at the rate of nine pecks per acre; my acres are 10 great chains; and Winchester bushels, the produce 40 bushels: this field contained nine acres, had been in tillage 24 years, in the Cleveland course of oats, fallow, and wheat. At the same time, or nearly, I sowed eight acres, an adjoining field, that had been in tillage eight years, in the same course as the former, with three bushels per acre; the produce but 40 bushels; the staple of the latter being much deeper and fresher than the former field, ought to have produced double. I am therefore fully sensible that there is not a more pernicious practice than loading poor soil with too much seed: the nine acres, three years before, was sown with three bushels per acre; the produce only two quarters: as to the quantity of straw, I could carry the produce of an acre on my back. I should at once condemn six or seven bushels, so large a quantity, mentioned in your tours, as would destroy our clay soils: their height would not exceed 10 or 12 inches, and be as light as chaff; their produce, perhaps, the seed again.

"In 1785, sowed 10 pecks per acre in April: at May-day, sowed clover-seed on four acres, on two of which I harrowed in the seed: the oats were in fine leaf; they were torn up by violence, and laid upon the ground thick. The other two acre I brushed over, by putting a bush of thorns into the harrows, which did not hurt the oats. The produce was, two acres harrowed, superior to any four acres in the field, which contained 12 acres in all. Some parts of this field were rank with wild oats; such places did not exceed one foot high, and were as light as chaff; their stalks produce no more than a corn or two. I always increase the quantity of seed oats, on rich soil, in order to keep them from running too much into straw, which is generally the case on rich land; otherwise to smother the weeds, for such land will grow something. I likewise find two bushels of barley a sufficient quantity on clay land that is free from weeds.

"I have frequently sown two bushels of wheat on one acre, and two bushels and a half on another, in order to compare the difference on cold bottomed clay land, but found no difference. If two bushels, broad-cast, will not produce a good crop, there is no forcing the land with too much seed. As to steeps for wheat, they are of no service at all. My mode of preparing wheat seed, is to sprinkle urine, otherwise clean water, on the heap until thoroughly wet, then sprinkle quick-lime over it till thoroughly covered, and white as dust, and then it is fit for sowing. I recommend lime: but as to steeps, there is no health in them; the crops will be just as large a quantity without them.

"As to beans, we usually sow four bushels per acre on cold clays; and the produce, in general, is not one half so much as in Essex, where they sow two bushels per acre, and hoe one half of them up. In short, I am an advocate against too much seed.

When the land is in proper condition to receive seed, is an object of the first importance: to sow dry, and set wet is proverbial; but as the husbandman cannot influence the weather, nor always have such as meets his wishes and convenience, he must be careful to let no favourable opportunity pass. When soil is easily pulverized, it is then best adapted to cover the seed; seize this opportunity, and patiently leave the rest to providence and nature."

SETTING OR DIBBLING.

This method of planting grain we have every reason to believe lays claim to the greatest antiquity, and is, on stiff loams or clay greatly practised at the present time. The mode of performing it is with a stick, about a foot long, in one hand, to make the hole, and immediately drop in the seed with the other, which should be carried in a bag, or apron, tied round the waist for that purpose. One particular advantage attends setting grain; it may be performed in rainy weather, when other means cannot be used. As we were under the necessity of noticing this method under the articles WHEAT, BEANS, &c. it will be useless to take further notice of it here.

DRILLING.

Drilling is the operation of depositing seed in the earth in rows parallel to each other at any given distance, or at any depth beneath the surface: this may be effected by manual labour; but the process is so tedious and expensive, that the advantages gained by this superior method do not yield an equivalent compensation for time and labour. To remove this obstacle, various machines have been constructed to facilitate the operation, and to render this valuable branch of agriculture as profitable in practice as it is rational in theory. The great inconveniencies attending implements for drilling seeds have been the complexity of their construction, and the difficulty of keeping them in repair; as the force with which a horse moves a machine is certain to derange some part or other of the work, if it meets roots, large rag stones, or other powerful obstructions, which occasion disappointment and loss of time; circumstances very disagreeable to a farmer in the time of seeding. To obviate those impediments, a drill machine should possess simplicity of design, and strength in its construction; a regular delivery of the seed, according to the quickness or speed with which it is drawn; and so contrived, as that the seed may be stopped, or let run, in a moment, at the pleasure and convenience of the person who attends it: and lastly, the price of the drill should be such as to render it within the purchase of those who follow agriculture from necessity. Without a combination of those essential qualifications, drilling will never become general; and with them, we make not the least doubt, no person will neglect the practice, whose soil is adapted to that mode of cultivation. This method of depositing seed is most certainly attended with many great advantages, when practised with discretion; and when hoeing is neglected, is the worst management that can be pursued. Many have been kept from drilling by the great expence of hoeing, an objection now, we hope, removed, by the Rev. Mr. COOKE's new constructed horse-hoe, which being an appendage to, and constituting part of, the drill, makes the practice cheap and expeditious.

When a person is in possession of a drill which will answer every purpose he could wish, it is not to be supposed every other mode of seeding is to be exploded; rather let him consider the situation the land is in, and other obvious circumstances, and judiciously follow that method which appears most eligible: this deliberate conduct will seldom disappoint the expectation, and will make those difficulties attendant on novelty easy and familiar.

We have attentively examined several drill machines, and attended to the report of others, from verbal accounts and written testimonials, and, without hesitation, acknowledge, that the *Drill Machine, invented and made* by the Rev. Mr. COOKE, is, in its present plain and simple construction, an implement which seems to render further improvement unnecessary. This we are further warranted in asserting, by letters received from two gentlemen of extensive experience, who, on application being made to them, wrote to the publisher. These letters we have introduced prior to the description of the machine. We could not avoid making this declaration, thinking it our duty to the public to exhibit merit to view wherever we find it. We shall also give descriptions and representations of every other drill machine worthy of notice.

Having, in the course of the former edition of this work, made enquiries amongst our agricultural acquaintance concerning the importance of the Rev. Mr. COOKE's DRILL MACHINE, were informed that Mr. BOOTE, of *Atherstone-upon-Stour*, near *Stratford-upon-Avon*, had made a very long trial of it: we therefore applied to Mr. BOOTE, who favoured us with the following answer, which was addressed to C. COOKE, the publisher of this work.

"SIR,

"In consequence of your request, I send you the following particulars respecting the Rev. Mr. COOKE's newly invented DRILL MACHINE, which you have the liberty to publish in your ENCYCLOPÆDIA, as I am always happy to serve the man to whose inventions I am so much indebted.

"For three years last past, I have used the Rev. Mr. Cooke's old drill machine with extraordinary success, particular accounts of which you will find in the fifth and sixth volumes of the Transactions of the Society of Arts, Manufactures, and Commerce of London. The crops of this year are not yet threshed; but I have reason to believe they will not fall short of the produce of the two preceding years, considering the dryness of the season. Some time since, I was informed that Mr. Cooke had made a great improvement in his drill machine, particularly by annexing to the same a method of horse-hoeing. This newly improved Drill with horse-hoes I procured a few days since, and have already used it upon 60 acres of land, in drilling wheat; and, as far as I am able to judge, it will turn out a real

real improvement. In juſtice to the inventor, I have only to obſerve that Mr. Cooke has exhibited a wonderful diſplay of mechanical knowledge, not only by ſimplifying, but by adding to the ſame, a method of horſe-hoeing without any additional apparatus, and has thereby rendered to this country an everlaſting ſervice.

I am, Sir,

To Mr. C. Cooke, Your moſt humble ſervant,

Pater-noſter Row, London. JOHN BOOTE."

On inſpecting the Tranſactions of the Society of Arts ſince the receipt of the preceding letter, we find a gold medal was adjudged to Mr. Boote, by that Society, as being the cultivator who had brought the drill ſyſtem to the greateſt perfection, he having drilled near *five hundred acres* of grain in one year, and with amazing ſucceſs.

Deſirous of procuring every information that could be obtained on this very valuable machine, we applied to Mr. Baldwin, of *Clapham Park, Surrey*, who favoured us with the following obſervations, in a letter addreſſed to the publiſher.

"SIR

"As I perceive you treat largely on Agriculture, in the well digeſted and uſeful Dictionary of Arts and Sciences you are publiſhing, and being always happy in doing juſtice to merit, I cheerfully avail myſelf of an opportunity to inform you, that I have ſucceſsfully uſed the Rev. Mr. Cooke's Drill Machine for two years paſt. I mean his firſt, for which he obtained his patent about four years ago, and has, I believe, ſold ſeveral hundreds of them; and which appeared to me ſo well adapted to the work for which it was intended, that I really had no idea there was a poſſibility of rendering it more uſeful and perfect. Juſtice to Mr. Cooke calls upon me to ſay, that I have this ſeaſon drilled ſeveral fields of wheat with his new improved drill, for which I underſtand a new patent is granted, and find it manifeſtly improved in every reſpect; all its parts being under the eye of the ploughman, and their deſign and uſe evident to every huſbandman; and, by making a ſet of horſe-hoes part of the whole, it is now become the moſt perfect inſtrument ever yet offered to the public, and to thoſe who known the ſuperiority of the drill huſbandry over the broad-caſt. As from experience I known the great advantages which attend the drill ſyſtem, from the ſame convincing evidence I find the Rev. Mr. Cooke,s Drill Machine equally ſuperior to every other which I have ſeen or tried; and I aſſure you I take every opportunity of informing myſelf as well by obſervation as experiment.

"I write in haſte, and have only time to add, that, in the European Magazine for September laſt, page 214, you will find a letter I wrote to the Editor on that ſubject. I am, Sir,

Mr. Cooke, Your moſt humble ſervant,

Paternoſter-Row, London. CHRIS. BALDWIN."

The following ideas on drilling, hoeing, and other matters relative to this mode of huſbandry, which were never before publiſhed, were commmunicated to us by the Rev. Mr. Cooke, to whom we have been previouſly indebted for the account of the *Chicorie Sauvage*. As this gentleman's abilities and experience render him ſo well qualified to enlighten the uſeful Art of Agriculture, we ſhall lay his information before our readers without further preface.

OBSERVATIONS on PRACTICAL DRILLING, &c.

By the Rev. JAMES COOKE.

"From the extraordinary ſucceſs which has attended a proper uſe of the ſyſtem of drilling and hoeing in general, individuals, in hopes of equal ſucceſs, have been induced to adopt the ſyſtem under ſuch abſurd practices as could only ſerve to bring it into diſrepute; not only by uſing the drill upon land ſhamefully exhauſted, and otherwiſe ſo foul, and out of condition, as to afford no hopes of ſucceſs whatever, but alſo by neglecting the uſe of the hoe entirely.

"To thoſe who wiſh to adopt the drill ſyſtem with ſucceſs, it is ſtrongly recommended, never to ſet two exhauſting crops together, but an exhauſting and an ameliorating one alternately. Wheat, rye, barley, and oats, are called exhauſting crops; beans, peaſe, vetches, turnips, cabbage, potatoes, and all kinds of artificial graſſes, are called ameliorating ones. It would be abſurd to ſuppoſe that one particular rotation of crops, ſelected from the above, ſhould be invariably adapted to all ſoils. It muſt remain with the cultivator to diſcover whether a better proceſs can be found out, than a bean fallow, &c. as a preparation for wheat upon ſtrong clays, and a turnip fallow, &c. as a preparation for barley, upon light ſoils; and whether one or the other may be better adapted to the cultivation of wet or dry, light or ſtrong loams, as times, ſeaſons, and circumſtances may point out.

"The following hint for obtaining four valuable crops in two years, from the ſame land, is ſubmitted to the conſideration of active cultivators of ſtrong productive ſoils, to make the experiment by drilling beans in rows at two feet apart, the land being previouſly manured, and properly cultivated. In the month of June, the ſpaces between the rows of beans being perfectly cleared from weeds, and the ſoil pulverized by repeated horſe-hoeing, two rows of turnip ſeed may be drilled in each ſpace, at twelve inches apart, by the above drill machine, particularly as the direction of the coulters is now ſo readily influenced; or, if th crop of beans ſhould be too high to admit of the uſe of the machine for drilling the turnip ſeed as above, a ſmall hand drill may be made and uſed for the purpoſe. When the beans are drawn and carried, the land will be ſtocked with a young crop of turnips, in rows at twelve inches apart, which will admit of the uſe of the horſe-hoe, in clearing the ſpaces between the rows of turnips from weeds, &c. In the middle of theſe ſpaces wheat may be drilled in October, or any other period previous to the turnip crop being ſo luxuriant as to exclude the proceſs. In the ſpring the turnips and young crop of wheat may be fed off together by ſheep, or the turnips may be drawn; by which means the turnip crop will be extirpated; but the young plants of wheat will remain, to go on for a crop, in drills or rows at twelve inches apart, which will admit of horſe or hand-hoeing, as in other inſtances. At the laſt hoeing of this crop of wheat, turnip ſeed, rape or cole, &c. may be diſtributed in the intervals, which will afford great plenty of food for ſheep or cattle in the winter. This proceſs of obtaining four crops in two years has but lately occurred to me; it will ſpeedily be put in practice, and in the hands of activity and induſtry, I have no dubt of its ſucceſs, ſuperior, perhaps, to any other rotation of crops heretofore adopted.

"Practical as well as ſcientific agriculturiſts in the drill ſyſtem have differed, and ſtill differ, in their opinions reſpecting the moſt advantageous diſtance at which grain ſhould be depoſited in rows or drills. If it is in my power to throw any light upon this undetermined point, I ſhall eſteem the attention I have paid to the circumſtances not altogether uſeleſs.

"In the year 1784 I made an experiment in order to aſcertain the moſt advantageous diſtance for drilling, by depoſiting wheat in rows, at different diſtances, of from 4 to 24 inches apart, varying 2 inches each diſtance; ſo that the progreſſive order of the different diſtances ſtood 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24 inches. During the growth of the experiment, the ſpaces between the rows were all hoed at ſeaſonable times, as well as the reſpective diſtances would admit of. At harveſt the rows were ſeparately reaped, when it appeared that the produce from the rows No. 10 and 12 were nearly equal, but ſuperior to any of the others. As I intended to make the public acquainted with the reſult of this experiment, I was very particular in ſtating the exact produce of each reſpective row; but the paper is now loſt or miſlaid, on which account I am induced to ſubmit to the conſideration of the curious a mathematical plan for aſcertaining the moſt approved diſtance for drilling and hoeing, in hopes of exciting a number of practical drillers to make experiments, in order to aſcertain, upon different ſoils, the moſt advantageous diſtance.

"It is univerſally allowed by ſcientific, and incontrovertibly proved by multitudes of practical drillers, that their crops have been conſiderably improved by the ſoil being thrown up to the rows of corn, ſo as to cauſe fibres to iſſue from the firſt joints of the ſtems above the ſurface of the land, which, without much accumulation of the ſoil to the plants, would never have exiſted.

"This premiſed, it appears reaſonable to diſcard drilling at every diſtance which will not admit of the ſoil being earthed up to the plants as above, which happens to be the caſe with drills at every diſtance under 10 inches apart, ſuppoſing the firſt joints of the ſtems to be formed two inches above the ſurface of the land, and the depth of the hoeing to be performed two inches under the ſurface.

"In order to demonſtrate the truth of this propoſition, I cauſed a drawing to be made, which I intended to preſent to the Society for the Encouragement of Arts, &c. but as the gentleman who compoſed the Syſtem of Agriculture for Mr. Cooke's New Royal Encyclopœdia, on ſeeing this drawing, expreſſed a deſire of introducing it in that ſyſtem, I complied with his requeſt; and I flatter myſelf that the diſtance above ſpecified, from the reaſons aſſigned, and which are illuſtrated by the plate annexed, will appear ſatisfactory, and that the diſtance of *ſeven* inches recommended by Mr. Winter, is upon erroneous principles.

EXPLANATION of PLATE I. *Fig.* 1.

"It is ſelf-evident that half the quantity of ſoil diſplaced by the hoe, and contained in the triangle DEF, Pl. I. *Fig.* 1. will be required to fill the triangle GHI, ſo as to reach the firſt joints of the ſtems C above the ſurface of the land; but ſoil in a dry, pulverized ſtate, as it ought to be when it is earthed up by the hoe to the rows of corn, will not reſt or remain ſtationary at an angle greater than 45 degrees, or the inclination GF. Therefore, in order that fibres may be encouraged to iſſue from the firſt joints of the ſtems above the ſurface of the land, by means of the ſoil being diſplaced by the hoe, and earthed up to the ſaid joints C, the ſpaces between the rows of corn muſt be ſuch that the triangle DEF and GHI will be equal, as in fact they will be when the ſpaces between the rows of corn are 10 inches apart.

"On the other hand, if the ſpaces between the rows of corn are leſs than 10 inches, ſay 7 inches wide, *Fig.* 2. (and I here allude to the diſtance of ſeven inches for Mr. Winter's ſerious and candid conſideration, ſince he avers it to be the moſt advantageous

taneous diſtance,) in that caſe, if fibres muſt be encouraged to iſſue from the firſt joints of the ſtems C, above the ſurface of the land, a column of ſoil equal to the triangle GHI will be required to earth up the plants to the ſaid joints C; but as the triangle GHI exceeds the triangle DEF, ſo will be the deficiency of ſoil required for earthing up the plants to the joints C, as it will not reach the joints; in which caſe the idea of cauſing fibres to iſſue from the ſaid joints C, by means of the ſoil being earthed up to the ſpaces drilled at 7 inches apart, as above, is manifeſtly abſurd.

"Individuals have wounded the reputation of the drill ſyſtem materially, and retarded its progreſs, by attempting to introduce it upon their lands, with an eye to the circumſtance of drilling only for ſucceſs, without paying the leaſt attention whatever to the circumſtance of hoeing, whereas nothing could be more abſurd. When the hoe is conſidered as the immediate and moſt eſſential cauſe of ſucceſs in drilling, and the machine as an accommodation to the hoe, the extraordinary ſucceſs which has attended a proper and ſeaſonable uſe of both, in numberleſs inſtances, will ceaſe to appear any longer myſterious to thoſe who have made an improper uſe of the drill, and totally neglected the uſe of the hoe. If weeds are ſuffered to grow all over the ſpaces between drills at twelve inches apart, the chance of their choaking the corn will be in their favour, nearly as 11 to one; whereas if the weeds are all cut up by the hoe when young, the triumphant ſtate of the crop over weeds will then be as 12 to 0.

"Wheat and rye cannot be hoed too early in the ſpring, provided the ſoil is dry enough to admit of being previouſly rolled. Nothing facilitates and expedites hoeing ſo much as rolling, by pulverizing the ſoil, and levelling the ſurface; but ought by no means to be done when the ſoil is not dry enough to quit the roller.

"The wings or moulding plates of the hoe, which are calculated to earth up the ſoil to the rows of corn, ſo as to cauſe roots to iſſue from the firſt joints of the ſtems above the ſurface, which otherwiſe would not have exiſted, ſhould never be uſed for the firſt hoeing; they ought always to be uſed for the laſt hoeing, except when land is to lie down with ſeeds; and uſed, or not uſed, at the option of the farmer, when any intermediate hoeing is performed. The laſt hoeing, or earthing up, ſhould not take place till the crop is eight or ten inches high, or till the young ears of corn are ſo far advanced in the ſtems as to be above the ſurface of the ſoil, when the earthing up is finiſhed. The young ears of corn will, on diſſecting a few ſtems, be found to exiſt (in embryo, as it were) much ſooner than is generally apprehended.

"The abſurdity of rolling any crop after the young ears are formed, and of earthing up the ſoil before they are advanced in the ſtems above the ſurface of the ſoil, muſt be ſelf-evident. In the former inſtance they will be cruſhed by the roller; in the latter they will be ſmothered by the ſoil. The young ears of corn will be found to exiſt as ſoon as the ſecondary or coronal roots are formed. The above obſervations on hoeing wheat and rye are applicable to the hoeing of ſpring crops; only the firſt hoeing of barley, oats, &c. ſhould take place as ſoon as the ſecond blade or leaf of the young ſtem appears; and of beans, peas, &c. as ſoon as the plants may be diſtinguiſhed in the rows.

"The beſt ſeaſon for hoeing is two or three days after rain, or ſo ſoon after rain as the ſoil will quit the inſtrument in hoeing. Light dry ſoils may be hoed almoſt any time; but this is far from being the caſe with ſtrong clay ſoils. The ſeaſon for hoeing ſuch is frequently very ſhort, and precarious; every opportunity, therefore, ſhould be attentively watched, and eagerly embraced. The two extremes of wet and dry are great enemies to vegetation in ſtrong clay ſoils: the bad effects of the former, though difficult to guard againſt, are, nevertheleſs, to be remedied, in ſome meaſure, by ploughs of a better conſtruction, and more properly conducted, than ſuch as are commonly met with in moſt ſtrong ſoils. For if the wing or feather of one plough-ſhare was made nearly as wide as the intended furrow, and fixed ſo as to work parallel to the ſurface of the land, the underſide of every furrow would be cut parallel to the ſurface; and a ſmooth under-floor, poliſhed by the bottom of the plough, would be found beneath every furrow, forming a regular plain, with an uniform deſcent from the top of the ridge into the water furrows; upon which poliſhed floor all ſuperfluous water, after filtrating through the looſe ſoil, or furrows turned over by the plough, would readily find its way in the water-furrow, which would prevent its ſtagnating in the ſoil, or at leaſt ſo as to ſtarve the plants. But ſo far from guarding, as much as poſſible, againſt the ill effects of ſuperfluous water, thus ſtagnating in clay ſoils, the conſtruction of the ploughs, commonly made uſe of in ſtrong clays, and the method of conducting them in many parts of this kingdom, have a direct tendency to the contrary: this is done by working their ploughs in ſuch a poſition, that the wing or feather of the ſhare, being neither ſo wide as the intended furrow, nor parallel to the ſurface when at work, but forming an angle of forty or fifty degrees with the ſurface, or, in other words, moving in an oblique direction to the ſame, turns over, not a ſquare or parallel, but a triangular furrow; in which caſe it is ſelf-evident, that ſuch lands are only half ploughed; that there will be ſo many ridges of faſt undiſturbed ſoil, as there are furrows forming ſo many troughs or trenches; and that, of all the ſuperfluous water that ſhall fall upon ſuch lands, ſo much only as ſhall remain over and above filling the trenches, will be able to find its way into the water furrows: for ſome clay ſoils, indeed, all ſoils, when puddled, will hold water; conſequently ſo much water as the above trenches ſhall contain, will remain there, till it is evaporated by ſun and air, ſtarving the plants, and puddling the ſoil to ſuch a degree, that the nutritive quality in the food of plants becomes ſo far impaired as not to be reſtored; or, if it ſhould, the tender fibres of the roots of plants may be turned to putrefaction, ſo as to be incapable ever after of anſwering their intended purpoſe in promoting vegetation.

"As to the bad effects of ſtrong clay ſoils caking in dry weather, nothing is more eaſy to prevent; for there is a period, between the time that clay ſoils run together, ſo as to puddle, by ſuperfluous wet, and the time of their caking upon the ſurface, that they are as tractable as need be: now this is the period, this is the juncture for hoeing; and ſo much land as ſhall be thus ſeaſonably hoed, will not cake or cruſt upon the ſurface, as it otherwiſe would have done, till it has been ſoaked, or drenched again with rain; in which caſe the hoeing is to be repeated, as ſoon as the ſoil will quit the inſtrument, and as often as neceſſary; by which time the crop will begin to cover the ground, ſo as to act as a ſcreen to the ſurface of the land, againſt the intenſe heat of the ſun, and thereby prevent, in a great meaſure, all the bad effects of the ſoil's caking in dry weather.

"When land is to be laid down with ſeeds, the ſeeds muſt not be ſown as uſual when the grain is ſown, but the day the laſt hoeing is to be performed. If ſeeds are ſown when barley is ſown, hoeing is excluded, conſequently the great advantages of drilling are loſt; but not being ſown till the laſt hoeing is juſt going to take place, every purpoſe is anſwered: for the crop is not only improved by hoeing, but the ſoil in the ſpaces between the rows of corn, being cleared from the weeds, and pulverized by hoeing, will be in a much better condition to receive the ſeeds; and the ſeeds being ſown broad-caſt, juſt before the laſt hoeing, will be incorporated with the ſoil by the action of the hoe, ſo as to vegetate better, and produce a much ſuperior crop. A ſmall and ſimple apparatus being added to the machine, graſs ſeeds may be depoſited in the ſame drills with the barley, and at the ſame time; alſo in the ſpaces between the rows of corn, at the laſt hoeing.

"Such ſtrong weeds as may grow in the rows of corn, and out of the reach of the hoe to cut up, ſhould be plucked up by hand, to prevent their coming to maturity, and dropping their ſeeds upon the ſoil, that has been previouſly made clean by hoeing. It is here obſerved, that, where this method of ſowing graſs-ſeeds before the laſt hoeing is intended to be put in practice, the crop (which is generally barley) ſhould be ſown early, at leaſt within the month of March, or by the middle of April, that the graſs-ſeeds may have time to vegetate before the hot weather commences, otherwiſe they may be burnt up by the intenſe heat of the ſun, as they ſpring out of the ground; which has been the caſe in a few inſtances, where the barley was not ſown before the month of May: and the cauſe of a failure in graſs-ſeeds has been very erroneouſly attributed to the above proceſs of ſowing them before the laſt hoeing; whereas the true cauſe of the failure has ariſen from ſowing the barley crop too late, and thereby poſtponing the ſowing of the graſs-ſeeds at the laſt hoeing ſo long, that the intenſe heat of the ſun has burnt them up as they have vegetated.

"Where a crop from the graſs-ſeed is of the utmoſt conſequence to a farmer, and the barley cannot poſſibly be ſown early enough to admit of the graſs-ſeeds being ſown at the laſt hoeing, it is recommended to ſow the graſs-ſeeds as in the uſual way, when the barley is ſown, and forego the advantages of hoeing. In this inſtance it may be aſked, Wherein conſiſt the advantages of drilling, if hoeing is excluded? In this caſe the advantages of drilling will conſiſt in ſaving more than half the ſeed, and producing a crop ſuperior to broad-caſt or hand ſowing, though not ſo great as if hoeing had taken place.

"To enſure ſucceſs in drilling, it is of the greateſt conſequence that land be reduced to a proper ſtate of cultivation previous to the time the proceſs of drilling takes place; in which caſe a crop equal to the production of the ſoil may reaſonably be expected, provided the buſineſs of hoeing is properly attended to, and ſeaſonably performed.

"In ten days or a fortnight, more or leſs, after ſpring corn is ſown, the tillering, or multiplying of the additional ſtems of offſets, will commence: the number of theſe additional ſtems, or offſets, will uniformly be in proportion to the quantity of pabulum, or food of plants, contained in the ſoil at the time the above tillering of the ſtems commences; and the nett produce of any given crop will generally be in proportion to the number of ſtems ſo tillered; conſequently, in order to obtain the beſt crop of corn, which any given land is capable of producing, it is eſſentially neceſſary that the ſoil ſhould be in the beſt ſtate of cultivation, of which it is capable, at the time the grain or ſeed is depoſited in the land. On the contrary, if grain or ſeed

is ſown when the ſoil is out of condition, i. e. not properly pulverized and ameliorated for the reception of the ſeed, which frequently happens when the ſowing of the ſeed takes place immediately after the plough, on a freſh, waxy furrow, in which caſe, if a dry ſeaſon ſhould ſet in, the greateſt part of the pabulum, or food of plants, will, during the dry ſeaſon, be ſet faſt, and locked up in the dry hard clods, the tillering will nevertheleſs begin to take place at the uſual time, viz. in ten days or a fortnight after the ſeed is ſown, without waiting for ſo much of the pabulum, or food of plants, as was ſet faſt in the dry clods, being ſet at liberty to aſſiſt vegetation, and will conſiſt of ſo many ſtems or offſets, as the pabulum, or food of plants, contained in the looſe pulverized ſoil only, ſhall be able to ſupport, and bring to maturity. Afterwards, when rain comes, and ſets at liberty ſo much of the pabulum, or food of plants, as was locked up in the dry clods when the above tillering was performed, there will be a ſurplus of pabulum to ſpare, over and above what was neceſſary to bring to maturity: the number of ſtems tillered as above this additional pabulum will prompt an additional number of ſtems at an unſeaſonable time, which, ſo far from adding to the crop at large, will amount to a conſiderable drawback upon it. This is eaſily obviated, and many advantages derived, by ploughing up all ſtrong ſoils, intended for cropping, before Chriſtmas, or as ſoon after as may be, in order to have the benefit of froſt and ſnow, which will, by pulverizing and ameliorating the ſoil, prepare it for the reception of the ſeed, much better than all the ploughing and harrowing in the world can poſſibly do, at, or juſt before, the time of ſowing grain or ſeed.

"It is well known that all ſoils, and eſpecially ſtrong wet ſoils, are pulverized and ameliorated by froſt. If the cauſe of theſe effects were as well underſtood as the effects themſelves are viſible, one would think there could not be found a ſingle cultivator of land who would not gladly avail himſelf of the means of his land being thus pulverized and ameliorated, without the labour of men and horſes, or any other expence but that of ploughing up his land before winter. It is not by reaſon of the effects which froſt has upon the ſoil, (for upon a dry ſoil froſt has no power at all,) but upon the water contained in the ſoil, that the ſoil becomes pulverized and ameliorated. It is very eaſy to conceive a given quantity of water, contained in a given quantity of ſoil, to be divided into an almoſt infinite number of globules, or particles, each capable of being conſiderably enlarged and expanded by froſt. But, before one of theſe particles of water can become conſiderably expanded and enlarged by froſt, ſo as to occupy a larger ſpace, in its congealed ſtate, than it occupied in its watery ſtate, the texture of the particles of ſoil contiguous to, and ſurrounding, the ſaid particle of congealed water, muſt be torn to pieces in giving way to the enlarged particle of congealed water.

"In like manner, the whole given quantity of water, contained in any given quantity of ſoil, by being enlarged and expanded by froſt, will break and tear to pieces the texture of the whole ſoil, in yielding to the ſuperior force of the congealed water, as it expanded; by which means the ſoil, by being thus torn to pieces, will not only become pulverized and ameliorated, but, in proportion as the pores are thereby opened, ſo will be the quantity of pabulum, or food of plants, imbibed from the atmoſphere. From whence it may be juſtly and truly ſaid, that, if land is only ploughed before winter, it will become more or leſs tilled, manured without labour or expence, and ready for the reception of ſeed in the ſpring.

"For the above reaſons I apprehend it is, that ſeveral of my agricultural correſpondents, who ſpend a conſiderable ſhare of their time and attention to improvements in cultivating the ſoil, are fond of drilling upon what they call a ſtale furrow, i. e. when land has been expoſed to the influences of the atmoſphere, for ſome time after it is ploughed, previous to the time of ſeedneſs.

"As far as my obſervations and experience have extended, no one need fear drilling a piece of land, though it ſhould not be ſo clean from weeds as might be wiſhed, provided the ſoil is powerful and productive, and reduced to a proper tilth for the reception of the ſeed; for it will be in vain, during the growth of that crop, to retrieve the loſs which will uniformly attend ſo groſs a neglect.

"However doubtful it might be a few years back, whether the ſyſtem of drilling would ever become general, there is now every reaſon to believe that it will, in a few years more, become the prevailing ſyſtem with all the active, the induſtrious, and enlightened cultivators of this iſland. Indeed, it is already become the favourite ſyſtem with multitudes, upon ſo extenſive a ſcale, that individuals, who, through an improper uſe of the ſyſtem, have not had equal ſucceſs, begin to find themſelves hardly at liberty to condemn it, as that would ſubject them to the reproach of their more ſucceſsful friends and neighbours, but ſeem rather diſpoſed to adopt their ways and methods: by this means many converts are daily made; and as one ſingle convert will make many more, there is every reaſon to believe that the ſyſtem will ſoon become general: and, whenever that period arrives, I can, with the greateſt propriety, and without fear of running into error, pronounce the produce of grain in this kingdom to be vaſtly ſuperior to what it is at the preſent time."

On the DRILL HUSBANDRY, *by Mr.* WILLIAM DANN, *of* Gillingham, Kent.

"SIR, "Gillingham, Nov. 2, 1791.

"I this day received the 94th Number of the Annals, and a deep ſnow falling (in the midſt of my potatoe harveſt) at the ſame time, gave me an immediate opportunity of peruſing it. I therein obſerve (p. 523.) your doubts of the good effects of the drill, and am therefore induced to ſend you the reſult of an experiment on half an acre of wheat, completed in Auguſt, 1791: and although it may not convince you of the ſuperiority of the drill, yet I cannot but think that a *ſufficient number* of like *facts* only are wanting to make at leaſt ſome impreſſion on you; and muſt, at any rate, be an additional proof of the advantage ariſing from the practice.

"Whatever might be the appearance of Mr. Goldby's barley (p. 523.) I have no ſcruple in aſſerting, that my barley crop, even *this year*, will be a good one; ſuppoſe near five quarters an acre, excluſive of the tythe; and that in the two preceding years it was much better than in the two moſt productive ones of the 20 years before; yet I can aſſign no reaſon for its being ſo, but that I then *drilled* and *horſe-hoed*.

	Buſh.	Quarts.
Half an acre with wheat (a clover lay) drilled, produced	15	8
Ditto adjoining, ſown by hand (in the middle of the field) produced	14	5
In favour of the drilled	1	3

"Which, at 6s. the buſhel, is about 13s. an acre, excluſive of 2s. more ſaved in ſeed: and I beg leave to ſay, that I think Mr. Cooke warranted in aſſerting, 'that wherever the drill ſyſtem is practiſed with *attention*, it will increaſe the produce nearly equal to the rents.' And give me leave to ſay alſo, that if I ſhould ever have the pleaſure to ſee you here, I will ſhew you the aggregate produce of my farm for the time I have been a driller.

"The ſoil, cultivation, time of ſowing, and harveſting the above, were the ſame; except horſe-hoeing the drilled part once, and half a buſhel an acre leſs of ſeed on that than on the other part.

"I remain, with the greateſt deference and reſpect, Sir,
Your moſt humble ſervant,
W. DANN."

On the DRILL HUSBANDRY, *by* LEWIS MAJENDIE, *Eſq.*

"DEAR SIR, "Heningham Caſtle, Eſſex, March 6, 1792.

"I have long wiſhed to trouble you with a few thoughts upon the intereſting ſubject of the drill huſbandry, but have hitherto been prevented by a variety of avocations, with which the farmer's life abounds. As far as the experience of a few years will reach, it appears to me, that, amidſt the various ſyſtems of agriculture which have lately occupied the thoughts of practical men, few ſeem likely, under proper reſtrictions, to produce advantages of a higher nature than that of the drill huſbandry. I have received great pleaſure from its practice for ſome time paſt; and, by generally confining it to ſoils adapted to this mode of culture, I have conſtantly obſerved a decided ſuperiority to the uſual method of ſowing by hand. It is not to be denied, that this valuable ſyſtem cannot be introduced indiſcriminately on all ſoils; thoſe who think ſo will aſſuredly find themſelves deceived in practice. One great object, amongſt others, in this mode of culture, is the depoſiting the ſeed at a regular and ſuitable depth: a ſecond, which is, indeed, indiſpenſible, and, as it were, the ſoul of the ſyſtem, is the active operation of the hoe. There are many ſoils which, from a variety of cauſes, will neither admit the one or the other. To attempt the introduction, therefore, of this practice, in ſuch caſes, would be empty labour: but on ſoils which, from their lightneſs, friability, or other practicable quality, are acceſſible to theſe two grand objects, I cannot heſitate, from my own experience, to ſay, that the drill huſbandry is likely to prove ſucceſsful in a very eminent degree; for, by enabling the cultivator, from time to time, to open and expoſe the pores of the earth to the vegetative principles of the atmoſphere, and at the ſame inſtant to check, and, for the moſt part, deſtroy the weeds, the ſoil, relieved in a great meaſure from ſuch unwelcome gueſts, *inſtantly* exerts its whole powers in bringing the crop

The BINDER *is deſired to obſerve that this* Sheet (F f 1) *is to be placed before* Sheet (F f 2) *in this Number, it being an* Additional Sheet *to the* SECOND *Edition of this Work.*

with which it is ſown to its higheſt perfection. Beſides, each hoeing ſeems to introduce the effects and benefits of a *tilth* to the land during the growth of the crop; an advantage not to be derived from any other mode of culture: hence reſults that general cleanlineſs on drilled ſoils which are properly attended, and which, by keeping them in heart, diſpoſes them to the future reception of a well-regulated rotation of crops, to the diminution of that waſte of time neceſſary to conſtitute what is called a complete fallow.

"I commenced the practice of this ſyſtem in October, 1786, and have had no reaſon to diſcontinue it ſince. I ſeldom ſow leſs than forty acres of wheat yearly with the drill; ſometimes more. I have alſo occaſionally ſown barley, beans, and turnips; but the crop to which my attention has been principally directed is wheat: I ſhall therefore trouble you with a ſhort account of ſeveral crops of this grain. October, 1786, a field of four acres, two roods, (a red clover-lay ſeeded,) was ſown with four buſhels and two pecks of wheat, or four pecks per acre, at an interval of twelve inches. The crop was three times hand-hoed in the ſubſequent ſpring. Produce, thirty-ſix coombs, or four quarters per acre. The inſtrument uſed, was the firſt of thoſe introduced by the Rev. Mr. James Cooke, with hand-hoes. Since this period a variety of eſſential improvements have been made to it, chiefly the *horſe-hoe*, by the uſe of which much labour is ſaved, and the operation of hoeing performed with greater effect and benefit to the ſoil.

"November, 1787, a field of four acres (a red clover-lay twice mown) was thus ſown; half by hand, at ten pecks per acre; the other half by the machine, at ſix pecks per acre, and at nine inches interval; the crop was hoed once in the month of *January*, 1788, and twice in the ſpring following.

Produce of the two acres drilled -	21 coombs
Produce of the two acres broad-caſt	17

Superiority of coombs on the drilled land 4 coombs,

which is ſixteen buſhels, or eight buſhels per acre, ſuperior to the broad-caſt crop. The land was a rich loamy earth, in the greateſt condition, having been highly manured (previous to the clover crop) in November, 1786.

"Auguſt 29, 1788, a field of ſix acres was ſown with ſix pecks of wheat per acre, at an interval of nine inches. It had been a clover-lay, but the plant dying in places, it was ploughed up in June, after which two more earths were given, and it was ſown as above. The firſt hoeing took place on the 8th of *October*, after which the crop flouriſhed greatly, and improved progreſſively from that period. The firſt hoeing to this and the preceding field may ſeem unſeaſonably early: but though it is moſt uſual to defer this operation till the ſpring, I have, in more than one inſtance, obſerved great benefit from hoeing in the autumn, or early in the winter, if the weather will permit, eſpecially when the crop has been ſown unuſually early, as in the preſent caſe. The land was in the loweſt ſtate of impoveriſhment, having juſt fallen into my hands, at the expiration of an eighteen years leaſe. The beſt farmers around me thought it unlikely that the field would return the ſeed ſown: the produce, however, amounted to thirty-five coombs, four gallons, and three pints, or ſomewhat more than twenty-three buſhels per acre. The ſecond and third hoeings were given on the 2d of February and 7th of April, 1789; and ſuch was the viſible effects of theſe operations upon the crop, that I muſt attribute great part of the produce to the hoe: and, from the reduced ſtate of the land, the moſt intelligent of the neighbouring farmers allowed, that the ſucceſs attending the crop was cauſed by this particular mode of ſowing, together with the ſubſequent uſe of the hoe.

"September 17 and 18, 1790, part of a field of ſixteen acres was divided into two exactly even parts, each meaſuring four acres, thirty-ſix perches; theſe were ſown on the above days; the one broad-caſt, at nine pecks and a half per acre; the other by the machine, at ſeven pecks per acre, and at nine inches interval. The field was a white clover-lay ſeeded. The part ſown by hand worked tolerably well; whilſt the coulters, from the dryneſs of the ſeaſon at the time, and the toughneſs of the creeping roots of the clover, were ſo impeded, that the ſeed was badly depoſited, and in many places remained on the ſurface. The broad-caſt ſeed, by repeated rollings and harrowings, was ſo well covered, as to come up a complete plant, whilſt the drilled appeared at beſt irregular, and in ſome ſpots had failed. I had no hopes from the compariſon. Nothing, indeed, but the determination that both methods of ſowing ſhould take place at one and the ſame time, would have induced me to have uſed the drill at all, under ſuch untoward circumſtances. During the growth, the general appearance was in favour of the broad-caſt crop, though the ears of the drilled were largeſt. The whole was harveſted the 12th of Auguſt laſt, and carefully ſeparated in the barns.

	Coombs.	Buſh.	Pecks.
Produce of the drilled crop -	23	1	2
Produce of the broad-caſt crop -	22	0	0
Superiority in the drilled crop -	1	1	2

Weight of the buſhel of drilled corn, of 8¼ gallons, excluſive of the ſack - - - - -	lb. 66¼
Weight of the buſhel of broad-caſt ditto - -	65¼
Superiority in weight of the drilled corn per buſhel	001

"Had the land, when ſown, been in proper order for the machine, the ſuperiority of the drilled crop would doubtleſs have been greater: but, in the whole proceſs of the drill huſbandry, little ſhort of diſappointment can be expected, unleſs the ſoil is in ſuch order as to admit the uninterrupted progreſs of the coulters. I have, therefore, regiſtered this experiment (which, under all circumſtances, muſt appear to have failed) purpoſely to impreſs your readers with the impropriety of uſing the drill in any caſe on land which is not in a mouldy ſtate. Though the ſuperiority to the broad-caſt is ſtill maintained in the above produce, it is too inſignificant to be of any account; and certainly had the drill ſyſtem no higher temptations of advantage to hold out than the above, it would long ſince have fallen into contempt and diſuſe.

"When I firſt commenced the practice of drilling my crops, the country around me were ſtrangers to the idea; it was exploded by the beſt farmers, who treated all reaſoning in its favour with contempt; and the notion of its ſuperiority, in any ſhape, to the broad-caſt mode, as viſionary. Since this, however, it has been a great ſatisfaction to me to obſerve many of the beſt informed amongſt them relax from their former opinions; and having commenced the practice on a ſmall ſcale, and, after comparative trials, found a ſuperiority to the former mode, have proceeded to more extenſive experiments. This is the deſired period for which I have waited; for when the common farmer is perſuaded to abandon prejudice, and to give a fair trial to any new practice in his art, from which he diſcovers an advantage, his ideas are inſtantly diſſeminated, and his example is imitated.

"It has frequently been ſaid, that drilled wheat muſt generally be more ſubject to the mildew than broad-caſt, from the ſmall quantity of ſeed ſown. Certain it is, that, on many ſoils, thin ſowing is conſtantly followed by the mildew; but, in behalf of the drill ſyſtem, it may be obſerved, that, though the quantity of ſeed ſown is, indeed, comparatively ſmall, it is delivered into, and grows in the drills, as thick as any broad-caſt whatſoever; hence it ſhould ſeem to follow, that in thoſe particular drills (as far as thick ſowing may be proved to be a preventative to this baneful viſitation) there ſhould appear as little of it in the one as the other proceſs. Indeed, in the courſe of my experience, I have never remarked that drilled crops were more attacked by the mildew than others, but rather the reverſe. Neither has it ever appeared to me, that effects ſimilar to the mildew have reſulted from the more active and frequent uſe of the hoe, although the crop, immediately after that operation, generally aſſumes a ſtrength and beauty of vegetation to juſtify ſuch an idea.

"Another advantage of the drill proceſs is, that the ſample is more even, and that there certainly is leſs *tail*, or off-corn, than in broad-caſt crops. To the moſt common obſerver it muſt appear, that the ears of corn are larger, and of a more regular ſize, in a drilled, than in a broad-caſt field of wheat; that the grains in each caſe are alſo more even, and that there are by far leſs ſmall ears in the former than the latter; hence it reſults, that the produce of a *marketable* commodity is greater from the one than the other, and that there is leſs refuſe, or tail corn. In the autumn, 1790, I ſowed a field of four acres (a tare ſtubble ſeeded) with ſix buſhels of wheat, at an interval of nine inches: the produce 36 coombs; and *two buſhels only* of tail corn from the *whole* field, which, had it been ſown by hand, would hardly have been the caſe. I have frequently made other comparative experiments, on a ſmall ſcale, for amuſement, as well as to confirm or reject the future uſe of the machine on my farm; in all theſe the ſuperiority has hitherto reſted with the drill, therefore I continue the practice. This is, however, to be underſtood of wheat only; to the culture of which I have chiefly confined the drill, and my comparative trials.

"But my chief happineſs is, that, having commenced this practice when it was unknown to the neighbourhood, it has inſenſibly fallen into abler hands than mine; I mean of thoſe who will not only ſtrictly attend to its intrinſic merit, but if, upon ſtricter trials than my experience in rural matters will admit, it does not bear them out, will abandon it altogether. This, indeed, was my ſole view in introducing the practice upon my farm; for I have always conſidered it as a pleaſing duty, incumbent on reſident country gentlemen, to practice, and encourage to conviction, every probable improvement in the admirable ſcience of agriculture, under which advantages may be ultimately derived to an induſtrious and highly valuable claſs of people, the farmers and tenantry of the country.

"The ſyſtem of drill huſbandry ſeems, on the whole, to gain ground, and to become daily an object of more general practice. Experiments will of courſe be multiplied, and every branch of the ſyſtem be minutely inveſtigated, ſo as to lead to a final deciſion, whether on ſoils ſuitable to this mode of cul-

New Invented Implements, used in Husbandry.
See System of Agriculture.

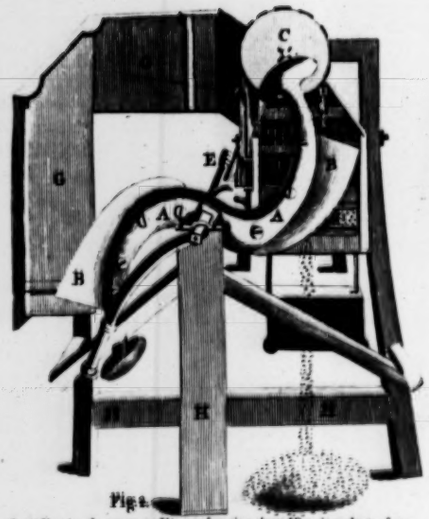


Fig. 2.

Chaff Engine the same as Fig. 3 taken in a front View, in order to shew more clearly the operation of the Knives as they revolve when at Work.

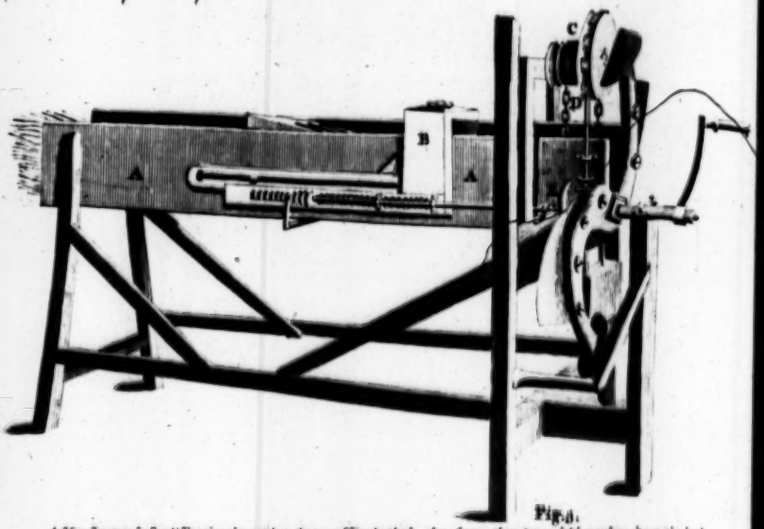


Fig. 3.

A New Invented Chaff Engine for cutting Straw or Hay for Cattle, also Sugar Cane tops, which renders it particularly useful for Sugar Plantations, as well as for the Purposes of Husbandry, Agriculture, and also for many other Uses.

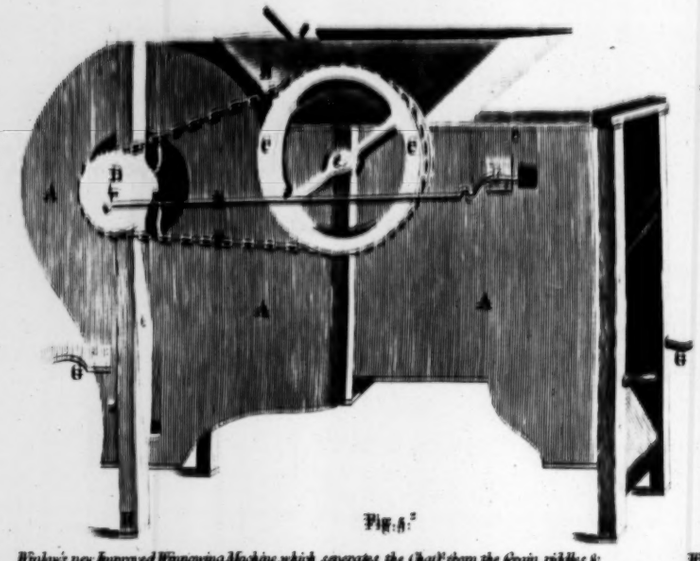


Fig. 5.

Winlaw's new Improved Winnowing Machine which seperates the Chaff from the Grain, riddles & Screens at one operation, it is equally useful for all kinds of Seed large or small Whatever.

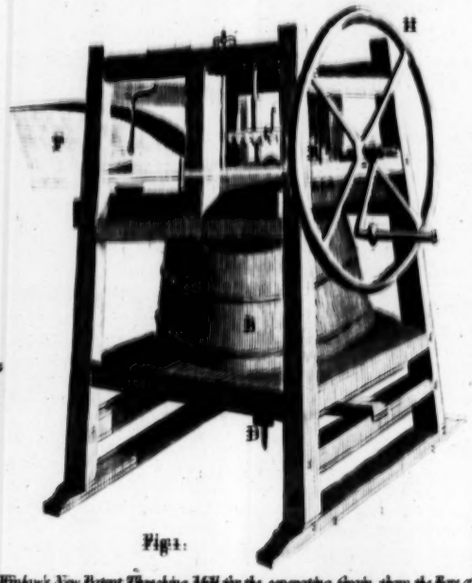


Fig. 1.

Winlaw's New Patent Threshing Mill for the seperating Grain from the Ears of Corn also Clover & other Seeds from the Husks instead of the laborious methods in general use.

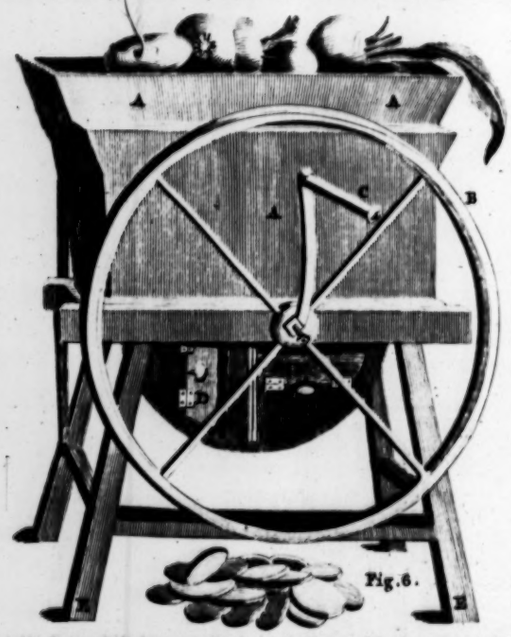


Fig. 6.

A New Invented Machine on a Simple Construction used for the purpose of Cutting Parsnips, Turnips, Potatoes, Cabbages, Carrots, Mangel, Worzel & other Roots for the use of Cattle.

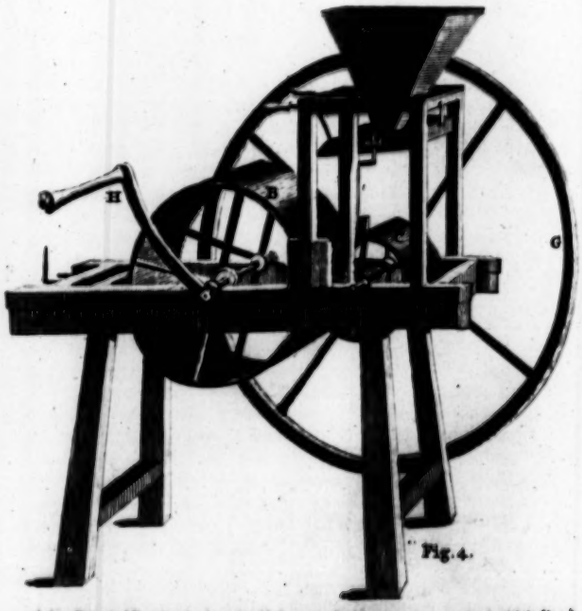


Fig. 4.

A New Invented Engine for bruising Malt, instead of the common method of Grinding it is useful also for Beans, and all kinds of Grain, given to Horses, and other Cattle.

Drawn by Milne.

Published as the Act directs, by C. Cooke No. 17 Paternoster Row. July 1st 1793.

Engraved by

ture, and in other reſpects equal, it is preferable to ſow by hand, or by the drill.

" I remain, dear Sir,
" Your very ſincere,
" And obedient humble ſervant,
" LEWIS MAJENDIE."

" P. S. From obſervations which have lately dropped from you upon the ſubject of drilling, I am led to think that its merits with you are highly queſtionable; and, perhaps, before this, you have made up your mind, upon the whole, in diſfavour of the practice. I am well convinced it can never become a *general* mode of culture. It has been aſſerted to me, that the drill could be introduced on *all* ſoils, even the moſt heavy and tenacious; the only difference between theſe and friable ſoils, in reſpect to the drill, being, that as the former require greater labour and attention to render them fit for the common mode of huſbandry than the latter, the ſame increaſe of care only will be neceſſary to render them acceſſible to the drill culture; but this is *vox et præterea nihil*; and the enthuſiaſt to the drill ſyſtem will never be able to make this reaſoning accord with advantageous practice. The ſcale on which I have adopted the uſe of the drill, has not hitherto occaſioned any increaſe of expence in horſes or labour, which have not been greatly over balanced by the general advantages of the practice."

Mr. Arthur Young, upon the foregoing obſervations, makes the following remark.—" My readers will conſider themſelves as much indebted to Mr Majendie for this perſpicuous detail of accurate experiments. Speaking *in general* of the drill, I muſt ſtill adhere to my former opinion; the point is not yet proved. But I know nobody more capable than this liberal cultivator, of throwing that light on the queſtion which is wanted. Should he ever be inclined to try ſuch an experiment, a very minute attention to the labour of both horſes and men, and the times when uſed, ſhould be given."

Compariſon between the BROAD-CAST *and* DRILL *Methods of Sowing.*

Drill-huſbandry is, as a good writer has juſtly defined it, " *the practice of a garden brought into the field.*" Every man of the leaſt reflection muſt be ſenſible, that the practice of the garden is much *better* than that of the field, only a little more expenſive; but if (as is the caſe) this extra expence be generally much more than repaid by the ſuperior goodneſs and value of drilled crops, it ought to have no weight in comparing the two modes of huſbandry. In the broad-caſt method the land is often ſown in bad tilth, and always ſcattered at random, ſometimes by very unſkilful hands. In drilling, the land muſt be in fine order; the ſeed is ſet in trenches drawn regularly, all of nearly an equal depth, and that depth ſuited to the nature of each kind of ſeed. Theſe ſeeds are alſo diſtributed at proper diſtances, and, by being equally and ſpeedily covered, are protected from vermin, and other injuries; ſo that the practice of the garden is here exactly introduced into the field. In the broad-caſt method the ſeed falls in ſome places too thick, in others too thin; and being imperfectly covered, a part of it is devoured by vermin, which follow the ſower; another part is left expoſed to rain or froſt, or to heats, which greatly injure it. When harrowed, a great part of it (ſmall ſeeds eſpecially) is buried ſo deep, that, if the ſoil be wet, it periſhes before it can vegetate. Again, when thus ſown, there is no meddling with the crop afterwards, becauſe its growth is irregular. The ſoil cannot be broken to give it more nouriſhment; nor can even the weeds be deſtroyed without much inconvenience and injury. But in the drill-huſbandry, the intervals between the rows, whether double or ſingle, may be horſe-hoed; and thereby nouriſhment may repeatedly be given to the plants, and the weeds almoſt totally deſtroyed.

The very ſame effects which digging has upon young ſhrubs and trees in a garden, will reſult from horſe-hoeing in a field, whether the crop be corn or pulſe: for the reaſon of the thing is the ſame in both caſes, and being founded in nature and fact, cannot ever fail. In drilling, no more plants are raiſed on the ſoil than it can well ſupport; and by dividing and breaking the ground, they have the full advantage of all its fertility.

The plough prepares the land for a crop, but goes no further; for in the broad-caſt huſbandry it cannot be uſed: but the crop receives greater benefit from the tillage of the land by the horſe-hoe, while it is growing, than it could in the preparation. No care in tilling the land, previous to ſowing, can prevent weeds riſing with the crop; and if theſe weeds be not deſtroyed while the crop is growing, they will greatly injure it. In the broad-caſt huſbandry this cannot be done; but in drilling, the horſe-hoe will effect it eaſily. And what adds to the farmer's miſfortune is, that the moſt pernicious weeds have ſeeds winged with down, which are carried by the wind to great diſtances; ſuch as thiſtles, ſow thiſtles, colts-foot, and ſome others.

If the expence of horſe-hoeing be objected, there are two anſwers which may very properly be made. The firſt is, that this expence is much leſs than that of hand-hoeing, were it practicable, or of hand-weeding. The ſecond is, that it is more than repaid by the quantity of ſeed ſaved by drilling; to ſay nothing of the extra quantity and goodneſs of the crops, which are generally ſelf-evident.

Upon the whole, if the particular modes of cultivating land by the new huſbandry ſhould, after all, be conſidered as perhaps too limited to be univerſally adopted, yet it has been of great uſe in raiſing ſuſpicions concerning the old method, and in turning the views of philoſophers and farmers towards improving in general. Many real improvements in agriculture have been the conſequences of theſe ſuſpicions; and as this ſpirit of enquiry remains in full vigour, a ſolid foundation is laid for expecting ſtill further improvements in this uſeful art.

Remarks on SCARIFYING *and* HORSE-HOEING, *by the Rev.* JAMES COOKE.

" As far as my obſervations have extended, it appears an object of the greateſt importance, to ſcarify all drilled crops of wheat and rye, as early in the ſpring as poſſible, viz. in the month of February, if the ſoil is dry enough to admit of it, in order to break the firm texture of the ſoil, which it may have acquired by remaining undiſturbed during the winter. At all events, the firſt proceſs of ſcarifying ſhould take place in all ſoils; and, in ſome ſtrong obdurate ſoils, it ſhould be repeated two or three times, before the plants begin to tiller or multiply. This will improve, enrich, and meliorate the ſoil, in the ſpaces between the drills; the conſequence of which will be, a conſiderable increaſe in the number of ſtems, ſize of ears, &c. For the number of ſtems tillered will be exactly in proportion to the production or fertility, the richneſs or poverty, the kindneſs or unkindneſs, of the ſoil, at the very time of tillering; hence the propriety of pulveriſing the ſoil, by ſcarifying it, ſo as to permit the air to enter, and the tender fibres of plants to extend freely in queſt of food; hence the propriety of reducing the ſoil in the ſpaces between the drills, to the beſt ſtate of cultivation of which it is capable, before the tillering begins to take place; in which caſe the farmer may rely upon ſo many ſtems being tillered, as the land is afterwards able to ſupport, and bring to maturity. On the contrary, if the pores of the ſoil are too much cloſed to admit the air, which is the life of vegetation, if the texture of the ſoil is too firm to admit the tender fibres of plants to extend at the time of tillering, the farmer need not be ſurpriſed at ſeeing a deficiency in the number of ſtems, with ſmall ears, and light grain in proportion, excluſive of the danger of an after-growth, or unſeaſonable tillering of ſtems, which will be quite green when the crop is ripe. On this account, it would be very eligible, and of importance, to know, or foreſee, the exact time of plants beginning to tiller, in order to prepare the ſoil accordingly, by ſcarifying it in due time. But this is impoſſible to know; and it is with regret that I ſay it cannot be known, otherwiſe than by taking a few plants out of the ground, and obſerving whether the ſecondary or coronal fibres are then formed from a knot or joint on the original ſtem, about an inch or an inch and a half under the ſurface of the ſoil: for the time of plants beginning to tiller will vary juſt as the ſeaſon varies, whether wet or dry, hot or cold, early or late: alſo as the land varies, whether wet or dry, light or ſtrong, rich or poor, ſheltered or expoſed: and the inſtant that the ſecondary or coronal fibres begin to exiſt, that inſtant the tillering of the ſtems will commence, though imperceptible to the naked eye.

" Since, therefore, it will be found of real and eſſential ſervice to all crops of corn, to ſcarify them before the plants begin to tiller, it is recommended (as the exact time of tillering cannot be foreſeen) to ſcarify as early as poſſible: the ſooner the better; and, in my opinion, the oftener the better, previous to the tillering: and when the plants have done tillering, being about ſix or ſeven inches high, the horſe-hoe may be uſed to great advantage in cutting up the weeds, and earthing the ſoil to the rows of corn, whenever the land is ſufficiently dry.

" The above obſervations on ſcarifying and hoeing wheat and rye are alſo applicable to ſpring corn, viz. barley and oats. The tillering of theſe plants will, like wheat and rye, be found, on examination, to take place at different times, juſt as ſeaſons, ſoils, and ſituation vary; but, in general, about three weeks after the grain is ſown. The cultivator will find his intereſt in embracing ſeaſonable opportunities of ſcarifying theſe crops alſo before they begin to tiller: and in horſe-hoeing them afterwards. Beans, peas, and tares, may be ſcarified and hoed from the time they are above ground, till they are too high.

" Theſe remarks on ſcarifying and hoeing are offered, in hopes they will be duly put in practice. The preſent advantages will be great; but greater ones will be found in reverſion, by keeping the land clear of weeds, and at the ſame time preparing it for future crops.

" Since, therefore, the advantages of ſcarifying and horſe-hoeing are evidently ſo great, too much attention cannot be paid to the circumſtance of doing the buſineſs at proper and ſeaſonable times, when the ſoil is dry. If two things cannot be done at one and the ſame time, ſurely it is adviſable to ſecure the preſent moment for doing that which is of the greateſt importance, and leave the other to be done ſome other time.

For

For inſtance, if men and horſes are at work at the common plough, and the latter part of the day ſhould turn out favourable for ſcarifying or horſe-hoeing, by all means let the man and horſes quit the common plough, and go to ſcarify and hoe; for if rain ſhould fall in the evening, or next day, and force the crop to expeditiouſly as to exclude the uſe of the ſcarificators or hoes, in all probability the neglect will be attended with the loſs of more pounds than all the men and horſes would have gained pence by continuing at the plough.

"When practitioners in drilling begin to look upon the proceſs of ſcarifying and horſe-hoeing, at proper and ſeaſonable times, as eſſentially neceſſary, and conducive to their intereſt, (as farmers in the old way do, to plough their land, before they ſow it), then, and not till then, will the drill ſyſtem be practiſed as it ought to be, or with ſuch beneficial effects as actually belong to it; and to practiſe it otherwiſe is doing it only by halves.

"Some ſoils have been found too hard and ſtoney for the horſe-hoes to work pleaſantly; but none have been found ſo obſtinate as to bid defiance to the ſcarificators; the repeated uſe of which will prove in ſuch ſoils a good ſubſtitute for horſe-hoeing.

"At the time of fixing the coulters in the beam for drilling, care ſhould be taken to fix them in ſo, that the points or ends of the coulters, which go into the ground, be all exactly at equal diſtances one from another: and when the hoe ſhanks or ſcarificators are fixed in the beam, care ſhould be taken that they are alſo fixed at the ſame equal diſtances one from another: by this means the ſcarificators, or hoes, will all move exactly in the middle of the ſpaces between the drills. Any ploughman, who has been accuſtomed to fix the coulter of a common plough to his mind, by wedges, can eaſily fix the coulters and hoes at equal diſtances, as above. In doing this, he ſhould not truſt to the eye for accuracy, but to a rule, or narrow piece of board, with the exact diſtances at which the coulters are intended to be fixed, marked upon it by figures or notches: by applying this rule, or ſlip of board, to the coulters, he will readily fix them at equal diſtances.

"In drilling, if ſoil drops from the wheels into the two end funnels behind the coulters, ſo as to ſtop them, a piece of ſtrong leather, or thin board, placed on the top of each funnel, with a hole in the middle of it for the tube to go through, will prevent the dirt from ſtopping the ſaid funnels.

"All ſtrong ſoils intended to be drilled in the ſpring, with beans, peaſe, tares, or barley, ſhould be deep ploughed before winter, and not ploughed any more in the ſpring. However loudly this method may be exclaimed againſt by ſome, it is nevertheleſs practiſed by others with good effects. If, at the time of ſeedneſs in the ſpring, the land ſhall be thought too cloſe and compact, let the ſcarificators be uſed upon it, weighted ſo as to force them into the ſoil four inches deep at leaſt; this, if the ſoil is tolerably dry, will break it up, and leave it lighter than if it had been freſh ploughed. And if weeds alſo appear at the time of ſeedneſs, they may be cut up by the horſe-hoe; and the land will afterwards be leſs productive of weeds during the growth of the crop, than it would have been after a freſh furrow. In ſhort, by this means, the ſoil, by being expoſed to a winter's froſt, and influences of the atmoſphere, alſo ſcarified and hoed as above, which will not coſt ſo much as once ploughing, will be in better condition for drilling in the ſeed, and more certain of a crop, than by the common method of ploughing a little time only before ſeedneſs.

"Of all weeds, quitch, or couch, is the greateſt enemy to drilling. It may, indeed, be very much curbed and weakened by repeated ſcarifying and horſe-hoeing; but where it abounds, a good ſummer fallow, the land being ploughed before winter, is the beſt and moſt effectual cure; after which, if a good rotation of crops is adopted, and two exhauſting or white ſtraw crops never taken two years together, but an exhauſting and a meliorating one alternately, and thoſe drilled, ſcarified, and horſe-hoed in a proper manner, it will not be able to injure or interrupt the cultivator materially."

Reflections on DRILL-MACHINES, *particularly ſuggeſted by an Account of one invented by* Mr. BARNES, *by* Mr. JOSEPH WIMPEY, *in a Letter to the Secretary of the Bath Society.*

"SIR,

"I congratulate the public on Mr. BARNES's invention of a new Drill-Machine. In Art. xliv. of your 4th volume, he ſays, 'Whenever it ſhall be fully before the public, I flatter myſelf, it will be found to poſſeſs, at the price of ten guineas, at leaſt *more* than all the valuable properties contained in other machines of a much higher price.' If ſo, I will venture to add, it has at *leaſt* twice their merit, as being more complete, and but little above half their price.

"The benefit accruing to the public from improvements in agriculture, by means of new inventions to facilitate its operations, and reduce its expences, muſt ever be in proportion to the extenſive uſe that is made of them; and theſe again will ever much depend upon the eaſe and moderate expence at which they may be acquired.

"Were I the inventor of any machine or implement in huſbandry, which I had reaſon to think would be acceptable to the public, I would ſet it at a price ſo moderate as could be no impediment to the ſale of it. It may be a queſtion, What would, in this caſe, be a moderate profit? The profits in trade, when the returns are not very large, we may ſuppoſe to run from 10 to 15 per cent. But in this caſe, where ingenuity is as neceſſary as diligence, we will ſuppoſe twice that ſum; or ſay, from 20 to 30 per cent. would not be generally thought immoderate. On theſe terms, therefore, I ſhould hope, every one, who had beſtowed his time and pains with a view to ſerve the public, would, in the large demands he might have for his inſtruments, find a full and ſatisfactory recompence for his ingenuity, expence, and trouble; eſpecially if, in the conſtruction, his principal object was œconomy, as far as could be made to conſiſt with convenience and utility.

"Had I the pleaſure of Mr. BARNES's acquaintance, I would beg leave to recommend theſe obſervations to his conſideration, being fully perſuaded, he would find the demand for his machine in proportion to the price; the lower, in reaſon, he makes it to the public, the higher his intereſt would riſe in proportion thereto. I am of opinion, where a man ſells one machine for fifteen guineas, he might ſell fifty for five guineas each. It is eaſy for every inventor, on this ſuppoſition, to calculate which will be moſt for his intereſt.

"The excellence of all inventions is meaſured by the quantum of good they afford the public. Every inſtrument or machine, therefore, be it ever ſo ingeniouſly conſtructed, and competent to its intended uſe, becomes almoſt uſeleſs, and of very little value to the public, if the price be ſo high as almoſt totally to obſtruct and prevent the ſale of it. It is a kind of *felo de ſe*, and may be fitly compared to a law which permits the importation of certain articles of commerce, upon the payment of cuſtoms ſo immoderate as, to all intents and purpoſes, to amount to an effectual prohibition, by which no one is a gainer but the illicit trader. Here then the ingenious inventor miſtakes his intereſt egregiouſly; he ſacrifices the virtue of the patriot, not to the *real*, but to the *imaginary*, intereſt of the individual, and ſuffers at once both in his intereſt and his credit. The ſureſt and moſt durable patent is moderation of price. Thoſe that are purchaſed at a very high and unreaſonable price, confine and reſtrain the ſale; but reaſonable prices encourage and promote it, whatever be the commodity at market.

"Immoderate taxes are ever unfriendly to trade; and heavy charges, and exorbitant expences, are not leſs ſo to ſcience and the arts. Ingenuity, even mere pretenſions to ingenuity, are often taxed as high as any article of commerce. Subſcriptions for thouſands, and tens of thouſands, are propoſed, and tendered, to the public, with as much eaſe, unconcern, and firmneſs of features now, as the moſt hardy veteran would have dared to have offered formerly for fives and for fifties. But this is an age in which credulity is become epidemical; and the alchemy and empiriciſm of BEN JOHNSON's days are faſt gaining ground under another denomination, and in a different form. Should a comic genius ariſe of equal humour and parts, he might now find as ample a field of impoſture to range in as ever diſgraced that poet's times. The ſureſt and moſt effectual means of promoting and extending knowledge for the general benefit of the public, is to render it attainable on the eaſieſt and leaſt expenſive means poſſible.

"I hope no proprietor of any machine now in uſe will conceive, that any thing is here meant inimical to his intereſt. It is the writer's ſincere wiſh that matters might be ſo ordered, as to render the intereſt of the proprietors compatible with that of the public in general. Should the drill huſbandry be generally extended, as there ſeems to be good reaſon to expect, I will venture to ſay, new inventions of machines for drilling will moſt probably ſoon appear, of a very ſimple conſtruction, and at a price ſo moderate, as will rarely be an impediment to their uſe, even among the loweſt claſs of farmers.

"I have been for ſome years paſt a conſiderable ſpeculator in this buſineſs, and have uſed many inventions for performing this mode of planting, hoping to find the eaſieſt, cheapeſt, and moſt œconomical manner poſſible. However, I am not able to determine the preciſe method of planting, ſo as to produce the moſt beneficial crops for any ſeries of years in ſucceſſion. I call that the moſt beneficial crop, which produces the greateſt nett gain upon any given quantity of land for any given term of years. For his purpoſe I have ſowed this ſeaſon ſeveral fields of wheat in drills of very different diſtances, and in different modes. Some were ſown in rows, of 18 inches diſtance, with a hand-machine, with which at this diſtance a day labourer ſowed from four to ſix acres a day, which was completely covered with one tine of the harrows. This ſimple machine was made by a country carpenter, under my directions, and coſt only half a guinea. Other fields I have planted in a very different manner, which, indeed, for the three laſt years, has been my uſual cuſtom. The land being well ploughed, I throw it into ſmall ridges, with three bouts of the plough. The diſtance then from the middle of one furrow to that of the next is about four feet ſix inches; the top of the ridge about a yard wide,

and

New Invented Patent Drill Machines.

See System of Agriculture.

Fig. 1.

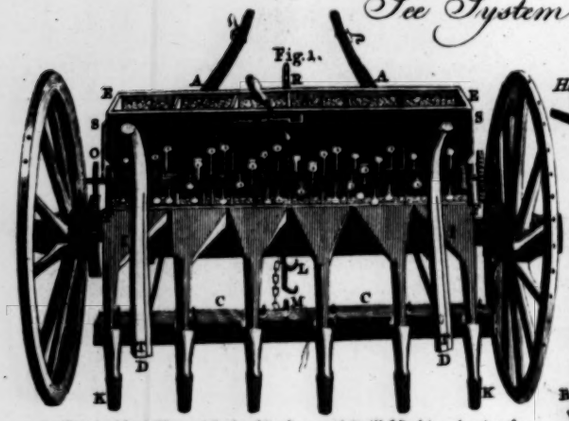


Fig. 1. A back View of Cookes New Improvid Drill Machine, shewing the manner in which y^e Seed is taken up by y^e Cups, & thrown into y^e Funnels.

Hand Hoe
Fig. 5.

Fig. 7.

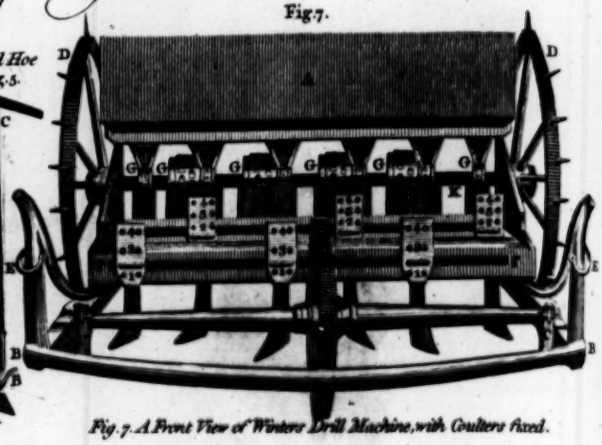


Fig. 7. A Front View of Winters Drill Machine, with Coulters fixed.

Fig. 2.

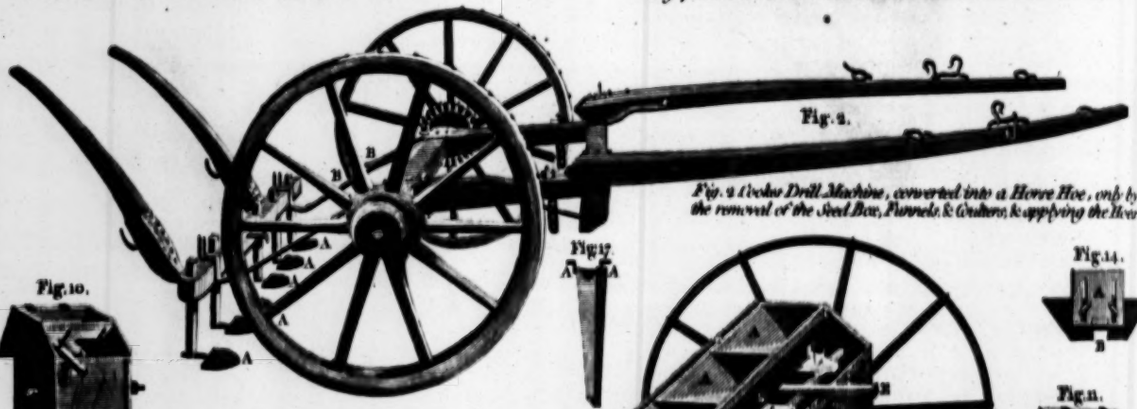


Fig. 2 Cookes Drill Machine, converted into a Horse Hoe, only by the removal of the Seed Box, Funnels, & Coulters, & applying the Hoes.

Fig. 10.

Fig. 17.

Fig. 14.

Fig. 11.

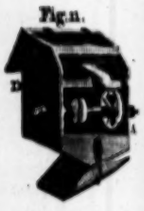


Fig. 9. Horne Patent Universal Sowing Machine, constructed to be drawn by a Horse.

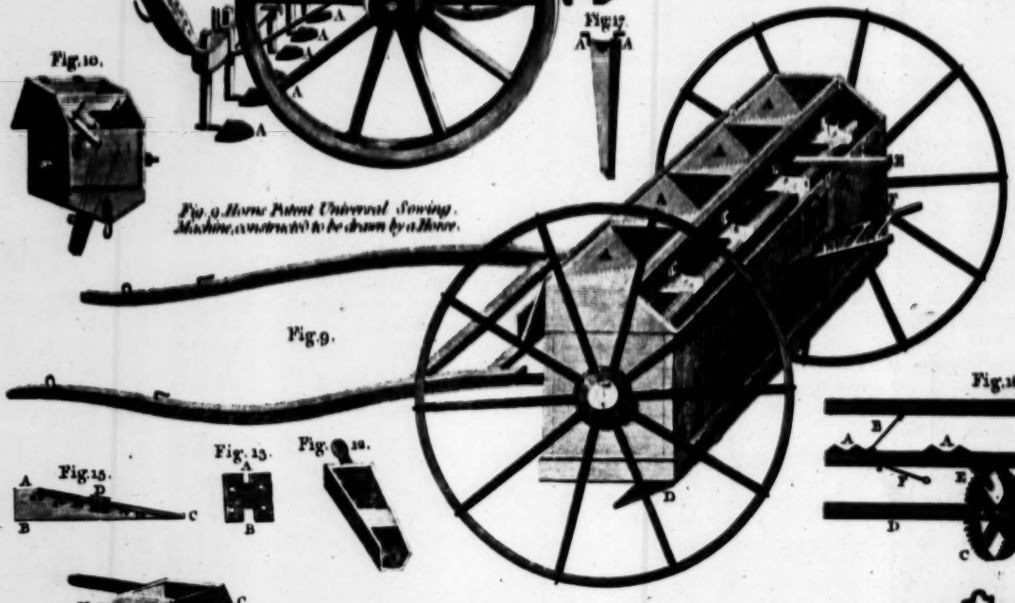


Fig. 9.

Fig. 16.

Fig. 15.

Fig. 13.

Fig. 12.

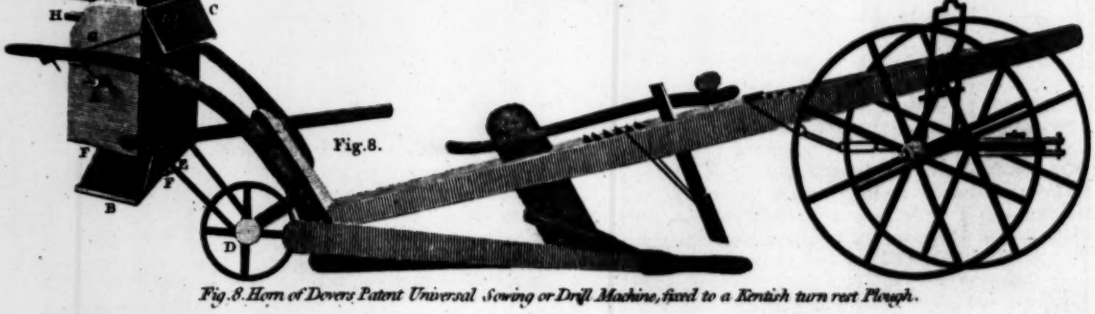
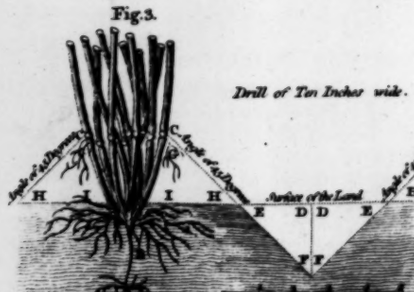


Fig. 8.

Fig. 8. Horn of Devers Patent Universal Sowing or Drill Machine, fixed to a Kentish turn rest Plough.

Fig. 3.



Drill of Ten Inches wide.

Fig. 3.

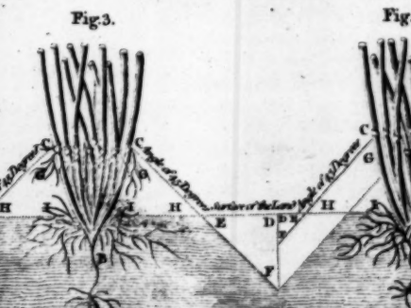
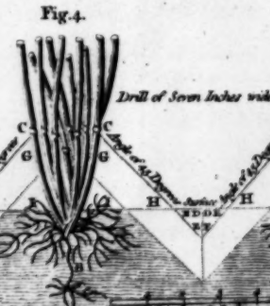


Fig. 4.



Drill of Seven Inches wide.

Fig. 4.

Fig. 1. Mathematical Rule, for ascertaining on demonstrative principles, the only correct distance for drilling. By the Revd James Cooke.

Fig. 2. Mathematical Definition, by the Revd J. Cooke, proveing the erroneous method, recommended by Mr Winter of drilling at the distance of 7 Inches only.

Engraved for Hall's Encyclopedia, & Printed for C. Cooke, N.º 7 Barrowster Row, Augt 1, 1788.

and the breadth of the furrow 18 inches. On the tops of the ridges I plant three rows of corn, at the distance of ten inches from each other. This is performed with a machine which makes the channels, drops the corn, and completely covers it at one operation. This machine was made by the same workman as the former, and did not cost me more than about 30s. This instrument performs extremely well; the corn is come up very regularly, the rows perfect, and the partitions clean. The first machine will sow single rows at any distance; and any seed, from a horse bean to a turnip seed. The other instrument will sow one, two, three, or five rows on each ridge, and any sort you please. This last, however, is capable of improvement; and when made as complete as can be desired, I think cannot exceed two guineas and a half. These are the facts on which I ground my prediction, that the time will come, when the price of instruments, for this mode of planting, will be no impediment to the general use of them, if that mode of practice should ever prevail. But I postpone any alteration till I am better satisfied of the most profitable method of planting.

North-Bockhamton, Your most obedient servant,
Feb. 14, 1789. JOSEPH WIMPEY."

The Bath Committee observe that Mr. WIMPEY's observations on Drill Machines contain much important truth; and as such, the Committee could have no inducement to withhold them from the public. On the contrary, they are inserted as a fresh proof of the estimation in which his correspondence on experimental husbandry is held: but while the Committee agree with Mr. WIMPEY on the inventing small, simple, and cheap machines, for small farmers, they are of opinion, that the expence of large and masterly pieces of mechanism is a trifling object, in comparison with the advantages of greater expedition on a large scale of farming.

Remarks on the Rev. Mr. COOKE's *new* SWING PLOUGH, *by* J. ADAM, Esq. *in a Letter to the Secretary of the Bath Society.*

"SIR,

"I beg leave to trouble you with some of my latest experience and remarks on the subject of ploughs, which I hope may become useful in leading towards farther improvement. On a former occasion, I have ventured to alledge, that ploughs, though the most common, have ever appeared to me the least perfect of all the instruments of husbandry; and that I was of opinion, they were not yet well understood, either with respect to their construction or mechanism. I have likewise observed, that the vast variety of ploughs over all Great Britain and Ireland, was to me a convincing proof that none of them were perfectly good; for if any one of them had a decided superiority, it would have been pretty universally adopted on similar soils. After many conversations of this kind, *Mr. Cooke* was induced to turn this subject in his mind, and some time after shewed me a model. He got some bodies of ploughs made of cast iron, consisting of a mould-board, regularly twisted with the land side of the plough, and a plug for fixing on the share, all in one piece. This combination of the parts, which so essentially affect the operation of the plough, prevents the possibility of their undergoing any [illegible] from the unskilfulness of country ploughwrights, who have only to add the common wood-work to these cast-iron bodies.

"Mr. *Cooke* had one of them fitted up at London as a swing-plough, with a share of wrought iron, a coulter, and the necessary wood-work. This he tried in a loamy soil, and it answered perfectly well: but this did not satisfy me: I therefore requested him to come and spend a few days with me in the country, and take along with us two of his iron casts, in order to have them fitted up, and make trial of them in some of the strongest soil in England, and in many places mixed with flints and pebbles. This he cheerfully complied with. We accordingly put our plan in execution; and, for a first essay, I think I may add, that we met with most extraordinary success. I was so much pleased with my two swing-ploughs of this new form and construction, that I have ploughed with them ever since; and I will venture to say it is the best ploughing ever performed on so strong a soil.

"I believe, Sir, it will be admitted that this plough has some peculiar excellencies, when I tell you that it requires but three horses instead of four, which I have always used on this land, which is not only strong, but hilly; and I am confident two horses would be quite sufficient in this plough, were the land level and loamy; and besides, that it turns a clean and square furrow of seven or eight inches deep, that it lays it over completely, and that it breaks and shivers it in the action of turning.

"When we find so many good qualities in a swing-plough, which is at the same time so simple in its construction and tackle, would it not be absurd ever to employ a wheel-plough, with four horses, to do the work which can be done by the swing with two or three at most? and yet so powerful is custom, or fashion, or prejudice, that I see every farmer round me dragging a heavy Hertfordshire wheel-plough over his lands, which in many soils does no more than scratch them. I am sure I do not exaggerate, when I say, that many farmers in this neighbourhood do not turn a furrow of above three inches deep. But, besides this, our clumsy wheel-ploughs are all made with straight mould-boards, which do not turn the flag, unless the ploughman lays them over so much on the land side edge, that the tail of the mould-board sweeps along the under side of the turning turf, and helps to lay it over. This position of the plough is attended with one very bad consequence, which is, that it raises the fin of the share out of the level; this makes it cut the bottom of the furrow obliquely; and the turf, or flag, thus raised, is not square or parallel, but triangular, leaving the soil, when ploughed, of unequal depths. This I call a very great defect in our wheel-ploughs; but this is not the only one: for the most skilful ploughman, in using that implement, must run it over a certain space, before he can lay sufficient hold of the soil to turn up a tolerable furrow; and at the further end of the ridge he repeats the same defect, and a certain space is blinked in gradually raising the share out of the soil; and thus both ends of the ridges are worse ploughed than the rest of the lands, which I call another great defect. But what is worst of all, is, that, in wettish or doughy land, the wheels of the plough are so clogged with the tough soil, that it is impossible to make them move round; and thus the ploughing is stopped, however pressing the season. Is it not then astonishing that, with all these capital defects, the wheel-plough should yet remain the favourite implement in this and other counties, where agriculture is so well understood, and that so light and so efficient an implement as the swing plough should be so much neglected? I will venture to assert that wherever there is a fair comparison made between the operation of the best wheel-plough, and the swing-plough invented by Mr. *Cooke*, that the latter will be greatly preferred. I do not, however, mean to alledge, that the swing-plough is altogether faultless; there is no implement I ever saw without some defect, and that of the swing-plough is its being liable to be thrown out of its work by some large flint or pebble, or by a slip of the ploughman's foot, who, leaning his weight on the handles, raises the share out of the ground; but this defect is soon remedied by drawing back the plough to where it first began to lose its depth, and re-entering the furrow on its former level. On the other hand, is not this defect more than compensated by the lightness of the draught, the simplicity of the tackle, the immediate depth of furrow, its being well turned over, clean, square, and deep, and its equality to the extremity of the ridge? When I mention a deep furrow, I mean one of seven or eight inches in a strong soil, which I have never yet seen done by any of our wheel-ploughs.

"From whence the ridiculous predilection in favour of these ploughs should arise, I am at a loss to determine, unless it be, as before observed, from custom, fashion, prejudice, or some such reason, as frivolous and unsatisfactory. I, who have tried both, and have given to each a most impartial observation, must fairly decide in favour of the swing, except in very particular cases, such as breaking up an old ley, or very strong soil rendered hard by a long continuance of drought, or for stirring to some uncommon depth, such as eighteen inches; which Mr. *Arbuthnot* did with a wheel-plough of his own construction, described in my first volume, page 214, where I have also given a plate of it.

"Before I conclude, I must observe, that the fin of the share of Mr. *Cooke's* swing-plough is very nearly as wide as the heel of the plough, by which means the bottom of the furrow is as completely cut by it as the land side is by the coulter; thus nothing is left to be done by the breast of the plough and mould-board, but to raise the flag gradually, and lay it over completely.

"I think it likewise necessary to mention, that the Suffolk cat-head and copse (as described in the above quoted essay, where a plate is given of them) are what I use for regulating the width and depth of my furrow. A small alteration in the length of the ridger over the thill-horse, also sets the plough more or less rank; but it must be observed, that it should never be taken up too short, for that creates a very hurtful angle in the line of traction. Neither must I omit to mention, that the rising flag sweeps along my cast-iron mould boards so glibly, touching every part as it passes, that it has polished it like bright steel. Some old farmers in this neigbourhood, not over-fond of novelties, and even the ploughwright who works for me, confess that they never saw so much execution done by so small and light an implement.

"I have been the more diffuse on this subject, because I see, in the fourth volume of your transactions, that the improvement of ploughs has been an object with your Society. I am not at all qualified to judge of the ploughs produced to the Society, having neither seen them, nor the work they performed; but I hope the Society will excuse my making some few remarks upon those trials as they are there related. In the first place, I should imagine that the trials of wheel-ploughs and swing-ploughs, in order to be correct, should be made separately, because they are intended for very different purposes; and

therefore, what is a task for a wheel-plough, is not a task for a swing, and *vice versa*. In the second place, the task prescribed by your committee was a furrow of four inches deep only, which does not seem to me a sufficient trial of a real effective implement, armed with two coulters, and drawn by six oxen. I confess, I should have supposed that no furrow under eight inches was adequate to such a formidable apparatus, let the soil be what it would. The execution of the work performed by this plough was surely abundantly rapid, and I have no doubt of its being very well done, as it was approved of by the committee; but I must still contend that the task was not suitable, or, in other words, this plough was improperly employed upon a four-inch furrow. However, this plough, if tried, would, perhaps, have performed its part equally well on a much deeper furrow. Your most obedient humble servant.

Shenley-Lodge, Herts, " JAMES ADAM."
Nov. 13, 1789.

The Society, in their papers, express themselves much obliged to Mr. ADAM for this letter, particularly as it describes a new plough which promises to become of public utility. With regard to Mr. ADAM's strictures on the ploughs used at the last public trial for the premiums of this Society, it is presumed, that had he been present, and a witness of the uncommon strength of the soil, under an old ley, and rendered still harder by frost, he would have thought the task no unequal one for six oxen drawing a double-coultered plough only on a four-inch furrow. Nor will the difficulty with which a light single plough could be drawn by four oxen, without the aid of a horse, be considered as a trivial argument in favour of the double plough.

SECTION XXVIII. IMPLEMENTS USED IN HUSBANDRY.

References to the Plan of the Rev. JAMES COOKE's *highly improved and simplified Patent* DRILL MACHINE, *with* HORSE-HOES *annexed, and comprized in one and the same instrument.* Fig. 3. Plate I.

A A, shafts of the machine, applied to the axis of the wheels, so that a horse may go on the land or in the furrow. C C, coulter beam, with mortices in it, at different distances. D D, handles of the machine, applied to the coulter beam at C C, by means of screw-bolts and nuts; also to the axis of the wheels, by hooks and eyes, or staples. E E, upper seed-box, in partitions. The lower seed-box, in partitions, is placed under the cups or ladles of the cylinder H H. G G, sliders between the upper and lower seed-boxes, to prevent the grain or seed from descending too fast into the lower boxes; by elevating or depressing of which, the quantity of grain or seed distributed in the drills may be varied at pleasure. H H, cylinder, with cups or ladles, by which the grain or seed is taken up from the lower seed-box, and dropped into the funnels I I, and directed thereby into incisions made in the land by the coulters K K. L, a chain and hook, applied to the coulter beam and axis of the wheels, to prevent the coulter going too deep in the land, and to prevent the coulter beam dropping so low as to unship the upper funnels in crossing deep furrows or gutters. M, a pin of iron, projecting from the coulter beam, which, being lifted on to the hook L at the end of the land, will bear the coulter out of the ground, while the machine is turning round, without any labour of the man, who attends the machine, in supporting the same. N, a cog wheel upon the nave of the wheel B. O, a cog wheel upon the gudgeon or axis of the cylinder H, which is turned by the wheel N. P, lever and string, passing over a pully to the axis of the cylinder H. By moving the lever P to a notch in the staple Q, the wheel O will be lifted out of generation with the wheel N, by which means the distribution of the grain or seed may be stopped at pleasure, particularly at the head land, while the machine is turning round. R, an iron bar, with holes in it, applied to the cross bar of the shafts by a staple, and to the front edge of the seed-box. By means of this box, the seed-box may be elevated or depressed, so as to keep the top of the same horizontally level, whether going up or down steep hills. S S, staples in the ends of the seed-box, for the reception of two slides of wood, with canvas applied to the same; also to a small staple in the end of the coulter beam, to prevent the wind from interrupting the grain or seed in its descent from the cups or ladles to the funnels or conductors I I. T T, hooks in the handles of the machine to which weights may be applied to force the coulters, if necessary, into the ground. *Fig.* 4 represents the shafts, the axis and wheels, the coulter beam, with handles applied to the same, as in *Fig.* 3. And the said drill machine is converted into a horse-hoe, only by taking away the seed-box E E, the cylinder H H, the funnels I I I I, and the coulters K K, as in *Fig.* 4. And introducing the hoes AAAAAA in the places of the coulters. B, B, a guide, projecting from the hoe beam, which the person who conducts the instrument must keep directly over one of the rows of corn, when hoeing drills at nine inches apart; and over the middle of one of the spaces between the drills, when hoeing the same at twelve inches apart; and so long as he does this, it will be impossible to injure the crop, by cutting up any of the rows of corn. He will, with the greatest facility, keep the guide B directly over one of the rows of corn, or over the middle of one of the spaces between the rows of corn, by means of the hoe beams with six hoes fixed in it, readily moving to the right or left upon the principles of the pentagraph, so as to counteract the irregularity of the horses' draught, notwithstanding he should deviate from the direction in which he ought to go, two feet or more.

Explanation of the HAND-HOE, Fig. 5. Plate I.

A, the hoe-plate. B, wings or mould plates, by which the soil is earthed up to the rows of corn. C, the handle, which is elevated or depressed by an iron wedge being applied to the upper or under side of the said handle.

We next lay before our readers two other Patent Drill Machines, of which the respective authors give very flattering accounts; but as we have no testimonials of the performance of either of them, our readers must be content with what the patentees are pleased to say in commendation of their own works.

Description and Use of MR. WINTER's *new invented Patent* DRILL MACHINE.

" This machine (says Mr. W.) is universally acknowledged to be superior to any hitherto invented: it is so strong, that nothing, but the greatest violence, can injure it; and is constructed on such plain mathematical principles, as to be worked by any person of the lowest capacity. It deposits grain, pulse, turnips, carrot, or any other seed, with the greatest accuracy, at any required depth in the earth, from the surface to six inches, at any required distance, from 6, 7, 8, 9, to 40 inches between the rows; and may be instantaneously regulated so as to increase or decrease the quantity sown, which is immediately covered. One man, a boy, and two horses, can drill ten acres of light, and eight acres of stiff land, in one day; and from one bushel of seed wheat, and one bushel and a half of barley, will produce a crop of from 6 to 20 bushels per acre, according to the richness of the soil, more than when sowed by the common mode of husbandry."

The Machine may be seen at the Exchange; or at Mr. HANCOCK's, Wheelwright, Old-market, Bristol. Orders to be directed to Mr. G. WINTER, Bristol. Price Sixteen Guineas.

Explanation of WINTER's *Drill Machine*, Fig. 7. Plate I.

It represents a front view of the above machine when at work, with six coulters fastened on, depositing grain at the depth of two inches, in drills at seven inches distance. A, the fore flap turned up, and the back board taken off, for the purpose only of representing the inside work, which, when drilling in the field, is all inclosed: it then appears as a box between two wheels, and all the inside work is perfectly secured from the effects of the most tempestuous weather. B, the frame. C, iron plates, in which the gudgeons of the fore-wheels are placed, and may be removed to any required depth. D D, the two hind wheels, with spikes, which are for the purpose of preventing the wheels from sliding over rough ground or clods; and by the spikes penetrating into the earth, the wheels are forced round, by which the grain is delivered; for when the wheels stop, or slide, no grain is discharged. E E, iron rings, fastened to the fore-standard, to which the chains are fixed for drawing the machine. F, coulter-bars, with grooves, through which the coulters are placed at any required distance, from 6, 7, 8, 9, 10, to 36 inches or more. 1, 2, 3, 4; six coulters, numbered between the bolt holes, with figures for setting the coulters so as to deposit the grain at any required depth: for instance, when the bolts are placed over No. 2, the grain is deposited at two inches deep; when over No. 3, at three inches deep; and so on. G, six cylinders, which occasionally slide off and on the axis, so that the whole, or any number of them, may be fixed at any required distance. H, boxes which contain the seed. I, conductors, into which the seed is delivered out of the cylinders, and conveyed into the grooves, in the back part of the coulters. K, the axis, which passes through the cylinders and large wheels.

Patent Universal SOWING MACHINE, *by* Mr. JOHN HORNE, *of* Dover.

" This machine, whether made to be worked by hand, drawn by a horse, or fixed to a plough, and used with it, is extremely simple in the construction, and not liable to be put out of order, as there is but one movement to direct the whole; nor does it require any skill in working. It will sow wheat, barley, oats, rye, clover, cole-seed, hemp, flax, canary, rape, turnip, besides a great variety of other kinds of grain and seeds broad-cast, with an accuracy hitherto unknown. It is equally useful in the new husbandry, particularly when fixed to a plough: it will then drill a more extensive variety of grain, pulse, and seed (through every gradation, with regard to quantity) and deliver each kind with greater regularity than any drill-plough whatever. When used in this manner, it will likewise be found of the utmost service to farmers who are partial to the old husbandry, as, among many other valuable and peculiar properties, it will not only sow in the broad-cast way with a most singular exactness, but save the expence of a seedsman; the seed being sown (either over or under furrow at pleasure) and the land plouged at the same operation.

Perhaps

Perhaps a fair and decisive experiment for ascertaining the superior advantage of broad-casting or drilling any particular crop, was never before so practicable; as the seed may now be put in with the utmost degree of regularity, in both methods of culture, by the same machine; consequently, the seed will be sown in both cases with equal accuracy, without which it is impossible to make a just decision.

"The excellence of this machine consists in spreading any given quantity of seed over any given number of acres, with a mathematical exactness, which cannot be done by hand; by which a great saving may be made in seeding the ground, as well as benefiting the expected crop. There has always been a difficulty in sowing turnip seed with any degree of exactness, both from the minuteness of the seed, and the smallness of the quantity required to be sown on an acre. Here the machine has a manifest advantage, as it may be set to sow the least quantity ever required on an acre, and with an accuracy the best seedsman never can attain to. It will also sow clover, cole, flax, and every other kind of small seed, with the utmost degree of regularity. It will likewise broad-cast beans, pease, and tares, or drill them with the greatest exactness, particularly when constructed to be used with a plough. Another advantage attending the use of this machine is, that the wind can have no effect on the falling of the seed."

Explanation of the Sowing machine. Plate I.

Fig. 8. The Machine fixed to a Kentish turn-rest Plough. A. the body of the machine. B. the apron, upon which the seed falls, and rebounds upon the land, in broad-casting. C, lid to cover the hopper. D, wheel at the heel of the plough. E, strap. FF, hook, upon which the apron turns by a pivot on each side. G, stay to keep the machine steady. H, lever to prevent it from sowing.

Fig. 9. The machine constructed to be drawn by a Horse. AAAA, the hoppers. BB, the diagonal supporters, near which are the upper spouts. D, the apron or shelf upon which the seed falls from the upper spouts. E, the level, which carries back the bar, and prevents the machine from sowing. FF, staples upon the handles, through which the reins pass, for the man who conducts the machine to direct the horse by. I, screw to fix the machine occasionally.

N. B. The knobs (by turning which each particular spout may be taken from off the bar, and thereby prevented from seeding) are over each upper spout, but (to prevent confusion) are not lettered in this Figure.

Fig. 10, is the same machine with that in *Fig.* 8, the dotted lines expressing the situation of the long spout, when the apron is removed, and the machine adapted for drilling.

Fig. 11. The Machine, with the Front laid open, to shew the Inside. A, the catch-wheel, fixed upon the axle. BB, the axle, upon which the machine hangs between the handles of the plough. C, the pulley, by which the strap from the heel at the plough turns the catch-wheel. D, the bar, upon which the upper spout rests, suspended by the diagonal supporters EE, bearing against the catch-wheel by the trigger, and thereby kept in motion while the plough is going. G, the apron in a sloping position, upon which the corn or seed falls from the upper spout, and is scattered by rebounding upon the land. It turns upon pivots, and by this means throws the seed either towards the right hand or left, at pleasure.

Fig. 12. The upper spouts. *Fig.* 13. The Plate which is placed between the bridge and the slider for sowing small seeds; the aperture A being downwards for sowing turnips; the larger one, B, downwards for sowing clover, &c.

Fig. 14. The Bridge fixed in the Upper Spouts. A, the slider, which contracts or enlarges the different apertures. B, the aperture in the bridge, through which the seed passes, when sowing any quantity, from one bushel upwards on an acre.

Fig. 15. The Regulator, made of Brass. D, the slider or horse which moves upon it, and is fixed at any particular degree by a screw in its side.

Fig. 16 represents the Movement in the Machine, *Fig.* 9. AAAA, cleets, between which the upper spouts rest. BB, the diagonal supporters, by which the bar with the upper spouts hang. C, the catch-wheel. D D, the axle. E, the trigger, upon the bar, which bears against the catch-wheel. F F, stays from the back of the machine.

Fig. 17. The long Spout. AA, the ears by which it hangs.

☞ The prices are, if constructed to be used with a single furrow plough, three guineas and a half. To a double furrow plough, four guineas and a half. The large machine (Plate I. *Fig.* 9.) seven furrows at a time, 8l. 18s. 6d.

Mr. WINLAW, of Margaret Street, Cavendish Square, having permitted us to make drawings, and give descriptions, of several new and improved machines, made by him for agricultural purposes, we present them to the public.

Description of W. WINLAW'S PATENT MILL, *made upon a Plan entirely new, for separating the Grain from the Ears of Corn, in Place of Threshing.* Fig. 1. Plate II.

"This Mill was tried in June, 1785, in the presence of many gentlemen, and gave the highest satisfaction; and since then to a great number of persons at sundry times, who all expressed pleasure at seeing a performance so complete, and the machine constructed upon a plan entirely new.

"Upon trial, there were passed through the mill one bushel of the heads of wheat in one minute, with very moderate labour to the man that turned it; and, by experiment, it is found that four bushels of the ears will yield one bushel of clean grain. This being allowed, the difference will clearly appear betwixt the expedition of the mill and the labour of a thresher: allowing that a man will thresh six bushels in a day, of eight hours work, the mill will clear that quantity in twenty-four minutes, and to an incomparable greater degree of perfection than can possibly be done by the flail, for it separates every grain from the ears, which must be allowed to be a very great saving; whereas much corn flies off by the flail, and a great deal lost by foul threshing, either when performed by task or day-work; and by using the mill, all fraudulent practices will be prevented: the straw is preserved in its original reed, which must answer the essential purposes of thatching, &c. much better than when bruised under the flail, and every other purpose equally well.

"The IMPROVED COMB, for stripping the ears from the straw, has been tried; and a lad, without having practised, combed out a bushel of ears in twenty minutes, which is at the rate of six bushels of clean corn for one day's work.

"It requires very little practice to enable any person to manage the mill. The dart painted on the fly directs which way to turn the handle, it being pointed as it should be turned. The hopper, which serves to feed the mill, is regulated by the two round pins to which the cords are fixed. The screw at the bottom of the frame is to adjust the distance of the inner nut from the outward cone; for if it is screwed up too much, it will bruise the grain; if lowered down too far, it will admit the ears to pass without effect. The cross bars, which support the axis on which the fly and pinion are fixed, are moveable upwards and downwards, as occasion requires. When the screw at bottom is turned to the right, it moves the nut upwards, and gives less space. The wedges must be slackened above, to admit the axle to rise upward or downward, as may be found necessary. These wedges may be slackened or tightened with great ease, and without any danger of injuring the mill.

References to Fig. 1. Plate II.

AAAA, is the frame of the mill. B, the outward cone. C, the large iron wheel. D, the regulating screw. E, the pinion. G, the top curb surrounding the nut. H, the fly. I, the comb for stripping the ears.

Directions for combing the Bottom of the Sheaves, and stripping the Ears from the Straw.

"The teeth or prongs of the comb are made of steel, and of an angular form, set at convenient distances, so as to strip the ears clean: if set too wide apart, they will pass through without effect; and if too near together, will not admit the straw to go between. The mill, upon a smaller scale, answers equally well for clover-seed: the flowers being first threshed off from the stems, it will clear as much seed from the outward integument, or husk, in three hours, as a man can perform, in the common mode of threshing, in one week; for a man cannot clean much above a bushel in that time. The tediousness of the operation is an evident reason why the seed bears so high a price: the barn floors are likewise quickly destroyed by that tedious forcible performance. It also answers for flax seed, canary, or any other small seeds: also for separating the husks from rice, which, by the present method in practice, is performed at a great expence of time and hard labour. The same methods may be observed in regulating the small one for clover seed as the corn mill."

How far this threshing mill may be capable of separating grain from the heads of wheat we will not pretend to determine, but we think it admirably calculated to thresh clover seed, after the heads are beat from the straw: this being an operation so tedious and expensive, a machine, on a simple construction, to render the business more easy and expeditious, has long been wished for. Having seen this machine at work, we are firmly persuaded it is a great acquisition to those who grow clover seed. We also saw it tried in milling, or separating the husks from trefoil, which it effected both completely and expeditiously.

An ENGINE *for cutting* STRAW *for Cattle; also* SUGAR-CANE TOPS, *&c. which renders it very useful for the Sugar-Plantations, as well as the Purposes of Husbandry.*

"This machine has given entire satisfaction, being so contrived, that it requires no practice to make any person perfect in working it, as the whole operation is performed by turning a winch, and can be made to cut the straw to any length required. I have lately improved this useful machine; and the great demand, both at home and abroad, sufficiently proves its utility and benefit to the purchaser.

Directions how to use the Chaff Engine. Fig. 2. Plate II.

"Put no more straw in the box at once than will be about two inches and a half thick at the front end, where the two knives are placed. When the straw is within two feet of being worked out, put in a fit quantity of fresh straw; for it is attended with more trouble to put it under the pressing board after the straw has been wholly worked out. Observe the sliding rack, that

that moves forward by turning the handle; when it is worked up to the end of the box, unhook the turn-buckle, lift up the rack, and move it back to the extent of the grooves, which are cut in the hinged board in the inside of the box, and turn the hooked catch into its place again. Its only use is to keep the rack in the worm below, that moves it forward."

Explanation of Fig. 2. Plate II.

It shews a front view of the machine, displaying its mechanical principles. A, A, the fly, of cast iron. B, B, knives annexed to the fly with screws. C, pulley wheel, to which an iron weight is suspended by a chain. D, iron weight, which compresses the straw at the instant it is cut by the knife. E, screw or worm, which brings forward the straw: this in the machine is in a right line with the spindle of the windlas, but is here elevated to display its action. F, handle or windlas, by which the fly is turned, and the operation performed. G, guard to prevent accidents as the fly revolves. H, frame to support the whole.

Explanation of Fig. 3. Plate II.

It shews a profile view of the same. A, the box, or hopper containing the sliding rack which holds the straw. B, sliding rack. C, pulley wheel. D, chain going round the wheel, and fastened to the weight. E, a short projecting iron, which being touched by another, as the fly and knives revolve, raises the weight, and gives permission to the straw to be brought forward.

As the cutting chaff for cattle is a circumstance of the most material consequence, and the common method being very laborious, we think this invention will greatly facilitate the operation; and that a strong boy may, with ease, do as much work with this machine as two men can in the common method.

BRUISING ENGINE *for* MALT, *instead of the common Method of Grinding; likewise for Beans, and other Grain, for Horses, and other Cattle, represented in* Fig. 4. Plate II.

"As Horses swallow great part of the corn given them whole, or without chewing, and which often passes through them in the same state, they cannot receive any nourishment from the grains that are unbroke; but when bruised in this machine, it eases mastication, and every grain is prepared for nutrition, consequently a much less quantity will be found sufficient for cattle.

"This machine is equally useful for bruising malt. By repeated experiments, it has been found, that malt, bruised, is more advantageous than the common method of grinding and flouring, by which a great part is wasted. It is much more expeditious than the common method, and by no means liable to be out of repair."

Directions how to use the above Engine.

"To bruise oats, screw the large roller close up to the small one, and do not feed too fast from the shoe, which you regulate by the pins which have strings fixed to them. When you bruise beans, unscrew the two regulating screws a little, and put the fly in motion with your hand, on account that the rollers are then a little space apart, and will not turn each other before the beans come between them. Feed slow and regular at first, until you have a little practice: oil the pivots frequently, or the iron will cut the coupling brasses, and damage the mill.

Of the superiority of bruising malt, in preference to grinding it, we can, from experience, give ample testimony: when two smooth surfaces are opposed to each other, at a distance which can be regulated at pleasure, neither grain, nor any other substance of a like nature, can pass between them without being flattened or bruised. This being the principle on which the bruising mill acts, the mealy substance, which is the essential part of malt, is entirely removed from the skin, or husk, which contains it, and all the virtues of the malt are with ease extracted by the water, in a manner superior to malt which is cut to peices by grinding. We attentively examined this machine; and Mr. WINLAW, at our request, procured a bushel of malt, purposely to exhibit the perfections of his machine; and we were witness that two men, with ease, bruised a bushel of malt in one minute, and believe there was not a single grain escaped whole.

References to the Bruising Mill, Fig. 4. Plate II.

A A A A, the frame. B, the large cylinder. C, the small ditto. D, the hopper. E, the shoe. F, the frame that supports the hopper. G, the fly wheel. H, the Windlas.

WINLAW'S WINNOWING MACHINE, *for Dressing* CORN, RAPE-SEED, FLAX-SEED, MUSTARD-SEED, &c.

"This machine winnows, riddles, and screens, all at one operation, and will finish, after the thresher, between twenty and thirty bushels in one hour; and will dress in the granary ten quarters in the hour. The three principal performances of this machine are, that it dresses better, is attended with less waste, and more expeditiously, than any other method yet found out; as has been proved by a great many gentlemen, corn-merchants and farmers. It gives corn an additional brightness, by passing through wire riddles and screens, both fixed and moving: and the benefit in a granary is, that it cleans the corn from dust, which breeds weevels; and blows them out, if any be in. The above machine will dress malt better than any other method yet found out, and much quicker."

In using this winnowing machine, three persons are necessary; one to supply the hopper, another to turn the handle which gives motion to the machine, and a third to remove the grain from the bottom of the screen. In Yorkshire, and other parts of the north, these implements are generally used, and with the greatest success; and as the construction is simple, and the performance expeditious, we think the invention of great utility. Those made by Mr. WINLAW are on a better principle than any other we have seen, and make no doubt they are much improved by his ingenuity.

Reference to the Winnowing Machine, Fig. 5. Plate II.

A, the body of the machine, in which are the fan, riddle, and screen. B, hopper, where the machine is supplied. C, wheel which gives motion to the work, the windlas being on the opposite side on the same spindle. D, pulley-wheel, that moves the fan, screen, and riddle. E, crank-rod, fastened to the riddle and screen, and gives them motion. F, chain going round each wheel in a groove. G, four short handles, to convey it from place to place by two men. H, feet or supporters. I, fan, made of wood, which blows chaff from the corn. There is annexed to this machine a riddle, which stops straw, the heads of corn, and other matters. Also a close screen, by which the corn is perfectly cleaned.

A MACHINE, *on a simple Construction to cut* TURNIPS, POTATOES, CARROTS, *or* CABBAGE, *before they are given to Cattle.*

This machine will cut into pieces of any size, according to the pleasure of the person who uses it, as many roots, and other such kind of substances, in one minute, by the turning of a wheel, as by the common method would employ a person one hour. It is perfectly simple in its operation and make, and composed of very few movements, of course not liable to be out of repair.

Reference to the Turnip-Cutter, Fig 6. Plate II.

A, the hopper, into which the roots or cabbages are put. B, fly-wheel, which by a windlas gives motion to the machine. C, handle or windlas. D, lower part of the wheel, which is armed with four knives, set narrow or wide by means of screws. E, frame. F, cutting-wheel, which contains the knives mentioned as above.

Before we dismiss this subject, we cannot but express our surprise that Agriculture is not more followed, as it is, of all others, the most rational and healthy employment that can possibly be pursued. It is a happy circumstance to reflect that it is now espoused by the wise and the wealthy. Those who imagine that the culture of the earth is not sufficient to employ all its inhabitants are greatly mistaken. An ancient Roman, we are told, could maintain his family from the produce of one acre of ground So might a modern Briton, if he would be contented to live like a Roman. This shews what an immense increase of inhabitants Britain might admit of; and all of them live by the culture of the ground.

Agriculture is the great source of domestic riches. Where it is neglected, whatever wealth may be imported from abroad, poverty and misery will abound at home. Such is, and ever will be, the fluctuating state of trade and manufactures, that thousands of people may be in full employment to-day, and in beggary to-morrow. This can never happen to those who cultivate the ground. They can eat the fruits of their labour, and can always, by industry, obtain at least the necessaries of life.

Premiums have a tendency to excite a spirit of emulation and industry, and to increase the produce of the earth according to the different mode to which any district or county has been accustomed; and Agriculture Societies, by holding out rewards, cannot fail to serve their country in the most essential manner.

It is devoutly to be wished, that every person concerned in Agriculture, would always communicate his discoveries to the public; for whenever any scheme of real utility, and national importance, is formed by men of genius and true patriotism, the worst kind of impediment it can meet with is that of national supineness and inattention. If it be not actually opposed, it is not promoted; and if people do not reflect on it, they cannot see its importance. If we consider how much the produce of the country is diminished through the mistaken prejudices of custom, and view the almost immeasurable quantity of improveable land which yet remains waste, and next to barren, we cannot but agree in the supposition of Mr. Harte, that the lands of England may be made to produce one sixth-part more than they do; a point this of great national importance, amounting to near four millions of money annually!

Gratitude obliges us to return our sincere thanks to those whose kindness we have experienced in their several communications. Our endeavours have been to render service to the art; if we have succeeded in any respect, the thought of having added in the smallest degree to so important a pursuit, is a most gratifying reward.

In the course of this System we have introduced such remarks and observations as are consentaneous to our ideas; and we trust they will appear to be founded on practical and experimental knowledge of the art we have endeavoured to illustrate.

AGROM, a diſeaſe frequent in Bengal, and other parts of the Indies, wherein the tongue chaps and cleaves in ſeveral places, being extremely rough withal, and ſometimes covered with white ſpots. The Indians are very fearful of this diſeaſe, which they attribute to extreme heat of the ſtomach. Their remedy is to drink ſome chalybeate liquor, or the juice of mint.

AGUE, a periodical diſeaſe, of the fever kind, conſiſting in a cold ſhivering fit, ſucceeded by a hot one; and going off in a diaphoreſis, or ſweating. If the coldneſs and ſhivering be inconſiderable, and only the hot fit felt, the diſeaſe is called an intermitting fever. According to the periods or times of the returns of the fit, the diſeaſe is either a *quotidian*, *tertian*, or *quartan ague*, or *fever*.

The cauſe of agues ſeems to be an obſtructed perſpiration, or whatever, by overloading the juices, retards their motion, or occaſions a lentor in the blood. The *cauſa proxima* ſeems to be a corruption of humours of the body. The ſymptoms are, heavineſs and reaching; a weak, ſlow pulſe; coldneſs and ſhivering felt firſt in the joints, thence creeping over the whole body; pain in the loins; and an involuntary motion of the under jaw.

A *vernal ague* is eaſily cured; but an *autumnal* one is more obſtinate, eſpecially in aged and cachectical perſons; and particularly, if complicated with a dropſy, peripneumony, &c. When an ague proves fatal, it is uſually in the cold fit, through the oppreſſion of the ſpirits. The cure is uſually begun with an emetic of *ipecacuanha*, an hour before the acceſs, and completed with the *Cortex Peruvianus*, adminiſtered in the interval between two fits; and continued, at times, to prevent a relapſe.

We meet with divers other methods of curing agues, beſides that by the cortex; as by the means of tea, which, taken an hour before the acceſs, is ſaid to remove the obſtruction, and correct the acidity; by *ſal volatile*, which acts by attenuating the blood. In the iſland of Tino, by an infuſion of flowers of little centaury. See Phil. Tranſ. No. 145.

Sir John Pringle accounts for them by means of the principle of putrefaction. The heat of the body, he obſerves, varies little; and, therefore, the corruption produced in any of the humours muſt happen in a determinate time. If we ſuppoſe that, in the paroxiſm, the more corrupted particles of the blood do not at all paſs off through the ſkin with the ſweat, but that ſome part of them is diſcharged with the bile, their particles coming into the inteſtines, and being from thence taken up by the lacteals, and carried into the blood, may there act as a new ferment; and occaſion a return of the fit. Thus the corruption of the bile may be the cauſe of the firſt fit, as well as of thoſe that follow. He farther adds, that, though all moiſt countries are ſubject to agues of ſome kind or other, yet, if the moiſture is pure, and the ſummers are not cloſe and hot, they will moſtly be regular *tertian agues*, and admit an eaſy cure. But if the moiſture ariſes from long ſtagnating water, in which plants, fiſhes, and inſects die and rot, then the damps, being of a putrid nature, occaſion not only more frequent, but more dangerous fevers, which more commonly appear in the form of quotidians, and double tertians, than that of ſingle ones. Accordingly, they are found to vary with the ſeaſon, on which the degree of putrefaction in a great meaſure depends. Though the bark be the moſt effectual remedy in this diſtemper, yet it has been known to cauſe worſe diſorders. For a farther deſcription of the cauſes, prognoſis, and cure, ſee the ſyſtem of MEDICINE, Genus ii. and iii.

AGUILLANEUF, or AUGILLANEUF, a form of rejoicing uſed among the ancient Franks on the firſt day of the year. The word is compounded of the French *A*, "to;" *gui*, "miſſeto;" and *l'an neuf*, "the new year." Its origin is traced from a druid ceremony: the prieſts uſed to go early in December, which with them was reputed a ſacred month, to gather miſſeto, from the oak; in great ſolemnity. The prophets marched in the front, ſinging hymns in honour of their deities: after them came an herald, with a caduceus in his hand: theſe were followed by three druids abreaſt, bearing the articles neceſſary for ſacrifice: laſt of all came the chief, or arch-druid, accompanied with a train of people. The chief druid climbing the oak, cut off the miſſeto with a golden ſickle, and the other druids received it in a white cloth. On the firſt day of the year it was diſtributed among the people, after having bleſſed and conſecrated it, by crying, *A gui l'an neuf*; to proclaim the new year. This cry is ſtill continued in Picardy, with the addition of *Plantez*, *Plantez*; to wiſh a plentiful year. In Burgundy, and ſome other parts, the children uſe the ſame word to beg a new-year's gift. Of later times the name *Aguillaneuf* was alſo given to a ſort of begging, practiſed in ſome dioceſes, for church tapers, on new-year's day, by a number of young people of both ſexes, having a chief, &c. It was attended with various ridiculous ceremonies, as dancing in the church, &c. which occaſioned the ſynods to ſuppreſs it.

AGUTI, a ſpecies of the Genus Mus, in the Syſtem of Mammalia. It is an American animal, much reſembling the Guinea-pig, as we call it, having the characters of the rat-kind, with the voice and hair of the hog. The hairs are very hard, thick, and gloſſy, and are of a mixt colour, of a reddiſh and brown, with more or leſs black: thoſe on the belly, however, are yellowiſh: its head and whiſkers are like thoſe of the rabbit-kind, but the noſe is ſharper, and the upper chop longer than the under one, as in the hog-kind; the upper lip is ſplit, as in the hare; and the legs are naked, or have at the utmoſt only a few ſcattered hairs on them; the fore-feet have four toes, and the hinder ones ſix, and theſe are much longer than the fore-legs; its tail is very ſhort, and its eyes prominent: its voice altogether reſembles the grunting of a hog. It is a very voracious animal, devouring its food with extreme eagerneſs, and uſing its fore feet for hands, in the manner of the ſquirrel. It runs very ſwiftly; and is very expert at digging, ſo that it ſoon buries itſelf in the earth. When provoked, it raiſes all the hair of its back upright, and ſtrikes the earth with its hinder feet. For a more particular deſcription, ſee MUS. For a repreſentation, ſee Plate VII. Genus 24. Species 2.

AIGUISCE, in heraldry, denotes a croſs with its four ends ſharpened, but ſo as to terminate in obtuſe angles. It differs from the *croſs-fitchee*, in as much as the latter tapers by degrees to a point, and the former only at the ends.

AIR, in natural philoſophy, a thin, fluid, elaſtic, tranſparent, ponderous, compreſſible, and dilatable body, ſurrounding the terraqueous globe to a conſiderable height. Air was conſidered by ſome of the ancients as an element; but then by element they underſtood a different thing from what we do. See ELEMENT.

It is certain that air, taken in the popular ſenſe, is far from the ſimplicity of an elementary ſubſtance; though ſome of its properties and uſes, in a ſtate of combination with various ſubſtances, from which it has been extricated by modern analyſis, may entitle it to this appellation. Hence air may be diſtinguiſhed into *proper* or *elementary*, and *vulgar* or *heterogeneous*.

Elementary AIR, or AIR *properly ſo called*, is a certain ſubtile, homogeneous elaſtic matter, the baſis, or fundamental ingredient, of the atmoſpherical air, and that which gives it the denomination. In this ſenſe it likewiſe enters into the compoſition of moſt, or, perhaps, all bodies, exiſting in them under a ſolid form, deprived of its elaſticity, and moſt of its diſtinguiſhing properties, and ſerving as their cement, and the univerſal bond of nature; but capable, by certain proceſſes, of being diſengaged from them, recovering its elaſticity, and reſembling the air of our atmoſphere. See Hale's Vegetable Statics, chap. vi.

The peculiar nature of this aerial matter we know but little of, what authors have advanced concerning it being chiefly conjectural. We have no way of altogether ſeparating it from the other matters with which, in its pureſt ſtate, it is more or leſs combined, and conſequently no way of aſcertaining, with ſatisfactory evidence, its peculiar properties, abſtractedly from thoſe of other bodies. Dr. Hooke, and ſome others, maintain, that it is the ſame with the *æther*, or that fine, fluid, active matter, diffuſed through the whole expanſe of the celeſtial regions, which coincides with Sir Iſaac Newton's *ſubtile medium*, or *ſpirit*. In this view it is ſuppoſed to be a body *ſui generis*, ingenerable, incorruptible, immutable; preſent in all places, in all bodies. Others, conſidering only its property of elaſticity, which they account its eſſential and conſtituent character, ſuppoſe it to be mechanically producible, and to be no other than the matter of other bodies, ſo modified and altered, as to become permanently elaſtic. Sir Iſaac Newton obſerves, that the particles of denſe, compact, and fixed ſubſtances, cohering by a ſtrong attractive force, are not ſeparable without a vehement heat, or perhaps not without fermentation; and ſuch bodies being at length rarefied by ſuch heat or fermentation, become true permanent air; and diſtinguiſhable from vapour, which is only apparent or tranſient air, as is evident from the experiment with the *æolipile*. Optics, Qu. 31. p. 371. 372. ed. 3.

Heterogeneous AIR is a coalition of corpuſcles of various kinds, which together conſtitute one fluid maſs, wherein we live and move, and which we are continually receiving and expelling by reſpiration. The whole aſſemblage of this makes what we call the *atmoſphere*. Where this air, or atmoſphere, terminates, there æther is ſuppoſed to commence, which is diſtinguiſhed from air, by its not making any ſenſible refraction of the rays of light, as air does. Air, in this popular and extenſive meaning of the term, is acknowledged by Mr. Boyle to be the moſt heterogeneous body in the univerſe. Boerhave ſhews it to be an univerſal chaos, or *colluvies*, of all kinds of created bodies. Beſide the matter of light or fire, which continually flows into it from the heavenly bodies, and probably the magnetic effluvia of the earth, whatever fire can volatilize is found in the air. Hence, for inſtance, 1. The whole foſſil kingdom muſt neceſſarily be found in it; for all of that tribe, as ſalts, ſulphurs, ſtones, metals, &c. are convertible into fume, and thus capable of being rendered part of the air. Gold itſelf, the moſt fixed of all natural bodies, is found to adhere cloſe to the ſulphur in mines, and thus to be raiſed along with it. Mr. Boyle obſerves, that, beſide the ſaline effluvia of the common ſort, ſuch as the nitrous, vitriolic, marine, &c. there may

may be many compounded kinds of salts in the air, which we have not on earth, arising from different saline spirits, fortuitously meeting and mixing together. Thus the glass windows of ancient buildings are sometimes observed to be corroded, as if they had been worm-eaten; though none of the simple salts above-mentioned have the faculty of corroding glass. Sulphurs too must make a considerable ingredient of the air, on account of those many volcanos, grottos, caverns, and other spiracles chiefly affording that mineral, dispersed through the globe. 2. All the parts of the animal kingdom must also be in the air: for, besides the copious effluvia continually emitted from their bodies, by the vital heat, in the ordinary process of perspiration, by means of which an animal, in the course of its duration, impregnates the air with many times the quantity of its own body, we find that any animal, when dead, being exposed to the air, is in a certain time wholly incorporated with it. 3. As to vegetables, none of that class can be supposed wanting, since we know that all vegetables, by putrefaction, become volatile. The articulations, separations, attritions, dissolutions, and other operations of one sort of matter upon another, may likewise be considered as sources of numerous other neutral, or anonymous bodies, unknown to us. Air, in this general sense, is one of the most considerable and universal agents in all nature, being concerned in the preservation of life, and the production of most of the phenomena relating to our world. Its properties and effects, including a great part of the researches and discoveries of the modern philosophers, have, in a considerable degree, been reduced to precise laws and demonstrations; in which form they make a very extensive and important branch of the mixed Mathematics, called *Pneumatics*. For the phenomena, properties, ingredients, nature, species, and uses of this branch of natural philosophy, see the System of AEROLOGY throughout; and for experiments to illustrate the weight, pressure, elasticity, and the effects arising from those properties, see the System of PNEUMATICS throughout, and the Plates which illustrate the same.

AIR, in medicine, &c. makes one of the six non-naturals. From observations on bleeding in rheumatisms, and after taking cold, it is evident the air can enter with all its qualities, and vitiate the whole texture of the blood, and other juices. From the palsies, vertigoes, and other nervous affections caused by damps, mines, &c. it is evident that air, thus qualified, can relax and obstruct the whole nervous system: and from the cholics, fluxes, coughs, and consumptions produced by damp, moist, and nitrous air, it is evident it can corrupt and spoil the noble organs, &c.

Circulation of AIR *in Rooms.* To render the circulation of air sensible, let the air of a room be heated by a strong fire, whilst the air of a contiguous room is cold: then let the door between these two rooms be opened, in which case the hot air of one room being lighter, will pass through the upper part of the opening of the door into the cold room; and, on the contrary, the cold air of the other room, being heavier, will pass into the former room through the lower part of the opening: accordingly, it will be found, that applying a lighted candle at the top, in the middle, and at the lower part of the opening, between the two rooms, a strong current of air will appear to pass from the hot into the cold room near the top; a contrary current of air will appear to pass from the latter into the former room, near the lower part of the said opening, whilst in the middle there is little or no motion at all, as may be clearly perceived by the direction of the flame of the candle. It is for the same reason that, when the fire is lighted in the chimney, a strong current of air is occasioned to enter the room, which may be felt by applying the hand near the key-hole, or other such small openings, if the doors and windows are shut; for the air over the fire being heated, becomes lighter, and ascends into the chimney, consequently other colder air must supply its place, which forces its way through all the small openings it can find. Were a room, with a fire in it, to be perfectly closed, excepting the chimney, the air in it would soon become unwholesome for respiration, and the fire would be soon extinguished, besides other inconveniencies. Hence it appears that those persons mistake, who expect to keep the air of a room sweet and wholesome, especially for convalescents, by closely stopping all the smallest openings that admit fresh air. When the current of air, that enters into a room, is on some side of it where it falls immediately upon the persons who sit in the room, then it may be offensive, especially to delicate constitutions. In that case, such opening should be closed; but at the same time another opening should be made for admitting fresh air, in another more convenient part; for a circulation of air, especially in rooms where a fire is kept, is not only salutary and useful, but absolutely necessary.

In an ingenious publication, entitled, *A Practical Treatise on Chimnies*, there are the following remarks relating to the properest method of admitting air into a room, and of expelling the contaminated air. The author, directing to make a vent-hole near the top of the room, in order to expel the heated and contaminated air, says, "this might be done by means of a small tube opening into the room, either in or near the ceiling; which might either be carried to the top of the building, or be made to communicate with the external air, by a small perforation through the wall at the roof of the room; by means of either of which, a proper circulation would be established, and the foul air be carried off: for the fire would no sooner have warmed any particles of air within the room, than these would be greatly expanded, and rise immediately upwards, so as to fill the higher parts of the room with rarefied air; and as other particles would be successively heated and rarefied in their turn, by their expansive force, they would press upon the sides of the apartment in every place, so as to force the lightest particles through the opening left for that purpose in the top of the room; by which means the foulest air would be gradually drawn off, without descending again into the lower regions, to the annoyance of the company." But, in order to admit fresh air into the room, "Let (says he) another opening be made in the ceiling of the room, having a communication with a small pipe, that should lead from thence either to the outside of the wall, or to any other part of the building, that might be judged more convenient, where it should be bent, and conducted downwards, till it reached the ground, where it should be left open, to communicate with the external air. In this situation the cool external air would be forced in at the lower opening of the tube, and made to ascend into the apartment, in proportion to the quantity that escaped towards the higher regions, by means of the ventilator; and as that weighty air would no sooner enter the room, than it would tend towards the floor by its own natural gravity, it would gradually mix with the heated air in its descent, become in some measure warmed by that means, and equally dispersed through the room, so as slowly and imperceptibly to reach the candles and the company in the room, and supply them with a sufficient quantity of fresh and wholesome air, without the inconveniences to which the company are subjected by the usual way of admitting fresh air. For if it enters near the floor of the apartment, it is hurried along in a rapid undivided stream towards the fire-place, and striking upon the legs, and inferior parts of the body, affects them with a strong sensation of cold. To overcome the effects of this, large fires must be kept, by which other parts of the body are warmed to an extraordinary degree, which is productive of most of those disorders that are pernicious to the young, and often prove fatal to the old, during the winter season, in these cold regions. Thus might our apartments be kept constantly, moderately, and equally warm, at a moderate expence, without endangering our health, on the one hand, by a respired, confined, stagnant, and putrid air, or, on the other hand, by subjecting ourselves to such danger of catching colds, consumptions, and rheumatic complaints, by being exposed to such exceedingly unequal degrees of heat and cold, as are unavoidable where our apartments are so open as to admit a ready passage to the external air during the winter season.

The reader will easily perceive, that all that has been here said, has a reference only to those apartments in cold climates, and rigorous weather, where fire to warm them becomes necessary. In warmer regions, or during the summer season, there can be no objection to the wheel ventilator in the window. It is a simple contrivance, and a safe and effectual means of preserving the air in our apartments sweet and wholesome at that season.

It is a vulgar error among many people, to believe that fire purifies the contaminated air, by destroying the noxious particles mixed with it; and for this reason they think that the fire kept in a room where the air is tainted, purifies the room, by rendering the air in it again fit for respiration. Indeed, a fire kept in a room or apartment where the air is tainted, as is the case with hospitals, gaols, and the like, does certainly purify the apartment, and the practice is very useful; but this effect is only because the fire promotes the circulation of the air, and dries the dampness of rooms, furniture, &c. so that it is not the infected air that is purified, but is new, fresh, and wholesome air, that, by the action of the fire, has taken the place of the infected air; which infected air, being rarefied by the heat, has been expelled from the apartment. Fire and combustion, in general, are so far from purifying contaminated air, that it actually contaminates a prodigious quantity of it in a short time; so that not only a common fire, but even a lighted candle, when kept in a well-closed room, wherein the external air has not a free access, instead of purifying, renders the air of that room noxious.

AIR *Balloons*, a general name given to bags of any light substance filled with inflammable air, or other permanently elastic fluid, whose specific gravity is considerably less than that of common atmospheric air. The consequence of their being filled in this manner is, that, if they are of any considerable magnitude, they ascend in the air to an amazing height, and will not only ascend in this manner by themselves, but carry up along with them great weights, and continue to rise till they attain an height in which the circumambient air is of the same specific gravity with themselves. In this situation they will either float, or be driven in the direction of the wind or current of air in which

which they are expoſed, remaining in theſe elevated regions, till the fluid eſcapes by the burſting of the bags from the ſuperior elaſticity of the fluid, or by its gradual evaporation through the pores of the envelope. The hiſtory, principles, &c. of theſe machines are copiouſly detailed in the Syſtem of AEROSTATION.

AIR-*Bladder*, in fiſhes. See COMPARATIVE ANATOMY, SECT. III.

AIR-*Gun*, a pneumatic machine for diſcharging bullets, &c. with great violence.

Air-guns of late years have received very great improvements in their conſtruction. *Fig.* 10, in the third Plate of PNEUMATICS, is a repreſentation of one made by the late Mr. B. Martin, of London, and now by ſeveral of the mathematical inſtrument and gun-makers of the metropolis. For ſimplicity and perfection, it exceeds any other heretofore contrived. A is the gun barrel, with the lock, ſtock, ram-rod, and of the ſize and weight of a common fowling-piece. Under the lock, at *b*, is a round ſteel tube, having a ſmall moveable pin in the inſide, which is puſhed out when the trigger *a* is pulled by the ſpring-work within the lock: to this tube *b*, a hollow copper-ball, *c*, ſcrews, perfectly air-tight. This copper ball is fully charged with condenſed air by the ſyringe B (*fig.* 11.) previous to its being applied to the tube *b* of *fig.* 10. It is then evident that if a bullet be rammed down in the barrel, and the copper ball ſcrewed faſt at *b*, and the trigger *a* be pulled, that the pin in *b* will, by the action of the ſpring-work within the lock, forcibly ſtrike out into the copper ball, and thereby puſhing in ſuddenly a *valve* within the copper ball, let out a portion of the condenſed air, which air will ruſh up through the aperture of the lock, and forcibly act againſt the bullet, driving it to the diſtance of 60 or 70 yards or further. If the air is ſtrongly condenſed at every diſcharge, only a portion of the air eſcapes from the ball, therefore, by re-cocking the piece, another diſcharge may be made, and this repeated to the amount of 15 or 16 times. An additional barrel is ſometimes made, and applied for the diſcharge of ſhot, inſtead of the one above deſcribed.

The air in the copper ball is condenſed by means of the ſyringe B (*fig.* 11) in the following manner: The ball *c* is ſcrewed quite cloſe on the top of the ſyringe at *b*, at the end of the ſteel-polliſhed rod: *a* is a ſtout ring, through which paſſes the rod *k*; upon this rod the feet ſhould be firmly ſet; then the hands are to be applied to the two handles *i i*, fixed on the ſide of the barrel of the ſyringe. Now by moving the barrel B ſteadily up and down on the rod *a*, the ball *c* will become charged with condenſed air; and it may be eaſily known when the ball is as full as poſſible, by the irreſiſtible action that the air makes againſt the piſton when you are working the ſyringe. At the end of the rod *k* is uſually a four-ſquare hole, which, with the rod, ſerves as a key to faſten the ball *c* faſt on the ſcrew *b* of the gun and ſyringe cloſe to the orifice in the ball *c*. In the inſide is fixed a valve and ſpring, which gives way for the admiſſion of air; but, upon its emiſſion, comes cloſe up to the orifice, ſhutting up the internal air. The piſton-rod works air tight, by a collar of leather on it, in the barrel B: it is therefore plain, when the barrel is drawn up, the air will ruſh in at the hole *h*. When the barrel is puſhed down, the air therein contained will have no other way to paſs from the preſſure of the piſton but into the ball *c* at top. The barrel being drawn up, the operation is repeated, until the condenſation is ſo ſtrong as to reſiſt the action of the piſton.

AIR-*Jacket*, a ſort of jacket made of leather, in which are ſeveral bags or bladders, compoſed of the ſame materals, communicating with each other. Theſe are filled with air through a leather tube, having a braſs ſtop-cock accurately fixed at the extremity, by which means the air blown in through the tube is confined in the bladders. The jacket muſt be wet before the air be blown into the bags, as otherwiſe it will immediately eſcape through the pores of the leather. By the help of theſe bladders, which are placed near the breaſt, the perſon is ſupported in the water, without making the efforts uſed in ſwimming.

AIR-*Pipes* an invention for drawing foul air out of ſhips, or any other cloſe places, by means of fire. Theſe pipes were firſt found out by one Mr. Sutton, a brewer in London; and from him have got the name of Sutton's air-pipes. The principle on which their operation depends is known to moſt people, being, indeed, no other than that air is neceſſary for the ſupport of fire; and if it has not acceſs from the places moſt adjacent, will not fail to come from thoſe that are more remote. Thus, in a common furnace, the air enters through the aſh-hole; but if this is cloſed up, and a hole made in the ſide of the furnace, the air will ruſh in with great violence through that hole. If a tube, of any length whatever, is inſerted in this hole, the air will ruſh through the tube into the fire, and of conſequence there will be a continued circulation of air in that place where the extremity of the tube is laid. Mr. Sutton's contrivance, then, as communicated to the Royal Society, by Doctor Mead, amounts to no more than this: "As in every ſhip, of any bulk, there is always provided a copper or boiling-place, proportionable to the ſize of the veſſel, it is propoſed to clear the bad air by means of the fire already uſed under the ſaid coppers or boiling places for the neceſſary uſes of the ſhip. It is well known that, under every ſuch copper or boiler, there are placed two holes, ſeparated by a grate; the firſt of which is for the fires, and the other for the aſhes falling from the ſame; and that there is alſo a flue from the fire-place upwards, by which the ſmoke of the fire is diſcharged at ſome convenient place of the ſhip. It is alſo well known, that the fire, once lighted in theſe fire-places, is only preſerved by the draught of air through the forementioned two holes and flue; and that if the ſaid two holes are cloſely ſtopped up, the fire, though burning ever ſo briſkly before, is immediately put out. But if, after ſhutting up the abovementioned holes, another hole be opened, communicating with any other room or airy place, and with the fire, it is clear the ſaid fire muſt again be raiſed, and burn as before, there being a light draught of air through the ſame, as there was before the ſtopping up of the firſt holes; this caſe differing only from the former in this, that the air feeding the fire will now be ſupplied from another place. It is therefore propoſed, that, in order to clear the holds of ſhips of the bad air therein contained, the two holes abovementioned, the fire-place and aſh-place, be both cloſed up with ſubſtantial and tight iron-doors; and that a copper or leaden pipe, of ſufficient ſize, be laid from the hold into the aſh-place, for the draught of air to come in that way to feed the fire; and thus it ſeems plain, from what has been already ſaid, that there will be, from the hold, a conſtant diſcharge of the air therein contained; and conſequently, that air, ſo diſcharged, muſt be as conſtantly ſupplied by freſh air down the hatches, or ſuch other communications as are opened into the hold; whereby the ſame muſt be continually freſhened, and its air rendered more wholeſome and fit for reſpiration. And if into this principal pipe, ſo laid into the hold, other pipes are let in, communicating reſpectively either with the well or lower decks, it muſt follow, that part of the air, conſumed in feeding the fire, muſt be reſpectively drawn out of all ſuch places to which the communication ſhall be ſo made.

This account is ſo plain, that no doubt can remain concerning the efficacy of the contrivance. It is evident that, by means of pipes of this kind, a conſtant circulation of freſh air would be produced through thoſe places, where it otherwiſe would be moſt apt to ſtagnate and putrify. Several other contrivances have been uſed for the ſame purpoſe; and Doctor Hale's ventilators, by ſome unaccountable prejudice, have been reckoned ſuperior in efficacy, and even ſimplicity, to Mr. Sutton's machine, which, at its firſt invention, met with great oppoſition, and even when introduced by Dr. Mead, who uſed all his intereſt for that purpoſe, was ſhamefully neglected.

A machine capable of anſwering the ſame purpoſe was invented by M. Deſaguliers, which he called the *ſhip's lungs*. It conſiſted of a cylindrical box, ſet up on its edge, and fixed in a wooden pedeſtal. From the upper edge of the box iſſued a ſquare trunk, open at the end, and communicating with the cavity of the box. Within this box was placed a cylindrical wheel, turning on an axis. It was divided into twelve parts, by means of partitions placed like the radii of a circle. Theſe partitions did not extend quite to the centre, but left an open ſpace of about eighteen inches diameter in the middle. Towards the circumference they extended as far as poſſible, without interfering with the caſe, ſo that the wheel might always be allowed to turn freely. Things being thus circumſtanced, it is plain, that if the wheel was turned towards that ſide of the box on which the trunk was, every diviſion would puſh the air before it, and drive it out through the trunk; at the ſame time that freſh air would come in through the open ſpace at the centre, to ſupply that which was thrown out through the trunk. By turning the wheel ſwiftly, a ſtrong blaſt of air would be continually forced out through the ſquare trunk, on the ſame principles on which a common fanner winnows corn. If the wheel is turned the oppoſite way, a draught of air may be produced from the trunk to the centre. If this machine then is placed in a room where a circulation of air is wanted, and the trunk made to paſs through one of the walls, by turning the wheel ſwiftly round, the air will be forced with great velocity out of that room, at the ſame time that freſh air will enter through any chinks by which it can have acceſs to ſupply that which has been forced out. It is evident that the circulation which is promoted by this machine is entirely of the ſame kind with that produced by Mr. Sutton's; the turning of the wheel in M. Deſaguliers's machine being equivalent to the rarefaction of the air by fire in Mr. Sutton's: but that the latter is vaſtly ſuperior, as acting of itſelf, and without intermiſſion, requires no arguments to prove. Mr. Sutton's machine has yet another conveniency, of which no other contrivance for the ſame purpoſe can boaſt; namely, that it not only draws out putrid air, but deſtroys it, by cauſing it to paſs through fire; and experience has abundantly ſhewn, that, though putrid air is thrown into a great quantity of freſh air, it is ſo far from loſing its pernicious properties, that it often produces noxious diſeaſes. We do not ſay, indeed, that putrid air becomes ſalutary by this means, but it is undoubtedly rendered leſs noxious

than before; though, whether it is equally innocent with the ſmoke of a fire fed in the common way, we cannot pretend to determine.

Beſides this machine by M. Defaguliers, the ventilators of Dr. Hales, already mentioned, and thoſe called *wind-ſails*, are likewiſe uſed for the ſame purpoſe; the former of which is an improvement of the Heſſian bellows. The other is a contrivance for throwing freſh air into thoſe places where putrid air is apt to lodge; but this has the laſt-mentioned inconvenience in a much greater degree than any of the others, as the blaſt of freſh air throws out that which was rendered putrid by ſtagnation, in ſuch a manner as to contaminate all around it.

AIR-*Trunk* is alſo a contrivance by Doctor Hales, to prevent the ſtagnation of putrid effluvia in jails, and other places where a great number of people are crowded together in a ſmall ſpace. It conſiſts only of a long ſquare trunk, open at both ends; one of which is inſerted into the ceiling of the room, the air of which is required to be kept pure; and the other extends a good way beyond the roof. Through this trunk a continued circulation is carried on; and the reaſon is, that the putrid effluvia, which do ſo much miſchief when collected, being much lighter than the pure atmoſphere, ariſe to the top of the room, and if they there find a vent, will continually go out through it. Theſe effluvia ariſe in very conſiderable quantities being calculated, by the late Dr. Keil, at no leſs than 39 ounces from one man in twenty-four hours. Theſe trunks were firſt made trial of by Mr. Yeoman, over the Houſe of Commons, where they were nine inches wide within; and over the Court of King's Bench, in Weſtminſter-Hall, where they were ſix inches wide. They are ſometimes made wide, and ſometimes narrower, but the wider they are, the longer they ought to be, more effectually to promote the aſcent of the vapour. The reaſon why vapours of this kind aſcend more ſwiftly through a long trunk than a ſhort one is, that the preſſure of fluids is always according to their different depth, without regard to the diameter of their baſis, or of the veſſel which contains them; and upon this principle a gallon of water may be made to ſplit a ſtrong caſk. When the column of putrid effluvia is long and narrow, the difference between the column of atmoſphere preſſing on the upper end of the trunk, and that which preſſes on the lower end, is much greater than if the column of putrid effluvia was ſhort and wide, and conſequently the aſcent is much ſwifter. One pan of a ſingle pair of ſcales, which was two inches in diameter, being held within one of theſe trunks over the Houſe of Commons, the force of the aſcending air made it riſe ſo as to require four grains to reſtore the equilibrium, and this when there was no perſon in the houſe; but when it was full, no leſs than twelve grains were requiſite to reſtore the equilibrium; which clearly ſhews that theſe trunks muſt be of real and very great efficacy.

AIR-*Pump*, a machine by which the air contained in a proper veſſel may be exhauſted or drawn out. For a copious deſcription of this uſeful machine, ſee the Syſtem of PNEUMATICS, Section II. wherein is alſo deſcribed Prince's American Air Pump, which is ſuperior to Smeaton's, and every other conſtruction of the kind.

AIR-*Shafts*, among miners, denote holes or ſhafts let down from the open air to meet the adits, and furniſh freſh air. The damps, want, and impurity of air, which occur when adits are wrought 30 or 40 fathoms long, make it neceſſary to let down air-ſhafts, in order to give the air liberty to play through the whole work, and thus diſcharge bad vapours, and furniſh good air for reſpiration; the expence of which ſhafts, in regard of their vaſt depths, hardneſs of the rock, drawing of the water, &c. ſometimes equals, nay exceeds, the ordinary charge of the whole adit. Sir Robert Murray deſcribes a method, uſed in the coal-mines at Liege, of working mines without air-ſhafts. When the miners at Mendip have ſunk a groove, they will not be at the charge of an air-ſhaft, till they come at ore; and, for the ſupply of air, have boxes of elm, exactly cloſed, of about ſix inches in the clear, by which they carry it down about twenty fathoms. They cut a trench at a little diſtance from the top of the groove, covering it with turf and rods diſpoſed to receive the pipe, which they contrive to come in ſideways to their groove, four feet from the top, which carries down the air to a great depth. When they come at ore, and need an air-ſhaft, they ſink it four or five fathoms diſtant, according to the convenience of the breadth, and of the ſame faſhion with the groove, to draw as well ore as air.

AIR-*Threads*, in natural hiſtory, a name given the long filaments, ſo frequently ſeen in autumn, floating about in the air. Theſe threads are the work of ſpiders, eſpecially of that ſpecies called the long-legged field-ſpider, which having mounted to the ſummit of a buſh or tree, darts from its tail ſeveral of theſe threads, till one is produced capable of ſupporting the body of the creature in the air: on this it mounts in queſt of prey, and frequently riſes to a very conſiderable height. See ARANEA.

AIR-*Veſſels* are ſpiral ducts in the leaves, &c. of plants, ſuppoſed to be analogous to the lungs of animals, in ſupplying the different parts of a plant with air.

AIR, in muſic, is taken in different ſenſes. It is ſometimes contraſted with harmony, and in this ſenſe it is ſynonymous with melody in general. Its proper meaning is, a tune which is ſet to words, or to ſhort pieces of poetry, that are called *ſongs*.

In operas, we give the name of *air* to ſuch pieces of muſic as are formed with meaſures and cadences, to diſtinguiſh it from the recitative; and, in general, every piece of muſic is called an *air*, which is formed for the voice, or even for inſtruments, and adapted to ſtanzas, whether it forms a whole in itſelf, or whether it can be detached from any whole of which it forms a part, and be executed alone. If the ſubject admits of harmony, and is ſet in parts, the *air* is, according to their number, denominated a *duet*, a *trio*, a *quartette*, &c. We need not follow Rouſſeau, and the other philologiſts, in their endeavours to inveſtigate the etymon of the word *air*. Its derivation, though found and aſcertained, would contribute little to illuſtrate its meaning in that remote ſenſe to which, through a long continuance of time, and the various viciſſitudes of language, it has now paſſed.

In modern muſic there are ſeveral different kinds of *airs*, each of which agrees to a certain kind of dancing, and from theſe dances the airs themſelves take their ſpecific names. The *airs* of our operas are, if we may be permitted the expreſſion, the canvaſs, or ſubſtratum, upon which are painted all the pictures of imitative muſic: melody is the deſign, and harmony the colouring: every picturеſque object ſelected from the moſt beautiful parts of nature, every reflected ſentiment of the human heart, are the models which the artiſt imitates: whatever gains attention, whatever intereſts the ſoul, whatever charms the ear, or cauſes emotion in the heart, theſe are the objects of his imitation. An air which delights the ear, and diſcovers the learning of the compoſer; an air invented by genius, and compoſed with taſte, is the nobleſt effort of muſic: it is this which explores the compaſs, and diſplays the delicacy, of a beautiful voice; it is in this where the charms of a well-conducted ſymphony ſhine; it is by this that the paſſions, excited and inflamed by nice gradations, reach and agitate the ſoul through the avenues of external ſenſe. After hearing a beautiful *air*, the mind is acquieſcent and ſerene; the ear is ſatisfied, not diſguſted: it remains impreſſed on the fancy, it becomes a part of our eſſence, we carry it with us, we are able to repeat it at pleaſure: without the ability acquired by habit to breathe a ſingle note of it, we execute it in our imagination in the ſame manner as we heard it upon the theatre: one ſees the ſcene, the actor, the theatre; one hears the accompaniments and the other the applauſes. The real enthuſiaſt in muſic never forgets the beautiful airs which he has heard; when he chooſes, he cauſes the opera to re-commence.

The words to which *airs* are adapted are not always rehearſed in regular ſucceſſion, nor ſpoken in the ſame manner with thoſe of the recitative; and though, in general, they are very ſhort, yet they are interrupted, repeated, and tranſpoſed, at the pleaſure of the artiſt. They do not conſtitute a narrative, which once told is over; they either delineate a picture, which it is neceſſary to contemplate in different points of view, or inſpire a ſentiment in which the heart acquieſces with pleaſure, and from which it is neither able or willing to be diſengaged; and the different phraſes of the *air* are nothing elſe but different manners of beholding the ſame image. This is the reaſon why the ſubject of an *air* ſhould be one. It is by theſe repetitions properly placed, it is by theſe redoubled efforts, that an impreſſion, which at firſt was not able to move you, at length ſhakes your ſoul, agitates you, tranſports you out of yourſelf: and it is likewiſe upon the ſame principle that the runnings, as they are called, or thoſe long, mazy and inarticulated inflections of the voice, which, in pathetic *airs*, frequently ſeem, though they are not always ſo, are improperly placed. Whilſt the heart is affected with a ſentiment exquiſitely moving, it often expreſſes its emotions by inarticulate ſounds, more ſtrongly and ſenſibly than it could do by words themſelves.

The form of *airs* is of two kinds. The ſmall airs are often compoſed of two ſtrains, which ought each of them to be ſung twice; but the important airs in operas are frequently in the form of rondeaus.

AIRING, a term peculiarly uſed for exerciſing horſes in the open air. It purifies the blood; purges the body from groſs humours; and, as the jockies expreſs it, teaches the horſe how to make his wind rake equally, and keep time with the other motions of his body. It alſo ſharpens the ſtomach, and keeps the creatures hungry; which is a thing of great conſequence, as hunters and racers are very apt to have their ſtomachs fall off, either from want of exerciſe, or from the too violent exerciſe which they are often expoſed to. If the horſe be over fat, it is beſt to air him before ſun-riſe, and after ſun-ſetting; and, in general, it is allowed, by all, that nothing is more beneficial to theſe creatures than early and late airings. Some of our modern managers, however, diſpute this: they ſay, that the cold of theſe times is too great for the creature; and that if, in particular, he is ſubject to catarrhs, rheums, or the like complaints, the dews and cold fogs, in theſe early and late airings, will be apt

to increaſe all theſe diſorders. Nature, we ſee, alſo points out the ſun-beams as of great uſe to theſe animals; thoſe which are kept hardy, and lie out all night, always running to thoſe places where the ſun-ſhine comes, as ſoon as it appears in a morning.

This ſhould ſeem to diſcommend thoſe airings that are to be made before ſun-ſet, and a little time after ſun-riſe; and as to the caution, ſo earneſtly inculcated by Markham, of uſing theſe early and late airings for fat horſes, it is found unneceſſary by many: for they ſay, that the ſame effect may be produced by airings at warmer times, provided only that they are made longer: and that, in general, it is from long airings we are to expect to bring a horſe to a perfect wind, and ſound courage.

AIRS, in horſemanſhip, denote the artificial or practiſed motions of a managed horſe. Such are the demi-volt, curvet, capriole, croupade, balotade, ſtep, and leap; alſo, advancing, yerking, and bounding.

Some authors take Airs in a more extenſive ſenſe, and divide them into low and high. The Low Airs include the natural paces, as walking, trotting, galloping, and *terra-a-terra*. To which may be added, prancing, ſidling, ſtopping, and turning. The High, or Raiſed Airs, are all ſuch motions as riſe higher than the *terra-a-terra*; as the demi-volt, curvet, &c.

AIX-LA-CHAPELLE waters are volatile, ſulphureous, ſaponaceous, powerfully penetrating, reſolvent, and containing a portion of iron. The three moſt noted hot waters in Europe, are thoſe of Aix-la-Chapelle, Bourbon, and Bath. Of theſe the firſt are the hotteſt, the moſt nauſeous, purgative, and abundant in ſulphur; the laſt is leaſt ſo. For a more particular account of the qualities and effects of theſe waters, ſee the article WATERS.

AL, an Arabic particle, prefixed to words, to exalt, or give them a more emphatical ſignification.—As, in *Al*koran, *Al*gebra, &c.

ALA, a Latin term, literally ſignifying wing, uſed, in anatomy, for ſeveral parts of the body, which bear ſome reſemblance to the figure of a wing. Thus the lobes of the liver are ſometimes called *alæ*. The ſoft ſpongious bodies in the *pudendum muliebre*, uſually called the *nymphæ*, are denominated *alæ*. The two cartilages of the noſe, which form the noſtrils, are called *alæ*. And the ſame denomination is given to the tip of the auricle. It is alſo applied to the proceſs of the *os ſphenoides*. ALÆ, in anatomy, is ſometimes applied to the arm-pits, otherwiſe called *axillæ*. Theſe parts abound with glands, and are great receptacles of humours; whence a rank ſmell ſometimes exhales, called *fœtor alarum*.

ALABASTER, in natural hiſtory, is a ſpecies of that genus of ſtones whoſe baſe is calcareous earth. It differs from marble in being combined, not with the aerial, but with vitriolic acid; therefore, when mixed with any acid, no effervеſcence appears. It is ſoluble in about 500 times its weight of water at the temperature of 60. It is fuſible alone in a long-continued porcelain heat, or by the blow-pipe. Specific gravity 1.87. Texture granular, with ſhining particles. In compoſition, and conſequently in its chymical properties, it does not differ from gypſum, ſelenite, and plaſter of Paris. It is found of all colours; ſome extremely white and ſhining, which is the moſt common; ſome reddiſh or tawny; and ſome is called *onyx*, from its colour, which reſembles that of the *onyx*, though very different from it in its nature.

There are three ſpecies of Alabaſter. 1. The ſnow-white ſhining alabaſter, or lygdinum of the ancients, is found in Taurus, in pieces large enough to make diſhes, or the like. It cuts very freely, and is capable of a fine poliſh. 2. The yelloviſh alabaſter, or phengites of Pliny, is found in Greece; and is of a ſoft, looſe, open texture, pretty heavy, and nearly of the colour of honey. This ſpecies has likewiſe been found in Germany, France, and in Derbyſhire in England. 3. Variegated, yellow, and reddiſh alabaſter. This ſpecies is the common alabaſter of the ancients, and is ſo ſoft that it may be cut with a knife: it is remarkably bright, and almoſt tranſparent: admits of a fine poliſh, and conſiſts of large angular, ſparry concretions. It is not proof againſt water; it ferments violently with aquafortis, and burns to a pale yellow. The colour of this ſpecies is a clear pale yellow, reſembling amber, and variegated with undulated veins; ſome of which are pale red, others whitiſh, and others of a pale brown. It was formerly brought from Egypt, but is now to be met with in ſeveral parts of England. The alabaſters are frequently uſed by ſtatuaries for ſmall ſtatues, vaſes, and columns. After being calcined and mixed with water, they may be caſt in any moulo like plaſter of Paris. See GYPSUM.

ALABASTER, Mr. Boyle obſerves, being finely powdered, and thus ſet in a baſon over the fire, will, when hot, aſſume the appearance of a fluid, by rolling in waves, yielding to the ſmalleſt touch, and emitting vapour; all which properties it loſes again, on the departure of the heat, and diſcovers itſelf a mere incoherent powder.

The fineneſs and clearneſs of this ſtone renders it, in ſome meaſure, tranſparent; whence it has been ſometimes alſo employed for windows. There is a church at Florence ſtill illuminated by alabaſter-windows; inſtead of panes of glaſs, there are ſlabs of alabaſter near fifteen feet high, each of which forms a ſingle window, through which the light is conveyed.

Naturaliſts alſo mention divers extraordinary kinds of alabaſter, ſoft, yellow, variegated, Indian, Caramanian, German, &c. Grew ſpeaks of a baſtard alabaſter, ſpotted, which he calls *gypſum variegatum*, whereof there are divers ſorts and colours in the repoſitory of the Royal Society. Theſe all make a ſtrong effervеſcence with ſpirit of nitre. They are found in Burgundy, Miſnia, &c.

The countries in Europe which abound moſt in alabaſter, are Germany, towards Coblentz; the province of Maconnois, in the neighbourhood of Cluni, in France; Italy, toward Rome; where that of Montalout is particularly remarkable, not only for its whiteneſs, but alſo for the ſize of its blocks, ſome of which are ſo large, that ſtatues as big as the life may eaſily be cut out of them. F. Labat, in his journey to Italy, obſerves, that there are quarries of alabaſter, in the neighbourhood of the village called de la Tuffa, near Civita Vecchia: there is alſo alabaſter to be found in ſome places of Lorrain; but it is not much eſteemed. A new manufacture of baſſo relievos, from a ſingular ſpecies of factitious alabaſter, has been lately eſtabliſhed by M. Letaple, at the baths of St. Philip, in Tuſcany. The ſtream at theſe baths depoſits a peculiar kind of ſand, which, when collected and condenſed in the cavities of any body employed to oppoſe its current, acquires the nature, hardneſs, and colour of alabaſter, and aſſumes the forms of thoſe cavities in which it is thus lodged. See Abbé Rozier's Obſervations, &c. for June, 1776.

ALAMODE, a phraſe originally French, importing a thing to be in the faſhion or mode. The phraſe has been adopted not only into ſeveral of the living languages, as the Engliſh and High Dutch, but ſome have even taken it into the Latin.

ALARAF, in the Mahometan theology, the partition wall that ſeparates heaven from hell. The word is plural, and properly written *al araf*; in the ſingular it is written *al arf*. It is derived from the Arabic verb *arafa*, to diſtinguiſh. Al araf gives the denomination to the ſeventh chapter of the alcoran, wherein mention is made of this wall. Mahomet ſeems to have copied his al araf, either from the great gulph of ſeparation mentioned in the New Teſtament, or from the Jewiſh writers, who alſo ſpeak of a thin wall dividing heaven from hell. Mahometan writers differ extremely as to the perſons who are to be found on al araf. Some take it for a ſort of limbus for the patriarchs, prophets, &c. others place here ſuch whoſe good and evil works ſo exactly balance each other, that they deſerve neither reward nor puniſhment. Others imagine this intermediate ſpace to be poſſeſſed by thoſe who, going to war without their parents' leave, and ſuffering martyrdom there, are excluded paradiſe for their diſobedience, yet eſcape hell becauſe they are martyrs.

ALARM, in fencing, denotes a ſtep, or ſtamp, made on the ground, with the advancing foot. This coincides with what is otherwiſe called an appel, or challenge. See the treatiſe on the Art, ſecond column.

ALAUDA, or LARK, in ornithology, according to Linnæus, is the ſixty-fifth Genus, and of the order of Paſſeres; but Latham, in his improved arrangement, makes it the thirty-ninth Genus of the ſame order. The Arvenſis, or common Sky-lark, and the Wood-lark are the only birds that ſing as they fly; the former raiſing its note as it ſoars, and lowering it till it quite dies away as it deſcends. It will often ſoar to ſuch a height, that we are charmed with the muſic when we loſe ſight of the ſongſter; it alſo begins its ſong before the earlieſt dawn. Milton, in his Allegro, moſt beautifully expreſſes theſe circumſtances; and biſhop Newton obſerves, that the beautiful ſcene that Milton exhibits of rural cheerfulneſs, at the ſame time gives us a fine picture of the regularity of his life, and the innocency of his own mind: thus he deſcribes himſelf as in a ſituation

> To hear the lark begin his flight,
> And, ſinging, ſtartle the dull night,
> From his watch-tow'r in the ſkies,
> Till the dappled dawn doth riſe.

It continues its harmony ſeveral months, beginning early in the ſpring, on pairing. In the winter they aſſemble in vaſt flocks, grow very fat, and are taken in great numbers for our tables. They build their neſts on the ground, beneath ſome clod, forming it of hay, dry fibres, &c. and lay four or five eggs. The place theſe birds are taken in the greateſt quantity, is the neighbourhood of Dunſtable; the ſeaſon begins about the 14th of September, and ends the 25th of February; and during that ſpace about 4000 dozen are caught, which ſupply the markets of the metropolis. Greater numbers than the above, however, are at times caught in different parts of Germany, where there is an exciſe upon them. Keyſler ſays, that the exciſe alone produces 6000 dollars (about 900l. ſterling) every year in the city of Leipſic; whoſe larks are famous all over Germany, as having the moſt delicious flavour. But it is not only at Leipſic that they are taken in ſuch numbers, but alſo in the country about Naumburg, Merſeburg, Halle, and other parts. For repreſentation, ſee Plate III, Genus 39.

The Arborea, or Wood-lark, is a native of Europe, and diſtinguiſhed by an annual white fillet about the head. It is inferior in ſize to the ſky-lark, and is of a ſhorter thicker form; the colours are paler, and its note is leſs ſonorous and leſs varied, though not leſs ſweet. It perches on trees, and whiſtles like the black-bird. It will ſing in the night; and, like the common lark, will ſing as it flies. It builds on the ground, and makes its neſt on the outſide with moſs, within of dried bents, lined with a few hairs. It lays five eggs, duſky and blotched with deep brown marks, darkeſt at the thicker end. The males of this and the laſt are known from the females by their ſuperior ſize. But this ſpecies is not near ſo numerous as that of the common kind.

ALAY, ſignifying in the Turkiſh language "the Triumph," a ceremony which accompanies the aſſembling together the forces of that vaſt empire upon the breaking out of a war. It conſiſts of the moſt inſipid buffoonery, and is attended with acts of the moſt ſhocking barbarity. That which took place upon occaſion of the late war between the Porte and Ruſſia is deſcribed by Baron Tott, in his Memoirs, as follows:

"It conſiſts in a kind of Maſquerade, in which each trade ſucceſſively preſents to the ſpectators the mechanical exerciſe of its reſpective art. The labourer draws his plough, the weaver handles his ſhuttle, the joiner his plane; and theſe different characters, ſeated in cars richly ornamented, commence the proceſſion, and precede the ſtandard of Mahomet, when it is brought out of the ſeraglio to be carried to the army, in order to enſure victory to the Ottoman troops. This banner of the Turks, which they name *Sandjax Cheriff*, or the ſtandard of the prophet, is ſo revered among them, that, notwithſtanding its reputation has been ſo often tarniſhed, it ſtill retains their implicit confidence, and is the ſacred ſignal unto which they rally. Every thing proclaims its ſanctity. None but the emirs are allowed to touch it; they are its guards, and it is carried by their chief. The muſſelmen alone are permitted to look upon it. If touched by other hands, it would be defiled; if ſeen by other eyes, profaned. In ſhort, it is encompaſſed by the moſt barbarous fanaticiſm.

"A long peace had unfortunately cauſed the folly, and eſpecially the danger, of this ceremony to be forgotten. The Chriſtians imprudently crowded to ſee it; and the Turks, who, by the ſituation of their houſes, could make money of their windows, began to profit by the advantage; when an emir, who preceded the banner, proclaimed with a loud voice, 'Let no infidel dare to profane with his preſence the holy ſtandard of the prophet; and let every Muſſelman who perceives an unbeliever, make it known under pain of reprobation.' From that moment no aſylum was to be found; even thoſe became informers, who, by letting out their houſes, had rendered themſelves accomplices in the crime. A religious fury ſeized on every mind, and put arms in every hand; the more atrocious the cruelty, the more was it meritorious. No regard was paid to ſex or age; pregnant women, dragged by the hair, and trodden under feet by the multitude, periſhed in the moſt deplorable manner. Nothing was reſpected by theſe monſters; and under theſe auſpices the Turks commenced the war."

ALBATROSSE, in Ornithology, the Engliſh name of a ſpecies of the genus Diomedea, a large ſea-bird, common about the Cape of Good Hope, Cape Horn, and in many other places. This is a thieviſh creature, and principally feeds on the prey which another ſea-bird called the Booby, provides for itſelf. It is ſaid that the head of the Albatroſſe changes from brown to a fine ſcarlet, while it ſits on its eggs, and afterwards becomes brown again. For a more particular deſcription, ſee DIOMEDEA; for repreſentation, ſee Plate V. Genus 83.

ALBIGENSES, a ſect about Tholouſe and Alb, in Languedoc, whence they derived their name; who, in the twelfth century, became remarkable for their oppoſition to the diſcipline and ceremonies of the church of Rome. They were alſo known by various other names; as, Petrobruſſians, Arnoldiſts, Cathari, Patarins, Publicans, Tiſſerans, Bons-hommes, Paſſagers, &c. Some will have them to be the ſame with the Albanenſes; and thoſe who think them different, attribute the ſame opinions to both. They were a party of the Paulicians, who migrated from Bulgaria and Thrace into other countries. Their firſt ſettlement was in Italy, whence they ſent out colonies into almoſt all the other provinces of Europe. It is ſaid that Peter Bruys was the firſt that brought them into Languedoc, about the year 1126.

The Albigenſes are frequently confounded with the Waldenſes; from whom, however, they differ in many reſpects, both as being prior to them in point of time, as having their origin in a different country, and as being charged with divers hereſies, particularly Maincheiſm, from which the Waldenſes are exempt. But ſeveral Proteſtant writers have vindicated them from that imputation. Dr. Allix ſhews, that a great number of Manichees ſpread over the weſtern countries from Bulgaria; and ſettled in Italy, Languedoc, and other places, where there were alſo Albigenſes; by which means, being both under the imputation of hereſy, they came, either by ignorance or malice, to be confounded, and called by the ſame common name, though in reality entirely different. Other errors imputed to them by their opponents, the monks of thoſe days, were, that they admitted two Chriſts; one evil, who appeared on earth; the other good, who has not yet appeared: that they denied the reſurrection of the body, and maintained human ſouls to be dæmons impriſoned in our bodies, by way of puniſhment for their ſins: that they condemned all the ſacraments of the church; rejected baptiſm as uſeleſs; held the euchariſt in abhorrence; excluded the uſe of confeſſions and penance; maintained marriage as unlawful; laughed at purgatory, prayers for the dead, images, crucifixes, &c. There were likewiſe ſaid to be two claſſes of them; the Perfect, and the Believers. The perfect boaſted of their living in continence, of eating neither fleſh, eggs, nor cheeſe. The believers lived like other men, and were even looſe in their morals; but they were perſuaded they ſhould be ſaved by the faith of the perfect, and that none were damned who received impoſition of hands from them. But from theſe charges alſo they are generally acquitted by Proteſtants; who conſider them as the inventions of the Romiſh church, whoſe members deem it meritorious by any means to blacken heretics.

However this be, the Albigenſes grew ſo formidable in a little time, that a holy league, or croiſade, was agreed upon among the Catholics; and war denounced againſt them, the Pope himſelf raiſing the firſt ſtandard. In 1229, a peace was made, and an inquiſition eſtabliſhed at Tholouſe; from which time the Albigenſes dwindled by degrees, till the times of the Reformation; when ſuch of them as were left fell in with the Vaudois, and became conformable to the doctrine of Zuinglius, and the diſcipline of Geneva.

ALBINOS, the name by which the Portugueſe call the white Moors, who are looked upon by the negroes as monſters. They at a diſtance might be taken for Europeans; but, when you come near them, their colour appears like that of perſons affected with a leproſy.

In Sauſſure's *Voyages dans les Alpes*, is the following account of two boys at Chamouni, who have been called Albinos. "The elder, who was, at the end of the year 1785, about twenty, or one-and-twenty years of age, had a dull look, with lips ſomewhat thick, but nothing elſe in his features to diſtinguiſh him from other people. The other, who is two years younger, is rather a more agreeable figure: he is gay and ſprightly, and ſeems not to want wit. But their eyes are not blue; the iris is of a very diſtinct roſe-colour: the pupil too, when viewed in the light, ſeems decidedly red; which ſeems to demonſtrate, that the interior membranes are deprived of the uvea, and of that black mucous matter that ſhould line them. Their hair, eye-brows, and eye-laſhes, with the down upon their ſkin, were all, in their infancy, of the moſt perfect milk-white colour, and very fine; but their hair is now of a reddiſh caſt, and has grown pretty ſtrong. Their ſight too is ſomewhat ſtrengthened; though they exaggerate to ſtrangers their averſion for the light, and half-ſhut the eye-lids, to give themſelves a more extraordinary appearance. But thoſe who, like me, have ſeen them in their infancy, before they were tutored to this deceit, and when too few people came to Chamouni to make this affectation profitable to them, can atteſt that then they were not very much offended with the light of day. At that time they were ſo little deſirous of exciting the curioſity of ſtrangers, that they hid themſelves to avoid ſuch; and it was neceſſary to do a ſort of violence to them before they could be prevailed on to allow themſelves to be inſpected. It is alſo well known at Chamouni, that when they were of a proper age they were unable to tend the cattle like the other children at the ſame age; and that one of their uncles maintained them out of charity, at a time of life when others were capable of gaining a ſubſiſtence by their labour. I am therefore of opinion, that we may conſider theſe two lads as true Albinos: for if they have not the thick lips and flat noſes of the white negroes, it is becauſe they are Albinos of Europe, not of Africa. This infirmity affects the eyes, the complexion, and the colour of the hair; it even diminiſhes the ſtrength, but does not alter the conformation of the features. Beſides, there are certainly in this malady various degrees; ſome may have leſs ſtrength, and are leſs able to endure the light: but theſe circumſtances in thoſe of Chamouni are marked with characters ſufficiently ſtrong to entitle them to the unhappy advantage of being claſſed with that variety of the human ſpecies denominated Albinos. When nature preſents the ſame appearance often, and with circumſtances varied, we may at laſt diſcover ſome general law, or ſome relation which that appearance has with known cauſes: but when a fact is ſo ſingular and ſo rare, as that of thoſe Albinos, it gives but little ſcope to conjectures; and it is very difficult to verify thoſe by which we attempt to explain it.

"I at firſt imagined that this diſeaſe might be referred to a particular ſort of organic debility; that a relaxation of the lymphatic veſſels within the eye might ſuffer the globules of the blood to enter too abundantly into the iris, the uvea, and even into the retina, which might occaſion the redneſs of the iris and of the pupil. The ſame debility ſeemed alſo to account for the intolerance of the light, and for the whiteneſs of the hair. But a learned phyſiologiſt, M. Blumenbach, profeſſor in the univerſity at Gottingen, who has made many profound obſervations on the

organs

organs of ſight, and has conſidered with great attention the Albinos of Chamouni, attributes their infirmity to a different cauſe. The ſtudy of comparative anatomy has furniſhed him with frequent opportunities of obſerving this phenomenon; he has found it in brutes, in white dogs, and in owls; he ſays, it is generally to be ſeen in the warm-blooded animals; but that he has never met with it in thoſe with cold blood.

"From his obſervations, he is of opinion, that the redneſs of the iris, and of the other internal parts of the eye, as well as the extreme ſenſibility that accompanies this redneſs, is owing to the total privation of that brown or blackiſh mucus, that, about the fifth week after conception, covers all the interior parts of the eye in its ſound ſtate. He obſerves, that Simon Pontius, in his treatiſe *de Coloribus Oculorum*, long ago remarked, that in blue eyes the interior membranes were leſs abundantly provided with this black mucus, and were therefore more ſenſible to the action of light. This ſenſibility of blue eyes agrees very well, ſays M. Blumenbach, with northern people during their long twilight; while, on the contrary, the deep black in the eyes of negroes enables them to ſupport the ſplendor of the ſun's beam in the torrid zone. As to the connection between this red colour of the eyes, and the whiteneſs of the ſkin and hair, the ſame learned phyſiologiſt ſays, that is owing to a ſimilarity of ſtructure, *conſenſus ex ſimilitudine fabricæ*. He aſſerts, that this black mucus is formed only in the delicate cellular ſubſtance, which has numerous blood-veſſels contiguous to it, but contains no fat; like the inſide of the eye, the ſkin of negroes, the ſpotted palate of ſeveral domeſtic animals, &c. And, laſtly, he ſays, that the colour of the hair generally correſponds with that of the iris. *Gazette litt. de Gottingue*, Oct. 1784. At the very time that M. Blumenbach was reading this memoir to the Royal Society of Gottingen, M. Buzzi, ſurgeon to the hoſpital at Milan, a pupil of the celebrated anatomiſt Moſcati, publiſhed in the *Opuſcoli Scelti di Milan*, 1784, t. vii. p. 11. a very intereſting memoir, in which he demonſtrates by diſſection what Blumenbach had only ſuppoſed.

"A peaſant of about 30 years of age died at the hoſpital of Milan of a pulmonary diſorder. His body, being expoſed to view, was exceedingly remarkable by the uncommon whiteneſs of the ſkin, of the hair, of the beard, and of all the other covered parts of the body. M. Buzzi, who had long deſired an opportunity of diſſecting ſuch a ſubject, immediately ſeized upon this. He found the iris of the eyes perfectly white, and the pupil of a roſe-colour. The eyes were diſſected with the greateſt poſſible care, and were found entirely deſtitute of that black membrane which anatomiſts call the Uvea; it was not to be ſeen either behind the iris, or under the retina: within the eye there was only found the choroid coat extremely thin and tinged, of a pale red colour, by veſſels filled with diſcoloured blood. What was more extraordinary, the ſkin, when detached from different parts of the body, ſeemed alſo entirely diveſted of the *rete mucoſum*: maceration did not diſcover the leaſt veſtige of this, nor even in the wrinkles of the abdomen, where it is moſt abundant and moſt viſible.

"A woman of Milan, named Calcagni, had ſeven ſons. The two eldeſt had brown hair and black eyes; the three next had white ſkins, white hair, and red eyes: the two laſt reſembled the two eldeſt. It was ſaid that this woman, during the three pregnancies that produced the Albinos, had a continual and immoderate appetite for milk, which ſhe took in great quantities: but that when ſhe was with child of the other four children, ſhe had no ſuch deſire. It is not however aſcertained, that this preternatural appetite was not itſelf the effect of a certain heat, or internal diſeaſe, which deſtroyed the *rete mucoſum* in the children before they were born.

"The Albinos of Chamouni are alſo the offſpring of parents with dark ſkins and black eyes. They have three ſiſters by the ſame father and mother, who are alſo brunettes. One of them that I ſaw had the eyes of a dark brown, and the hair almoſt black. They are ſaid, however, to be all afflicted with a weakneſs of ſight. When the lads are married, it will be curious to obſerve how the eyes of their children will be formed. The experiment would be particularly deciſive, if they were married to women like themſelves. But this faulty conformation ſeems to be more rare among women than among men; for the four of Milan, the two of Chamouni, the one deſcribed by Maupertius, the one by Helvetius, and almoſt all the inſtances of theſe ſingular productions, have been of our ſex. It is known, however, that there are races of men and women affected with this diſeaſe, and that theſe races perpetuate themſelves, in Guinea, in Java, at Panama, &c. Upon the whole, this degeneration does not ſeem to be owing to the air of the mountains; for though I have traverſed the greateſt part of the Alps, and the other mountains of Europe, theſe are the only individuals of the kind I ever met with.

ALBUGINEA is applied to the third coat of the teſticles; ſo called from its colour, which is white. It is a ſtrong thick membrane, very ſmooth on the outer ſurface; the inner, which adheres to the ſubſtance of the teſticle, being rough and uneven. Into its upper part are inſerted blood-veſſels, nerves, and lymphatics, which from thence ſend divers branches into the ſubſtance of the teſticles. See TUNICA.

ALBUGO, or *Album oculi*, the ſame with Albuginea, or the white of the eye. Albugo is a whitiſh, denſe, opake ſpot, or film, growing on the horny tunic, by which it loſes its native colour, and becomes white and opaque. The Albugo is the ſame with what is otherwiſe called Leucoma. It is moſt commonly the conſequence of inflammations, by the extravaſation of humours, between the membranes of this tunicle; and particularly in the ſmall pox, by the ſuppuration of puſtules upon this part; but they ſometimes ariſe from ſcars left after punctures in the Cornea, from ſwords, knives, glaſs, &c. from burns, or from cauſtic ſubſtances falling into the eye, or by a peculiar tunic growing to the eye itſelf.

The cure is various, according to circumſtances. If the diſorder ariſes from inſpiſſated humours, an attenuating diet and medicines, eſpecially ſudorific decoctions and infuſions, together with phlebotomy, ſcarifications, bliſters, and pediluvia, are uſeful. Cold and aſtringent collyria, eſpecially thoſe of white vitriol, are here pernicious; whereas warm applications are of the greateſt ſervice. But if theſe diſorders be of long ſtanding, there is little or no hope of a cure. Spots in the cornea, ariſing from wounds, ſcars, or the abuſe of vitriolic collyria, are ſeldom curable. Dr. Mead tells us of ſeveral cures of the Albugo, performed by means of an eye-powder, which he recommends. The receipt is thus: take of common glaſs any quantity, pound it in a mortar to a very fine powder; then add an equal quantity of white ſugar-candy, and levigate the mixture till it becomes impalpable. A little of this powder put into the eye with a quill, every day, gradually wears off the ſpot. Another method of removing the ſpeck is to have it pared by a ſurgeon every day with a knife: but this ſeems a doubtful remedy.

ALBUMEN, the white of an egg. This, according to Boerhaave, makes an extraordinary menſtruum. A little putrid white of egg taken into the ſtomach, occaſions a naufea, horror, fainting, vomiting, diarrhœa, and gripes; it inflames the bile, excites heat, thirſt, fever; and diſſolves the humours like the plague. On the contrary, the white of freſh-laid eggs, if taken while warm from the hen, is extremely nouriſhing to the infirm: it may be taken in luke-warm milk; but if any other heat is applied to it, the nutritious quality will be deſtroyed. The freſh white of egg prevents burns from riſing in bliſters, if it is uſed immediately after the accident: it mitigates inflammations of the eyes, and preſerves the face from ſun-burning. White of eggs are alſo uſeful for clarifying liquors; to which purpoſe, being mixed and incorporated with the liquors to be clarified, and the whole afterwards boiled, the whites are by this means brought together and hardened, and thus carry off the groſs parts of the liquor along with them.

ALCA, or AUK, in Ornithology, according to Linnæus, is the 20th Genus belonging to the order of Anſeres; but Latham, in his improved arrangement, makes it the 81ſt Genus, and of the order webb-footed. The beak of this Genus is without teeth; ſhort, convex, compreſſed, and frequently furrowed tranſverſely, the inferior mandible is gibbous near the baſe; the feet have generally three toes. The ſpecies of the Alca are 12; of which the following are the moſt remarkable:

The Impennis, northern penguin, or great auk, with a compreſſed bill furrowed on each ſide, and an oval ſpot on each ſide of the eyes. According to Mr. Martin, this bird breeds on the iſle of St. Kilda; appearing there the beginning of May, and retiring the middle of June. It lays one egg, which is ſix inches long, of a white colour; ſome are irregularly marked with purpliſh lines croſſing each other, others blotched with black, and ferruginous about the thicker end: if the egg is taken away, it will not lay another that ſeaſon. Mr. Macaulay informs us that it does not viſit that iſland annually, but ſometimes keeps away for ſeveral years together; and adds, that it lays its egg cloſe to the ſea-mark, being incapable, by reaſon of the ſhortneſs of its wings, to mount higher. The length of this bird, to the end of its toes, is three feet: but its wings are ſo ſmall, as to be uſeleſs for flight; the length, from the tip of the longeſt quill-feathers to the firſt joint, being only four inches and a quarter. This bird is obſerved by ſeamen never to wander beyond ſoundings; and according to its appearance they direct their meaſures, being then aſſured that land is not very remote. It ſometimes frequents the coaſts of Norway, the Ferroe iſles, Iceland, Greenland, and Newfoundland; and feeds much on the lump-fiſh, father-laſher, and other fiſh of that ſize. The young birds eat roſe-root, and other plants. The old ones are very rarely ſeen on ſhore, though the young ones are not unfrequently met with. It is a very ſhy bird. It walks ill; but dives well, and is taken in the manner uſed for the razor-bill and puffin. The ſkin between the jaws is blown into a bladder, and uſed for the darts of the Greenlanders, as is alſo that of ſome other birds. The ſkin of the body is ſuppoſed to be uſed by the Eſquimaux Indians for garments. For repreſentation, ſee Plate V. Genus 84.

The arctica, or puffin, with a compreſſed bill and four furrows; the orbit of the eyes and temples are white. The legs of this ſpecies are very ſmall, and placed ſo far behind as to diſ-

qualify

qualify it from ſtanding except quite erect, reſting not only on the foot, but the whole length of the leg. This circumſtance makes the riſe of the puffin from the ground very difficult, and it meets with many falls before it gets on wing; but when that is effected, few birds fly longer or ſtronger. Theſe birds frequent the coaſts of ſeveral parts of Great Britain and Ireland; but no place in greater numbers than Prieſtholm iſle, where their flocks may be compared to ſwarms of bees for multitude. Theſe are birds of paſſage; they reſort there annually about the fifth or tenth of April, quit the place (almoſt to a bird), and return twice or thrice before they ſettle to burrow and prepare for ovation and incubation. They begin to burrow the firſt week in May; but ſome few ſave themſelves that trouble, and diſlodge the rabbits from their holes, taking poſſeſſion of them till their departure from the iſle. Thoſe which form their own burrows, are at that time ſo intent upon the work as to ſuffer themſelves to be taken by the hand. This taſk falls chiefly to the ſhare of the males; who alſo aſſiſt in incubation. The firſt young are hatched the beginning of July. The old ones ſhow vaſt affection towards them; and ſeem totally inſenſible of danger in the breeding ſeaſon. If a parent is taken at that time, and ſuſpended by the wings, it will in a ſort of deſpair treat itſelf moſt cruelly, by biting every part it can reach; and the moment it is looſed, will never offer to eſcape, but inſtantly reſort to its unfledged young: this affection ceaſes at the ſtated time of migration, which is moſt punctually about the 11th of Auguſt, when they leave ſuch young as cannot fly, to the mercy of the peregrine falcon, who watches the mouths of the burrows for the appearance of the little deſerted puffins, which, forced by hunger, are compelled to leave their burrows. They lay only one egg. The eggs differ much in form: ſome have one end very acute; others have both extremely obtuſe; all are white. Their fleſh is extremely rank, as they feed on ſea-weeds and fiſh, eſpecially ſprats: but when pickled and preſerved with ſpices, are admired by thoſe who love high-eating. Dr. Caius ſays, that in his days the church allowed them in lent inſtead of fiſh: he alſo acquaints us that they were taken by means of ferrets, as we take rabbits: at preſent they are either dug out, or drawn from their burrows by a hooked ſtick; they bite extremely hard, and keep ſuch faſt hold on whatever they faſten, as not to be eaſily diſengaged. Their noiſe, when taken, is very diſagreeable; being like the efforts of a dumb perſon to ſpeak. Theſe birds are alſo common in Ireland; on the iſland Sherries, three leagues N. N. W. of Holyhead; and in the S. Stack, near Holyhead, they breed in plenty. They inhabit Iceland and Greenland; and breed in the extreme parts of the iſlands. It is alſo found in the Ferroe iſles, where it is called Lunda; and in the Farn iſles, where it is called Coulterneb, from the ſhape of the bill. It goes alſo by various other names; ſuch as Gulden-head, Bottle-noſe, and Helegug, in Wales; at Scarborough, Mullet; and in Cornwall, Pope. In America they are ſaid to frequent Carolina in winter; and have been met with in Sandwich Sound by our late voyagers: the natives ornament the fore parts and collar of their ſeal-ſkin jackets with the beaks of them; and thoſe of Oonalaſhka wear gowns of their ſkins, along with thoſe of other birds. On the coaſt of Kamtſchatka and the Kurulſchi iſlands they are common, even on the Penſchinſki Bay, almoſt as far as Ochotka: the nations of the two firſt wear the bills about their necks faſtened to ſtraps; and, according to the ſuperſtition of theſe people, their ſhaman or prieſt muſt put them on with a proper ceremony, in order to procure good fortune.

The torda, or razor-bill, with four furrows on the bill, and a white line on each ſide running from the bill to the eyes. Theſe birds, in company with the guillemot, appear in our ſeas the beginning of February; but do not ſettle on their breeding places till they begin to lay, about the beginning of May. They inhabit the ledges of the higheſt rocks that impend over the ſea, where they form a groteſque appearance; ſitting cloſe together, and in rows one above another. They properly lay but one egg each, of an extraordinary ſize for the bulk of the bird, being three inches long: it is either white, or of a pale ſea-green, irregularly ſpotted with black: if this egg is deſtroyed, both the auk and the guillemot will lay another: if that is taken, then a third: they make no neſt, depoſiting their egg on the bare rock; and though ſuch multitudes lay contiguous, by a wonderful inſtinct each diſtinguiſhes its own. What is alſo matter of great amazement, they fix their egg on the ſmooth rock with ſo exact a balance, as to ſecure it from rolling off; yet ſhould it be removed, and then attempted to be replaced by the human hand, it is extremely difficult, if not impoſſible, to find its former equilibrium. According to Mr. Latham, it is by means of a cement that the bird fixes its egg. The eggs are food to the inhabitants of the coaſt they frequent, which they get with great hazard, being lowered from above by ropes, truſting to the ſtrength of their companions, whoſe footing is often ſo unſtable, that they are forced down the precipices, and periſh together. Theſe birds are found in the north of Europe, alſo in Iceland, Greenland, and on the coaſt of Labrador. In Europe they extend along the White Sea into the Arctic Aſiatic ſhores, and from thence to Kamtſchatka and the gulph of Ochotka: It is the only one which reaches the inland Baltic; being found there on the Carls-Oxar iſles, near Gothland, and the iſle of Bondon off Angermania.

ALCES, or ELK, a ſpecies of the Genus Cervus, in the ſyſtem of Mammalia. For deſcription, ſee CERVUS. For repreſentation, ſee Plate VIII. Genus 29. Species 2.

ALCEDO, or KINGSFISHER, in ornithology, a genus of the order of Piceæ. The Alcedo has a long, ſtraight, thick, triangular bill; with a fleſhy, plain, ſhort, flat tongue.

Of this Genus there are a great many ſpecies, with one or other of which almoſt every part of the world is furniſhed. Moſt of them frequent rivers, and live on fiſh, the ſingularity of catching which is admirable: ſometimes hovering over the water, where a ſhoal of ſmall fiſhes is ſeen playing near the ſurface; at other times waiting with attention, on ſome low branch hanging over the water, for the approach of a ſingle one who is ſo unlucky as to ſwim that way; in either caſe dropping like a ſtone, or rather darting with rapidity on its prey; when, ſeizing it croſſways in its bill, it retires to a reſting place to feaſt on it; which it does piece-meal, bones and all, without reſerve, afterwards bringing up the indigeſtible parts in pellets, like birds of prey. The wings of moſt of the Genus are very ſhort; yet the birds fly rapidly, and with great ſtrength. It may be remarked, that throughout this Genus, blue, in different ſhades, is the moſt predominant colour. —The ſpecies found in the South Sea Iſlands are held in a kind of ſuperſtitious veneration by the natives of the places they ſeverally inhabit, perhaps on account of their being frequently ſeen flying about the morais, or burial-places. That which inhabits Otaheite, where it is called Erooro, is accounted particularly ſacred, and not allowed to be taken or killed. See BANKES's GEOGRAPHY, Page 56.

The Iſpida, or common Kingsfiſher, is not much larger than a ſwallow; its ſhape is clumſy; the bill diſproportionably long; it is two inches from the baſe to the tip; the upper chap black, and the lower yellow. But the colour of this bird atones for its inelegant form: the crown of the head and the coverts of the wings are of a deep blackiſh green, ſpotted with bright azure: the back and tail are of the moſt reſplendent azure; the whole under-ſide of the body is orange-coloured; a broad mark of the ſame paſſes from the bill beyond the eyes; beyond that is a large white ſpot: the tail is ſhort, and conſiſts of twelve feathers of a rich deep blue; the feet are of a reddiſh yellow, and the three joints of the outmoſt toe adhere to the middle toe, while the inner toe adheres only by one.

From the diminutive ſize, the ſlender ſhort legs, and the beautiful colours of this bird, no perſon would be led to ſuppoſe it one of the moſt rapacious little animals that ſkims the deep. Yet it is for ever on the wing, and feeds on fiſh; which it takes in ſurpriſing quantities, when we conſider its ſize and figure. It takes its prey after the manner of the Oſprey, balancing itſelf at a certain diſtance above the water for a conſiderable ſpace, then darting into the deep, and ſeizing the fiſh with inevitable certainty. While it remains ſuſpended in the air, in a bright day, the plumage exhibits a beautiful variety of the moſt dazzling and brilliant colours. This ſtriking attitude did not eſcape the notice of the ancients; for Ibycus, as quoted by Athenæus, ſtyles theſe birds αλκυονες πτανιπτεροι, the halcyons with expanded wings. It makes its neſt in holes in the ſides of the cliffs, which it ſcoops to the depth of three feet; and lays from five to nine eggs, of a moſt beautiful ſemi-tranſparent white. The female begins to lay early in the ſeaſon, and excludes her firſt brood about the beginning of April. The male, whoſe fidelity exceeds even that of the turtle, brings her large proviſions of fiſh while ſhe is thus employed; and ſhe, contrary to moſt other birds, is found plump and fat at that ſeaſon. The male, that uſed to twitter before this, now enters the neſt as quietly and as privately as poſſible. The young ones are hatched at the expiration of 20 days; but are ſeen to differ as well in their ſize as in their beauty.

Whoever has ſeen the neſt of the kingsfiſher will obſerve it ſtrewed with the bones and ſcales of fiſh; the fragments of the food of the owner and its young. On the foundation laid by the philoſopher, ſucceeding writers formed other tales extremely abſurd; and the poets, indulging the powers of imagination, dreſſed the ſtory in all the robes of romance. This neſt was a floating one. It was therefore neceſſary to place it in a tranquil ſea, and to ſupply the bird with charms to allay the fury of a turbulent element during the time of its incubation; for it had, at that ſeaſon, power over the ſeas and the winds; according to the following tranſlation from the Greek poet Theocritus:

> May Halcyon ſmooth the waves, and calm the ſeas,
> And the rough ſouth-eaſt ſink into a breeze;
> Halcyons, of all the birds that haunt the main,
> Moſt lov'd and honour'd by the Nereid train. FAWKES.

As the ancients have had their fables concerning this bird, ſo have the modern vulgar. It is an opinion generally received among them, that the fleſh of the kingsfiſher will not corrupt, and that it will even baniſh all vermin. This has no better foundation than that which is ſaid of its always pointing, when hung up dead, with its breaſt to the north. The only truth which can be affirmed of this bird when killed is, that its fleſh is utterly unfit

unfit to be eaten; while its beautiful plumage preserves its luſtre longer than that of any other bird we know.

This bird is found not only in Britain, but throughout Europe, Aſia, and Africa; as ſpecimens have been received from both China, Bengal, and Egypt. Belon alſo remarks his having met with it in Romania and Greece; and Scopoli notices it as a bird of Carniola, where he ſays it remains the whole year as in England. M. D'Aubenton has kept theſe birds for ſeveral months, by means of ſmall fiſh put into baſons of water, on which they have fed; for on experiment they have refuſed all other kinds of nouriſhment. For repreſentation of this bird, ſee Plate II. Genus 23.

Above 30 ſpecies of theſe birds have been deſcribed by ornithologiſts.

ALCHYMY, or ALCHEMY, a kind of Chymiſtry, employed in the more abſtruſe reſearches of the art. The great objects, or ends purſued by Alchymy, were

1. The making of gold, which is attempted three different ways; by ſeparation, by maturation, and by tranſmutation; which laſt is to be effected by means of what they call the Philoſopher's Stone. 2. An univerſal medicine, adequate to all diſeaſes. 3. An univerſal diſſolvent, or Alkaheſt. 4. An univerſal ferment; or a matter, which being applied to any ſeed, ſhall increaſe its fecundity to infinity. See a Hiſtory of Alchymy, and its Principles, &c. Dr. Lewis's Commerc. Philoſoph. Tech. p. 199, & ſeq. and the Article Philoſopher's Stone.

How far theſe may be accounted proper objects of ſtudy, the diſappointments, which all the practitioners in this art have met with, will readily certify; for after a ſucceſſion of labour and expence for many ages, and in different regions, not one of the pretenders to this art has been able to make gold, or to produce any one medicine, diſſolvent or ferment, capable of operating effectually on every body or ſubject. Yet we find the names of very learned men in the liſt of authors, who have eſpouſed the ſtudy of Alchymy; and ſome of them vain enough to imagine the poſſibility of diſcovering an univerſal menſtruum. According to the received opinion of adepts in this pretended ſcience, nothing more is required than caſting a ſmall quantity of the powder of projection upon metals in infuſion, which will convert all the true mercurial part of metal into pure gold; there being no other requiſite for this wonder-working change, than to do that by art, which nature does in many years and ages; for as gold and lead but little differ in weight, there cannot be much in lead beſides mercury and gold; conſequently, if any body could be found that would agitate all the parts of lead, ſo as to burn all that is not mercury therein, having alſo ſulphur to fix the mercury; the queſtion then is, Would not the maſs remaining be converted into pure gold?

Such is the foundation for the opinion of the Philoſopher's Stone, which the Alchemiſts contend to be a moſt fixed concentrated fire, which, as ſoon as it melts with any metal, does, by a magnetic virtue, immediately unite itſelf to the mercurial body of the metal, volatizes and cleanſes off all that is impure therein, and leaves nothing but a maſs of pure gold. Upon this principle many have ſet out to try their fortunes in the Alchymiſt's furnace. Some have attempted the tranſmutation of the moſt imperfect into perfect metals, both ſilver and gold, by ſeparation; others by maturation and real tranſmutation. Thoſe who proceed by the method of ſeparation, muſt ſuppoſe that all inferior metals contain a quantity of gold more or leſs. For unleſs it could be made appear that ſuch a ſeparation was ever diſcovered, and that the quantity of gold ſeparated from the baſer metals was ſufficient to defray the expence of the operation, neither of which can be affirmed, there can be little or no hopes of making gold by this method.

The proceſs by maturation is no leſs liable to exception. Nothing but mercury could be changed into gold by maturation, becauſe the principles of all other metals not being pure mercury, their abundant heterogeneous particles, and the ſmall quantity of imperfect ones which enter into their compoſition, cannot be ſeparated from it by a digeſtion.

Mr. Chambers in his Dictionary ſuggeſts an opinion, that could mercury be once purged of its impurities by maturation, it might eaſily be changed into gold, becauſe (ſays he) it would then be as heavy as gold. A very ſuperficial reaſon! for weight is not the eſſential quality conſtitutive of that perfect metal. It muſt be ductile and malleable; qualities which have never been diſcovered by the maturation of mercury. Beſides, there is another moſt eſſential quality; the mercury ſhould equal gold in its fixedneſs in the fire, reſulting from the homogenity and equality of its parts, which all have equal pores or interſtices through which the fiery corpuſcules find an eaſy paſſage; and therefore cannot haſten its fuſion with the ſame facility as that of leſs perfect metals, where, through the obliquity and unequal poſition of the pores, they meet with more reſiſtance.

The affair of Monſ. Languille, an adept in this art, about the middle of the laſt century, will ſerve to illuſtrate and confirm this obſervation. This gentleman piqued himſelf very highly on having diſcovered the art of converting mercury into gold by maturation; but when his metal ſo prepared was put into the crucible, he was ſoon convinced of his error and preſumption: for its pores not being in the ſame poſition, nor at the ſame equal diſtances, his metal evaporated into ſmoak.

The Alchymiſts in general ſeem to have the practice of real tranſmutation moſt at heart: and they ſay this tranſmutation of metals is to be done by melting them in the fire, and by caſting a certain quantity of a powder, termed by them the Powder of Projection, into the matter fuſed, whoſe effects they aſſert will be the ſame as mentioned before reſpecting the philoſopher's ſtone; the practicability of which operation has never been proved by any ſcientific profeſſor more fully than by the late Dr. Price, as the following extract from the London Review for October 1782 will evince.

"Account of ſome experiments in mercury, ſilver and gold,
"made at Guildford in May 1782, in the laboratory of
"James Price, M. D. F. R. S.

"We ſhall proceed to the experiments, ſeven in number, three of which were made in the preſence of many great and reſpectable perſons, to whom the author appeals for the truth of his accounts; and the reſult of all theſe experiments was, the partial tranſmutation of mercury into gold or ſilver, and of ſilver into gold.

"The author informs us, that the perſons preſent at the firſt of theſe experiments were, the Rev. Mr. Anderſon, a clergyman reſiding near Guildford, well verſed in experimental philoſophy, and ſtudious of its chymical branches; Captain Francis Groſe, a gentleman known in the chymical world by his reſearches and publications; Mr. Ruſſel, a magiſtrate of the place, and a perſon, from his technical employments, converſant with the appearance of the precious metals, well acquainted with the uſual operations on them, and with the methods employed by artiſts for aſcertaining their commercial value; and enſign D. Groſe. And theſe gentlemen ſeem, at the expreſs inſtance of the author, to have provided every inſtrument or ingredient employed in the proceſs, except the POWDER ITSELF, which poſſeſſed ſuch wonderful properties. Half an ounce of mercury, the principal ingredient, was bought by Capt. Groſe at an apothecary's in the town, and placed in a crucible brought by Mr. Ruſſel, on a flux, the ingredients of which were either brought or examined by the company, and the very mortar in which they were pounded previouſly inſpected. Before the crucible was placed on the fire, half a grain of a deep red powder, furniſhed by the author, was weighed by Mr. Ruſſel, and added by Mr. Anderſon to the other ingredients. In about a quarter of an hour after the projection of this powder, and placing the crucible on the fire, it was obſerved, 'that though the crucible was now become red-hot, the mercury ſhewed no ſigns of evaporation, or even of boiling.' And the fire being raiſed to a ſtrong glowing red, or white-red heat, a clean iron rod was dipped into the matter, and the ſcoriæ which adhered to the point being knocked off when cold, were found to be replete with ſmall globules of whitiſh metal, which the author repreſented as 'an immediate ſubſtance, between mercury and a more perfect metal.'

"A ſmall quantity of borax, brought by Mr. Ruſſel, was now injected into the crucible; and the matter kept in a ſtrong red-white heat about a quarter of an hour; when the crucible being cooled and broke, a globule of yellow metal was found at the bottom; which together with ſome ſmaller globules found in the ſcoriæ, weighed full ten grains. This metal was ſealed up in a phial; and the next morning, in the preſence of the ſame company, and Captain Auſten, the large globule was hydroſtatically examined, when its ſpecific gravity compared with water, was eſtimated to be nearly in the ratio of 20 to 1. The globule, which weighed nine grains and a quarter, was then beat into a thin plate, and examined, in the manner of artiſts; by Mr. Ruſſel, who declared it to be as good gold as the grain gold of the refiners; and half the plate being ſent to Dr. Higgins, he was alſo of opinion that it was pure gold.

"The author mentions other chymical trials which were alſo made, and eſtabliſhed its pretence to the character of gold. In the ſecond and third experiments, a white powder is projected on mercury, which produces a white metal: the mercury lying quiet after the crucible had acquired a red heat in the former of theſe experiments; but in the latter, it accidentally began to boil; when on applying the white powder, the ebullition ceaſed, and did not return. In the fourth and fifth of theſe experiments, ſilver appeared to be tranſmuted by the projection of a ſmall quantity of the red powder; and to be found, on a regular aſſay, to contain pure gold, to the quantity of one-eighth of the joint weight. In the ſixth experiment, made before Sir Philip Norton Clarke, the Rev. Mr. Anderſon, Captain Groſe, Dr. Spence, Enſign Groſe, and Mr. Hallamby, two ounces of quickſilver were rubbed with a drop or two of vitriolic æther, in a ſmall mortar of Wedgwood's ware; and barely a grain of the white powder was put to it, and rubbed up with it for about three minutes. When the mercury was poured out of the mortar, it appeared to have acquired a degree of ſpiſſitude, and to be full of lumps; on ſtraining it through a cloth, an amalgam of a pretty ſolid conſiſtence remained, from which the unmixed mercury was expelled by the flame of a lamp directed by a blow-pipe, as it laid on a piece of charcoal: and the remainder was a bead of fine metal, which, on ſubſequent trials, appeared to be ſilver. The weight of this

bead was eighteen grains, and as much more was ſeparated from the ſtrained mercury as made the whole twenty-nine grains of ſilver; and the ſilver to the powder as 28 to 1.

"On the 25th of May, Lords Onſlow, King, and Palmerſton; Sir Robert Barker; Sir Philip N. Clarke, Bart. the Rev. O'Manning, B. Anderſon, G. Pollin, J. Robinſon, Clerks; Dr. Spence, W. Mann Godſchall, Wm. Smith, Wm. Godſchall, Jun. eſqrs. and Meſſrs. Gregory and Ruſſel, being preſent, the ſixth experiment was made with the uſual precautions and ſimilar ſucceſs, and ſilver obtained in a ſtill larger proportion. And the firſt experiment being alſo again tried, with the variation of placing the mercury in a depreſſion made in a flux of charcoal and borax, pure gold was obtained as before. The author relates two other experiments, made before ſome of the ſame company, on a much larger ſcale; in which his white powder produced fifty times its weight of ſilver, and his red powder ſixty times its weight in gold: and the produce of theſe experiments as well as ſome of the former, the author informs us have been preſented to his majeſty.

"On reading this very extraordinary publication, it is difficult to avoid falling into thoſe doubts, which the author ſays have been illiberally entertained of the truth of the fact; yet the evidence is unqueſtionable, and the precautions taken ſuch as ſeem to preclude every poſſibility of deceit. Could it be poſſibly ſuſpected of a gentleman whoſe ſituation in life can by no means render him deſirous of attaining fame by indirect means? And, as the teſtimony of the fact muſt be admitted without controverſy, he very reaſonably aſks, By what arts of deceit can Mercury be prevented from boiling in red heat? Or, when actually boiling and evaporating, can it be almoſt inſtantaneouſly fixed by the addition of a ſubſtance not above one 48oth of its weight? On the whole, we might have flattered ourſelves, in the courſe of reading this publication, that many more experiments of the like kind would have been tried, and the facts have received the additional ſanction of ſome learned public ſociety, if we had not unfortunately peruſed the introduction previous to the work; and, at the cloſe of it, found, to our great mortification, and to the diſappointment of the curious at large, the following paragraph:

"The whole of the materials, producing the extraordinary "change produced in the metal employed, was expended in per- "forming the proceſſes; nor can the author furniſh himſelf with "a ſecond portion, but by a proceſs equally tedious and operoſe; "whoſe effects he has recently experienced to be injurious to his "health, and of which he muſt therefore avoid a repetition."

"It appears that Dr. Price, the author of this pamphlet, was a Fellow of the Royal Society, and a phyſician of eminence at Guildford in Surry."

Theſe ſingular experiments, exhibited ſo repeatedly, and in the preſence of ſuch reſpectable characters, bore the appearance of plauſibility that the tranſmutation of metals was to be obtained. It had long before been tried by various ſcientific gentlemen without effect; but from the reſult of the above experiments it appeared to be at length accompliſhed. It is no wonder that ſo very ſingular a diſcovery ſhould have engaged the attention of the public at large, but in particular that auguſt body, the Royal Society, of which Dr. Price was a member. Theſe diſtinguiſhed amateurs of ſcientific knowledge, deſirous of being ſatisfied of the truth of what had been aſſerted by ocular demonſtration, requeſted Dr. Price to repeat his experiments in the preſence of the general aſſembly that compoſe that body. This the doctor thought proper to decline; the conſequence of which was that the Society being determined to be ſatisfied, laid a peremptory injunction on him that he ſhould comply with their requeſt, or no leſs penalty, in caſe of refuſal, than that of being expelled. This mandate ſtruck the philoſopher to the quick; his mind was agitated to a degree not to be diſpenſed with, and he ſunk beneath his burthen. Conſcious, no doubt, of the deception he had practiſed on ſo many reſpectable characters, and apprehenſive that a diſcovery would be made ſhould he attempt a repetition before ſo diſcerning a body of people, at the ſame time reflecting on the irreparable odium that would infallibly fall on him in his expulſion from one of the moſt diſtinguiſhed ſocieties in the kingdom, he knew not what ſtep to take; till at length, determined not to outlive his ſhame, he formed the dreadful reſolution of terminating his anxiety of mind by putting a period to his exiſtence.

Notwithſtanding the foregoing circumſtances, the alchymiſts are ſo far from being diſcouraged, that they look for the ſeed of gold not only in baſe metals, but in plants, blood, hair, and even in the very excrements of divers animals with as little ſucceſs. Thus the celebrated philoſopher the Hon. Mr. Boyle caught the credulous diſtemper; for he very gravely aſſerts, that the chalk, or earth, which was left at the bottom of an alembic, after a quantity had been diſtilled and re-diſtilled two hundred times, might have been converted into gold. This mighty change, no doubt, was to be effected in the uſual way by the help of the Powder of Projection; but herein we are left to think for ourſelves, as the experimentaliſt makes no mention of the proceſs or performance of the operation. And, as before obſerved, this miraculous powder never was defined, or pretended to be acquired, by any of the adepts in Alchymy; nor did any of the alchymiſts ever preſume to ſhew the manner by which the powder operates, except our unfortunate countryman already mentioned.

This art (although generally proſtituted and miſapplied) is not to be finally rejected, or held in contempt, for the reaſons which we ſhall now deduce, and which will corroborate the juſtice of theſe obſervations, notwithſtanding the many objections that may be contraſted, or oppoſed, to the whole of this ſyſtem.

1. The artiſt, in his aſſiduous and indefatigable labour to make gold, has frequently ſtumbled upon ſpecific remedies or medicines, which cure effectually, and ſooner a chronic or ſome other dangerous malady, than a galenical or other preparation uſed by our anceſtors. A diſcovery well worth the moſt laborious and expenſive proceſs, and more to be prized than the acquiſition of the Philoſopher's Stone, which, could it be found, would only ſerve to gratify coveteouſneſs, avarice and ambition, three of the worſt paſſions our nature is prone to indulge, inaſmuch as they attend us to the hour of death, though the moſt rare caſe of longevity ſhould be our portion. But it does not appear that any of thoſe hits have the deſerved name of a panacea, or univerſal medicine, to cure all diſeaſes; though this is ſo frequently boaſted of by quacks, and other impoſtors, in all countries.

2. The univerſal diſſolvent of Paracelſus and Van Helmont are arguments in favour of this ſyſtem. "There is (ſay they) a cer- "tain fluid in nature capable of reducing all ſublunary bodies, as "well homogeneous as mixed, into their firſt principle, or origi- "nal matter of which they are compoſed; or into an uniform, "equal, and portable liquor that will unite with water and the "juices of our bodies, yet retain its ſeminal virtues, and if mixed "with itſelf again will thereby be converted into pure elemen- "tary water."

Van Helmont is poſitive that he was maſter of that noble menſtruum, and Mr. Boyle conceived ſuch an advantageous opinion of it on his report, that he preferred it to the Philoſopher's Stone. As he (Mr. Boyle) conceived there was not the abſurdity attendant on the notion of an univerſal ens that reſolved all bodies into their general ens; by freeing them of the heterogeneous particles they were wrapped in; and thereby reſtore them to their priſtine liberty of directing themſelves, as there is to believe that at the ſame inſtant they are thus freed they acquire another form without the allowance of the leaſt moment for a new direction.

3. No perſon can doubt but that all bodies proceed originally from a firſt matter, which was itſelf once in a fluid ſtate, whoſe particles, by the continual agitation and compreſſion of the atmoſphere, the diverſity of their figures, and the occult quality which direct them to their different poles, have been concatenated together for the formation of thoſe different bodies.

This menſtruum is called the Alkaheſt by the adepts in this ſcience; the invention of which Van Helmont honours Parcelſus with, who has left the character of it. "There is (ſays this "author) the liquor alkaheſt, of great efficacy in preſerving the "liver, as alſo in curing hydropical and other diſeaſes ariſing from "diſorders of that part. If it has once conquered its like, it "becomes ſuperior to all hepatic medicines, and though the liver "itſelf were broken and diſſolved, this medicine could ſimply "ſupply its place."

Yet neither Van Helmont, or Paracelſus, has done that juſtice to mankind as to tranſmit ſo valuable a medicine to poſterity, and perhaps the reaſon was, that they might have, in the courſe of their practice, great reaſon to doubt of that ſovereign power above aſcribed to it. Be that as it will, there is great reaſon to doubt of its ſingular efficacy, as ſtated by Van Helmont, agreeable to the maxim, "he that proves too much is no evidence;" ſo that to ſubſtitute the alkaheſt in the place or ſtead of a broken or diſſolved liver, is as far an hyperbole in quackery, as to pretend to reſtore a dead man to life by it.

From the known practice of Paracelſus, he gave names to his remedies by reverſing their real orthography; hence this word alkaheſt is formed of the words *alkali* and *eſt*, which is corruptly pronounced Alkal-eſt, or Alkaheſt; conſequently the ſecret medicine is no other than the Alkaline Salt of Tartar volatilized, as Glauber very accurately defines.

It is thus deſcribed by the elder Helmont: "It is the higheſt "and moſt ſucceſsful among ſalts, which having obtained the ſu- "preme degree of ſimplicity, purity, and ſubtility, alone enjoys "the faculty of remaining unchanged and unimpaired by the ſub- "ject it works upon, and of diſſolving the moſt ſtubborn and un- "tractable bodies, as ſtones, gems, glaſs, earth, ſulphur, me- "tals, &c. into real ſalt equal in weight to the matter diſſolved; "and this with as much eaſe as hot water diſſolves ſnow; and "by being ſeveral times cohobated with Paracelſus's ſal circu- "latum, this ſalt loſes all its fixedneſs, and at length becomes "an inſipid water, equal in quantity to the ſalt it was made "from."

Hence we may infer that Paracelſus and Van Helmont, whatever deficiencies might be in their Alkaheſt, took water for the univerſal inſtrument of chymiſtry and philoſophy; and earth for the unchangeable baſis of all things; that fire was deſigned as their efficient cauſe; that ſeminal impreſſions were lodged in the mechaniſm of the earth; and that water by diſſolving and fermenting

menting with the earth as it does by means of fire, brings every thing forth; from whence proceed the animal, vegetable, and mineral kingdoms of nature.

The origin and antiquity of Alchymy are much controverted.—If regard may be had to legend and tradition, it muſt be as old as the flood. But in effect, not one of the ancient poets, philoſophers, or phyſicians, from Homer, till four hundred years after Chriſt, mention any ſuch thing.—The firſt author who ſpeaks of making gold, is Zoſimus the Panopolite, who lived towards the beginning of the fifth century.

Kercher aſſerts, that the theory of the Philoſophers Stone is delivered at large in the table of Hermes; and that the ancient Egyptians were not ignorant of the art, but declined to proſecute it. They did not need to tranſmute gold; they had ways of ſeparating it from all kinds of bodies, from the very mud of the Nile, and ſtones of all kinds: however, he adds, theſe ſecrets were never written or publiſhed, but confined to the royal family, and handed down traditionally from father to ſon. Kircher, inſtructed in all the ſecrets of chymiſtry, has, upon the whole, fully expoſed the artifices and impoſtures of alchymiſts. For further particulars on this ſubject, ſee the Syſtem of CHYMISTRY, *Introduction*.

Mr. Harris very properly diſtinguiſhes Alchymy from Chymiſtry; and defines the former to be *ars ſine arte, cujus principium eſt mentiri, medium laborare, et finis mendicare*; and the Italians have a proverb, *non ti fidiare al alchemiſta povero o medico amalato*.

The beſt writers in Alchymy, according to the judgment of Boerhaave, are Gaber, Morienus, Roger Bacon, Ripley, Raim, Lully, Bern, count Treviſanus, John and Iſaac Hulandus, Sendivogius, Baſil Valentine, Artephius, Paracelſus, Irenæus Philalethes, and Van Helmont. See *Petri Borelli, Bibliotheca Chymica, ſive Catalogus Librorum Philoſophicarum Hermeticorum*, Par. 1654, 12mo. It contains an account of about 4000 writers.

ALCOHOL, or ALCOOL, in Chymiſtry, the pureſt ſpirit of wine, raiſed, or rectified by repeated diſtillations, to its utmoſt ſubtilty and perfection. Alcohol is the moſt complete production of vegetable fermentation; and, when brought to its higheſt degree of perfection, is the lighteſt fluid next to air; perfectly tranſparent, very thin, moſt ſimple, totally inflammable, without producing any ſmoke, or diffuſing any diſagreeable ſcent while it is burning; is exceeding volatile, without leaving any fæces: abſolutely immutable in diſtillation, extremely expanſible by heat, very eaſily diſpoſed to ebullition by fire, of a very pleaſant ſmell, and of a particular grateful taſte. All the humours of the human body that we are acquainted with, it coagulates in an inſtant, excepting the pure water and urine: whilſt it hardens all the ſolid parts, and thus preſerves both from putrefaction, or ſpontaneous colliquation. It preſerves the bodies of inſects, fiſh, birds, and other animals that are put into it, from corruption, or alteration, for ages, if cloſely ſtopped. With water, vinegar, any acid liquors, oils, and pure volatile alkaline ſalts, it ſuffers itſelf to be mixed, and that nearly of an equable mixture; gummy and reſinous ſubſtances it diſſolves. So that we are acquainted with no liquid, produced either by nature, or by the art of chymiſtry, that is capable of being united with more bodies than Alcohol: but in a particular manner it proves an excellent vehicle for the *ſpiritus rector* of vegetables, which, by uniting with it, may be extracted from its proper body, retained, and applied to medicinal and other uſes. In the human body, by its ſmell, taſte, and vapour, it wonderfully quickens, gratefully affects, and invigorates the animal, natural, and vital ſpirits, nerves, and brain. Flames fed by Alcohol of wine, though of the ſame bigneſs with other flames, cauſe different degrees of dilatation in metals. Since there are various, and ſometimes very inviting occaſions, in which chymiſts, and other artificers, ſtand in need of the true and pureſt Alcohol, the leaſt remainder of water will render the operations unſucceſsful.

The internal uſe of Alcohol is highly deſtructive to the animal flame, as, among other inconveniences, it dries and contracts the nerves, and coagulates the juices. Alcohol, however, and fermented ſpirits in general, are of good ſervice externally applied, in many caſes. Thus, ſpirit of wine, eſpecially camphorated, is a very good addition to fomentations deſigned to reſolve inflammations, whether external or internal. Pure Alcohol likewiſe, according to Boerhaave, is the beſt of ſtyptics. According to Juncker, it is a combination of the acetous acid, phlogiſton, and water; but the ableſt chymiſts are not yet agreed as to the conſtituent principles of this fluid. See the Syſtem, Part iv. C. 3. Sect. 1.

ALCOHOLIZATION, in Chymiſtry, the rectification of a vinous ſpirit. This is otherwiſe called Alcolization. Alcolization, according to Starkey, denotes the circulation of a volatile ſpirit on a fixed alkali, till ſuch time as out of the two ariſes one neutral body, different from both the former. Alcoholation is one way of volatizing alkalis.

ALCORAN, or AL KORAN, the Mahometan goſpel; or revelations, doctrines and propheceies, of the pretended prophet Mahomet. It is vulgarly called Alcoran; but the firſt ſyllable of the word is nothing more than an article ſignifying *the*; and therefore the true orthography of the word is *Al Coran*, or *Al Koran*, that is, the Koran. It is derived from the Arabic word *karan*, to read, and ſignifies the reading, or what ought to be read Thus Mahomet gave it this title by way of eminence, in imitation of the Jews and Chriſtians, who call the Old and New Teſtament *Scripture*; and the *Bible*, i. e. the Book.

Beſides this peculiar name, the Koran is alſo honoured with ſeveral appellations common to other books of ſcripture: as *al Farkan*, from the verb *faraka, to divide*, or *diſtinguiſh*; not, as the Mahometan doctors ſay, becauſe thoſe books are divided into chapters or ſections, or diſtinguiſh between good and evil; but in the ſame notion that the Jews uſe the word *perek*, or *pirka*, from the ſame root, to denote a ſection or portion of ſcripture. It is alſo called *al Moſhaf, the volume*, and *al Kitab, the book*, by way of eminence, which anſwers to the *Biblia* of the Greeks; and *al Dhikr, the admonition*, which name is alſo given to the Pentateuch and Goſpel.

The Koran is divided into 114 larger portions of very unequal length, which we call *chapters*; but the Arabians *ſowar*, in the ſingular *ſura*; a word rarely uſed on any other occaſion, and properly ſignifying a row, order, or a regular ſeries. Every chapter is ſubdivided into ſmall portions of very unuſual length, which we commonly call verſes.

Beſides theſe unequal diviſions of chapter and verſe, the Mahometans have divided their Koran into ſixty equal portions. Some chapters have two or more titles, occaſioned by the difference of the copies. Some of them having been revealed at Mecca, and others at Medina, the noting this difference makes a part of the title: but the reader will obſerve, that ſeveral of the chapters are ſaid to have been revealed partly at Mecca and partly at Medina; and as to others, it is yet a diſpute among the commentators to which of the two places they belong.

The Koran is uſually divided into thirty ſections, named *Ajza*, each of them generally twice the length of the former, and ſubdivided into four parts. Theſe diviſions are for the uſe of the readers of the Koran in the royal temples, or in the adjoining chapels were the emperors and great men are interred. There are thirty of theſe readers belonging to every chapel, and each reads his ſection every day; ſo that the whole Koran is read over once a day. Next after the title, at the head of every chapter, except only the ninth, is prefixed the following ſolemn form, by the Mahometans called the *Biſmollah*, IN THE NAME OF THE MOST MERCIFUL GOD; which form they conſtantly place at the beginning of all their books and writings in general, as a peculiar mark of diſtinguiſhing characteriſtic of their religion, it being counted a ſort of impiety to omit it. The Jews, for the ſame purpoſe, make uſe of the form, *In the name of the* LORD, or *In the name of the great* GOD; and the eaſtern chriſtians that of, *In the name of the Father, and of the Son, and of the Holy Ghoſt*. But Mahomet probably took this form, as he did many other things, from the Perſian Magi, who uſed to begin their books in theſe words, *Benam Yezdam bakſhaiſhgher dadar;* that is *In the name of the moſt merciful juſt God*.

There are twenty-nine chapters of the Koran, which have this peculiarity, that they begin with certain letters of the alphabet, ſome with a ſingle one, others with more. Theſe letters the Mahometans believe to be the peculiar marks of the Koran, and to conceal ſeveral profound myſteries; the certain underſtanding of which, the more intelligent confeſs, has not been communicated to any mortal, their prophet only excepted. Notwithſtanding which, ſome will take the liberty of gueſſing at their meaning by that ſpecies of Cabala called by the Jews *Notarikon*, and ſuppoſe the letters to ſtand for as many words, expreſſing the names and attributes of God, his works, ordinances, and decrees; and therefore theſe myſterious letters, as well as the verſes themſelves, ſeem in the Koran to be called *ſigns*.

The Koran is univerſally allowed to be written with the utmoſt elegance and purity of language, in the dialect of the tribe of Koreiſh, the moſt noble and polite of all the Arabians, but with ſome mixture, though very rarely, of other dialects. It is confeſſedly the ſtandard of the Arabic tongue, and, as the more orthodox believe, and are taught by the book itſelf, inimitable by any human pen (though ſome ſectaries have been of another opinion), and therefore inſiſted on as a permanent miracle, greater than that of raiſing the dead, and alone ſufficient to convince the world of its divine original. And to this miracle did Mahomet himſelf chiefly appeal for the confirmation of his miſſion, publicly challenging the moſt eloquent men in Arabia, which was at that time ſtocked with thouſands whoſe ſole ſtudy and ambition it was to excel in elegance of ſtyle and compoſition, to produce even a ſingle chapter that might be compared with it.

As the compoſition and arrangement of words, however, admit of infinite varieties, it can never be abſolutely ſaid that any one is the beſt poſſible. In fact, Hamzah Benahmed wrote a book againſt the Alcoran with at leaſt equal elegance; and Moſelema another, which even ſurpaſſed it, and occaſioned a defection of a great part of the Muſſulmen.

To the pomp and harmony of expreſſion ſome aſcribe all the force and effect of the Alcoran; which they conſider as a ſort of muſic, equally fitted with other ſpecies of that art to raviſh and amaze. In this, Mahomet ſucceeded ſo well, and ſo ſtrangely captivated the minds of his audience, that ſeveral of his oppo-

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nents thought it the effect of witchcraft and enchantment, as he himself complains. Others have attributed the effect of the Alcoran to the frequent mention of rewards and punishments; heaven and hell occurring almoſt in every page. Some ſuppoſe, that the ſenſual pleaſures of paradiſe, ſo frequently ſet before imaginations of the readers of the Alcoran, were what chiefly bewitched them; though, with regard to theſe, there is a great diſpute whether they are to be underſtood literally or ſpiritually. Several have even allegorized the whole book.

The general deſign of the Koran was to unite the profeſſors of the three different religions, then followed in the populous country of Arabia (who for the moſt part lived promiſcuouſly, and wandered without guides, the far greater number being idolaters, and the reſt Jews and Chriſtians moſtly of erroneous and heterodox belief), in the knowledge and worſhip of one God, under the ſanction of certain laws, and the outward ſigns of ceremonies partly of ancient and partly of novel inſtitution, enforced by the conſideration of rewards and puniſhments both temporal and eternal; and to bring them all to the obedience of Mahomet, as the prophet and ambaſſador of God, who, after the repeated admonitions, promiſes, and threats, of former ages, was at laſt to eſtabliſh and propagate God's religion on earth, and to be acknowledged chief pontiff in ſpiritual matters, as well as ſupreme prince in temporal. The great doctrine then of the Koran, is the unity of God; to reſtore which point Mahomet pretended was the chief end of his miſſion; it being laid down by him as a fundamental truth; that there never was, nor ever can be, more than one true orthodox religion; for, though the particular laws or ceremonies are only temporary, and ſubject to alteration, according to the divine direction; yet the ſubſtance of it being eternal truth, is not liable to change, but continues immutably the ſame. And he taught, that, whenever this religion became neglected, or corrupted in eſſentials, God had the goodneſs to re-inform and re-admoniſh mankind thereof, by ſeveral prophets, of whom Moſes and Jeſus were the moſt diſtinguiſhed, till the appearance of Mahomet, who is their ſeal, and no other to be expected after him. The more effectually to engage people to hearken to him, great part of the Koran is employed in relating examples of dreadful puniſhments formerly inflicted by God on thoſe who rejected and abuſed his meſſenger; ſeveral of which ſtories, or ſome circumſtances of them, are taken from the Old and New Teſtaments, but many more from the apocryphal books and traditions of the Jews and Chriſtians of thoſe ages, ſet up in the Koran as truths in oppoſition to the ſcriptures, which the Jews and Chriſtians are charged with having altered: and, indeed, few or none of the relations or circumſtances in the Koran were invented by Mahomet, as is generally ſuppoſed; it being eaſy to trace the greateſt part of them much higher, as the reſt might be, were more of thoſe books extant, and was it worth while to make the inquiry. The reſt of the Alcoran is taken up in preſcribing neceſſary laws and directions, frequent admonitions to moral and divine virtues, the worſhip and reverence of the ſupreme being and reſignation to his will. One of their moſt learned commentators diſtinguiſhes the contents of Alcoran into *allegorical* and *literal*; under the former are comprehended all the obſcure, parabolical, and enigmatical paſſages, with ſuch as are repealed, or abrogated; the latter, ſuch as are clear, and in full force.

The moſt excellent moral in the whole Alcoran, interpreters ſay, is that in the chapter *Al Araf*, viz. Shew mercy, do good to all, and diſpute not with the ignorant; or, as Mr. Sale renders it, Uſe indulgence, command that which is juſt, and withdraw far from the ignorant. Mahomet, according to the authors of the *Kaſſhaf*, having begged of the angel Gabriel a more ample explication of this paſſage, received it in the following terms: "Seek "him who turns thee out, give to him who takes from thee, par"don him who injures thee; for God will have you plant in your "ſouls the roots of his chief perfections." It is eaſy to ſee that this commentary is copied from the goſpel. In reality, the neceſſity of forgiving enemies, though frequently inculcated in the Alcoran, is of a later date among the Mahometans than among the Chriſtians: among thoſe latter, than among the heathens; and to be traced originally among the Jews. See EXODUS xxxiii. 4, 5.) But if matters not ſo much who had it firſt, as who obſerves it beſt. The caliph Aaſſan, ſon of Hali, being at table, a ſlave unfortunately let fall a diſh of meat reeking hot, which ſcalded him ſeverely. The ſlave fell on his knees, rehearſing theſe words of the Alcoran, "Paradiſe is for thoſe who reſtrain their anger." I am not angry with thee, anſwered the caliph. "And for thoſe who forgive offences againſt them," continued the ſlave. "I forgive thee thine," replies the caliph. "But above all, for thoſe who return good for evil," adds the ſlave. "I ſet thee at liberty, rejoined the caliph; and I give thee ten dinars."

There are alſo a great number of occaſional paſſages in the Alcoran, relating only to particular emergencies. For this advantage Mahomet had in the piecemeal method of receiving his revelation, that whenever he happened to be perplexed and gravelled with any thing, he had a certain reſource in ſome new morſel of revelation. It was an admirable contrivance of his, to bring down the whole Alkoran at once, only to the loweſt heaven, not to earth; ſince had the whole been publiſhed at once, innumerable objections would have been made, which it would have been impoſſible for him to ſolve; but as he aſſerted to have received it by parcels, as God ſaw fit they ſhould be publiſhed for the converſion of the people, he had a ſure way to anſwer all emergencies, and to extricate himſelf with honour from any difficulty which might occur. It is the general and orthodox belief among the Mahometans, that the Koran is of divine original; nay, that it is eternal and uncreated, remaining, as ſome expreſs it, in the very eſſence of God: that the firſt tranſcript has been from everlaſting by God's throne, written on a table of vaſt bigneſs, called the *preſerved table*, in which are alſo recorded the divine decrees paſt and future: that a copy from this table, in one volume on paper, was by the miniſtry of the angel Gabriel ſent down to the loweſt heaven, in the month of Ramadan, on the night of *power*: from whence Gabriel revealed it to Mahomet by parcels, ſome at Mecca, and ſome at Medina, at different times, during the ſpace of 23 years, as the exigency of affairs required; giving him, however, the conſolation to ſhew him the whole (which they tell us was bound in ſilk, and adorned with gold and precious ſtones of paradiſe) once a-year; but in the laſt year of his life he had the favour to ſee it twice. They ſay, that few chapters were delivered entire, the moſt part being revealed piecemeal, and written down from time to time by the prophet's amanuenſis in ſuch a part of ſuch and ſuch a chapter, till they were completed, according to the directions of the angel. The firſt parcel that was revealed is generally agreed to have been the firſt five verſes of the 96th chapter. After the new-revealed paſſages had been from the prophet's mouth taken down in writing by his ſcribe, they were publiſhed to his followers; ſeveral of whom took copies for their private uſe, but the far greater number got them by heart. The originals, when returned, were put promiſcuouſly into a cheſt, obſerving no order of time; for which reaſon it is uncertain when many paſſages were revealed.

When Mahomet died, he left his revelations in the ſame diſorder, and not digeſted into the method, ſuch as it is, in which we now find them. This was the work of his ſucceſſor Abu Beer; who, conſidering that a great number of paſſages were committed to the memory of Mahomet's followers, many of whom were ſlain in the wars, ordered the whole to be collected, not only from the palm-leaves and ſkins on which they had been written, and which were kept between two boards or covers, but alſo from the mouths of ſuch as had gotten them by heart. And this tranſcript, when completed, he committed to the cuſtody of Haſſa the daughter of Omar, one of the prophet's widows. From this relation it is generally imagined that Abu Beer was really the compiler of the Koran; though, for aught appears to the contrary, Mahomet left the chapters complete as we now have them, excepting ſuch paſſages as his ſucceſſor might add or correct from thoſe who had gotten them by heart; what Abu Beer did elſe, being perhaps no more than to range the chapters in their preſent order, which he ſeems to have done without any regard to time, having generally placed the longeſt firſt.

However, in the 30th year of the Hegira, Othman being then caliph, and obſerving the great diſagreement in the copies of the Koran in the ſeveral provinces of the empire; thoſe of Irak, for example, following the reading of Aba Muſa al Aſhari, and the Syrians that of Meadad Ebn Aſwad; he, by the advice of the *companions*, ordered a great number of copies to be tranſcribed from that of Abu Beer, in Haſſa's care, under the inſpection of Zeid Ebn Thabet, Abd'allah Ebn Zubair, Said Ebn al As, and Ad'alrahman Ebn al Hareth the Makhzumite; whom he directed, that, wherever they diſagreed about any word, they ſhould write it in the dialect of the Koreiſh, in which it was at firſt delivered. Theſe copies, when made, were diſperſed in the ſeveral provinces of the empire, and the old ones burnt and ſuppreſſed. Though many things in Haſſa's copy were corrected by the abovementioned reviſers, yet ſome few various readings ſtill occur. In fine, the book of the Alcoran is held in the higheſt eſteem and reverence among the Muſſelmen. They dare not ſo much as touch the Alcoran without being firſt waſhed, or legally purified; to prevent which, an inſcription is put on the cover or label, *Let none touch but they who are clean*. It is read with great care and reſpect; being never held below the girdle. They ſwear by it; take omens from it on all weighty occaſions; carry it with them to war; write ſentences of it on their banners; adorn it with gold and precious ſtones; and knowingly ſuffer it not to be in the poſſeſſion of any of a different religion. Some ſay, that it is puniſhable even with death, in a Chriſtian, to touch it; others, that the veneration of the Muſſelmen leads them to condemn the tranſlating it into any other language as a profanation: but theſe ſeem to be aggravations. The Mahometans have taken care to have their ſcripture tranſlated into the Perſian, the Javan, the Malayan, and other languages; though, out of reſpect to the original, theſe verſions are generally, if not always, interlineated.

Comparative View of Chriſtianity and Mahometaniſm.

"By the advocates of Mahometaniſm the Koran, as already obſerved, has always been held forth as the greateſt of miracles, and equally ſtupendous with the act of raiſing the dead. The miracles

miracles of Moſes and Jeſus, they ſay, were tranſient and temporary; but that of the Koran is permanent and perpetual; and therefore far ſurpaſſes all the miraculous events of preceding ages. We will not detract from the real merit of the Koran: we allow it to be generally elegant, and often ſublime: but, at the ſame time, we reject, with diſdain, its arrogant pretence to any thing ſupernatural; all the real excellence of the work being eaſily referable to natural and viſible cauſes.

"In the language of Arabia, a language extremely loved and diligently cultivated by the people to whom it was vernacular, Mahomet found advantages which were never enjoyed by any former or ſucceeding impoſtor. It requires not the eye of a philoſopher to diſcover in every ſoil and country a principle of national pride: and if we look back for many ages on the hiſtory of the Arabians, we ſhall eaſily perceive that pride among them invariably to have conſiſted in the knowledge and improvement of their native language. The Arabic, which has been juſtly eſteemed the moſt copious of the Eaſtern tongues; which had exiſted from the remoteſt antiquity; which had been embelliſhed by numberleſs poets, and refined by the conſtant exerciſe of the natives; was the moſt ſucceſsful inſtrument which Mahomet employed in planting his new religion among them. Admirably adapted by its unrivalled harmony, and by its endleſs variety to add painting to expreſſion, and to purſue the imagination in its unbounded flight; it became in the hands of Mahomet an irreſiſtible charm to blind the judgment, and to captivate the fancy of his followers.

"Of that deſcription of men, who firſt compoſed the adherents of Mahomet, and to whom the Koran was addreſſed, few, probably, were able to paſs a very accurate judgment on the propriety of the ſentiments, or on the beauties of the diction: but all could judge of the military abilities of their leader; and, in the midſt of their admiration, it is not difficult to conceive, that they would aſcribe to his compoſitions every imaginary beauty of inſpired language. The ſhepherd and the ſoldier, though awake to the charms of thoſe wild but beautiful compoſitions, in which were celebrated their favourite occupations of love or war, were yet little able to criticiſe any other works than thoſe which were addreſſed to their imagination or the heart. To abſtract reaſonings on the attributes or the diſpenſations of the Deity, to the comparative excellencies of rival religions, to the conſiſtency of any one religious ſyſtem in all its parts, and to the force of its various proofs, they were quite inattentive. In ſuch a ſituation the appearance of a work which poſſeſſed ſomething like wiſdom and conſiſtence; which preſcribed the rules, and illuſtrated the duties of life; and which contained the principles of a new and comparatively ſublime theology; independently of its real and permanent merit, was likely to excite their aſtoniſhment, and to become the ſtandard of future compoſition.

"In the firſt periods of the literature of every country, ſomething of this kind has happened. The father of the Grecian poetry very obviouſly influenced the taſte and imitation of his countrymen. The modern nations of Europe all profeſs ſome original author, who, riſing from the darkneſs of former ages, has begun the career of compoſition, and tinctured with the character of his own imagination the ſtream which has flowed through his poſterity.

"But the prophet of Arabia had in this reſpect advantages peculiar to himſelf. His compoſitions were not to his followers the works of man, but the genuine language of Heaven, which had ſent him. They were not confined therefore to that admiration which is ſo liberally beſtowed on the earlieſt productions of genius, or to that fond attachment with which men every where regard the original compoſitions of their country: but with their admiration they blended their piety. To know and to feel the beauties of the Koran, was in ſome reſpect to ſhare in the temper of heaven; and he who was moſt affected with admiration in the peruſal of its beauties, ſeemed moſt fitly the object of that mercy which had given it to ignorant man. The Koran, therefore became naturally and neceſſarily the ſtandard of taſte. With a language thus hallowed in their imaginations, they were too well ſatisfied, either to diſpute its elegance or improve its ſtructure. In ſucceeding ages, the additional ſanction of antiquity, or preſcription, was given to theſe compoſitions which their fathers had admired: and while the belief of its divine original continues, that admiration, which has thus become the teſt and the duty of the faithful, can neither be altered nor diminiſhed.

"When therefore we conſider theſe peculiar advantages of the Koran, we have no reaſon to be ſurpriſed at the admiration in which it is held. But if, deſcending to a more minute inveſtigation of it, we conſider its perpetual inconſiſtence and abſurdity, we ſhall indeed have cauſe for aſtoniſhment at that weakneſs of humanity which could ever have received ſuch compoſitions as the work of the Deity.

"The firſt praiſe of all the productions of genius, is invention: that quality of the mind, which, by the extent and quickneſs of its views, is capable of the largeſt conceptions, and of forming new combinations of objects the moſt diſtant and unuſual. But the Koran bears little impreſſion of this tranſcendent character. Its materials are wholly borrowed from the Jewiſh and Chriſtian ſcriptures, from the Talmudical legends and apocryphal goſpels then current in the Eaſt, and from the traditions and fables which abounded in Arabia. The materials collected from theſe ſeveral ſources are here heaped together, with perpetual and needleſs repetitions, without any ſettled principle or viſible connection.

"After a great part of the life of Mahomet had been ſpent in preparatory meditation on the ſyſtem he was about to eſtabliſh, its chapters were dealt out ſlowly and ſeparately during the long period of 23 years. Yet thus defective in its ſtructure, and no leſs exceptionable in its doctrines, was the work which Mahomet delivered to his followers as the oracles of God.

"The moſt prominent feature in the Koran, that point of excellence in which the partiality of its admirers has ever delighted to view it, is the ſublime notion it generally impreſſes of the nature and attributes of God. If its author had really derived theſe juſt conceptions from the inſpiration of that Being whom they attempt to deſcribe, they would not have been ſurrounded, as they now are, on every ſide, with error and abſurdity. But it might eaſily be proved, that whatever it juſtly defines of the divine attributes, was borrowed from our holy ſcripture; which even from its firſt promulgation, but eſpecially from the completion of the New Teſtament, has extended the views and enlightened the underſtandings of mankind; and thus furniſhed them with arms, which have too often been ineffectually turned againſt itſelf by its ungenerous enemies.

"In this inſtance particularly, the copy is far below the great original, both in the propriety of its images, and the force of its deſcriptions. Our holy ſcriptures are the only compoſitions that can enable the dim ſight of mortality to penetrate into the inviſible world, and to behold a glimpſe of the Divine perfections. Accordingly, when they would repreſent to us the happine s of Heaven, they deſcribe it, not by any thing minute and particular, but by ſomething general and great; ſomething, that without deſcending to any determinate object, may at once, by its beauty and immenſity, excite our wiſhes and elevate our affections. Though in the prophetical and evangelical writings, the joys that ſhall attend us in a future ſtate are often mentioned with ardent admiration, they are expreſſed rather by alluſion than ſimilitude, rather by indefinite and figurative terms, than by any thing fixed and determinate. 'Eye hath not ſeen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love him.' 1 *Cor.* ii. 9. What a reverence and aſtoniſhment does this paſſage excite in every hearer of taſte and piety! What energy, and at the ſame time what ſimplicity, in the expreſſion! How ſublime, at the ſame time how obſcure, is the imagery! Different was the conduct of Mahomet in his deſcriptions of heaven and of paradiſe. Unaſſiſted by the neceſſary influence of virtuous intentions and Divine inſpiration, he was neither deſirous, nor indeed able, to exalt the minds of men to ſublime conceptions, or to rational expectations. By attempting to explain what is inconceivable; to deſcribe what is ineffable; and to materialize what in itſelf is ſpiritual; he abſurdly and impiouſly aimed to ſenſualize the purity of the Divine eſſence. Thus he fabricated a ſyſtem of incoherence, a religion of depravity, totally repugnant indeed to the nature of that Being, who, as he pretended, was its object; but therefore more likely to accord with the appetites and conceptions of a corrupt and ſenſual age.

"That we may not appear to exalt our Scriptures thus far above the Koran by an unreaſonable preference, we ſhall produce a part of the ſecond chapter of the latter, which is deſervedly admired by the Mahometans, who wear it engraved on their ornaments, and recite it in their prayers. 'God! there is no God but he; the living, the ſelf-ſubſiſting; neither ſlumber nor ſleep ſeizeth him: to him belongeth whatſoever is in heaven, and on earth. Who is he that can intercede with him but through his good pleaſure? He knoweth that which is paſt, and that which is to come. His throne is extended over heaven and earth, and the preſervation of both is to him no burthen. He is the high, the mighty.' *Sale's Kor.* ii. p. 30, 4to edit. To this deſcription who can refuſe the praiſe of magnificence? Part of that magnificence, however, is to be referred to that verſe of the Pſalmiſt, whence it was borrowed, 'He that keepeth Iſrael, ſhall neither ſlumber nor ſleep.' *Pſal.* cxxi. 4. But if we compare it with that other paſſage of the ſame inſpired Pſalmiſt, all its boaſted grandeur is at once obſcured, and loſt in the blaze of a greater light. 'O my God, take me not away in the midſt of my days; thy years are throughout all generations. Of old haſt thou laid the foundations of the earth; and the heavens are the work of thy hands. They ſhall periſh, but thou ſhalt endure; yea all of them ſhall wax old, as doth a garment; as a veſture ſhalt thou change them, and they ſhall be changed; but thou art the ſame, and thy years ſhall not fail.' The Koran, therefore, upon a retroſpective view of theſe ſeveral circumſtances, far from ſupporting its arrogant claim to a ſupernatural work, ſinks below the level of many compoſitions confeſſedly of human original; and ſtill lower does it fall in our eſtimation, when compared with that pure and perfect pattern which we juſtly admire in the ſcriptures of truth. It is therefore abundantly apparent, that no miracle either

either was externally performed for the ſupport, or is internally involved in the compoſition, of the Mahometan revelation."

ALCORANISTS, among Mahometans, thoſe who adhere ſtrictly to the letter or text of the Alcoran, from an opinion of its ultimate ſufficiency and perfection. The Perſians are generally Alcoraniſts, as admitting the Alcoran alone for their rule of faith. The Turks, Tartars, Arabs, &c. beſides the Alcoran, admit a multitude of traditions. The Alcoraniſts, among Mahometans, amount to much the ſame with the textuaries among the Jews. The Alcoraniſts can find nothing excellent out of the Alcoran; are enemies of philoſophers, metaphyſicians, and ſcholaſtic writers. With them the Alcoran is every thing.

ALDERMAN, in the Engliſh Polity, an aſſociate to the mayor, or civil magiſtrate, of a city or town, for the better adminiſtration of his office. The *aldermen* are an order of magiſtrates, in our cities, and moſt of the municipal, or incorporate towns, who form a kind of council, and regulate things relating to the policy of the place. They ſometimes alſo take cognizance of civil and criminal matters; but that very rarely, and only in certain caſes. Their number is not limited; but in ſome places is more, in ſome leſs, from ſix to twenty-ſix. Out of theſe are annually elected the mayor, or chief magiſtrates, of places; who, at the expiration of their mayoralty, return again into the body of the *aldermen* whoſe delegates they were before. The twenty-ſix *aldermen* of London preſide over the twenty-ſix wards of the city. When one of them dies or reſigns, the wardmote chuſe a ſucceſſor, who is admitted, and ſworn into office, by the lord-mayor and court of *aldermen*. All the *aldermen* are juſtices of the peace, by a charter of 15 Geo. II. The *aldermen* of London, &c. are exempted from ſerving inferior offices; nor ſhall they be put upon aſſizes, or ſerve on juries, ſo long as they continue to be *aldermen*. 2 Cro. 585.

ALE, a fermented liquor obtained from an infuſion of malt, and differing from beer chiefly in having a leſs proportion of hops. (See BREWING). This liquor, (the natural ſubſtitute of wine in ſuch countries as could not produce the grape), was originally made in Egypt, the firſt planted kingdom, on the diſperſion from the eaſt, that was ſuppoſed unable to produce grapes. And, as the Noachian colonies pierced further into the weſt, they found, or thought they found, the ſame defect, and ſupplied it in the ſame manner. Thus the natives of Spain, the inhabitants of France, and the aborigines of Britain, all uſed an infuſion of barley for their ordinary liquor: and it was called by the various names of *Cælia* and *Ceria* in the firſt country, *Cereviſia* in the ſecond, and *Curmi* in the laſt; all literally importing only *the ſtrong water*.

"All the ſeveral nations (ſays Pliny) who inhabit the weſt of Europe, have a liquor with which they intoxicate themſelves, made of corn and water. The manner of making this liquor is ſomewhat different in Gaul, Spain, and other countries, and is called by many various names; but its nature and properties are every where the ſame. The people of Spain, in particular, brew this liquor ſo well, that it will keep good a long time. So exquiſite is the cunning of mankind, in gratifying their vicious appetites, that they have thus invented a method to make water itſelf intoxicate." The method in which the ancient Britons, and other Celtic nations, made their ale, is thus deſcribed by Iſidorus, and Oroſius. "The grain is ſteeped in water and made to germinate, by which its ſpirits are excited and ſet at liberty; it is then dried and ground; after which it is infuſed in a certain quantity of water; which being fermented, becomes a pleaſant, warming, ſtrengthening, and intoxicating liquor." This ale was moſt commonly made of barley; but ſometimes of wheat, oats, and millet.

Anciently the Welch and Scots had alſo two kinds of ale, called *common ale and ſpiced ale*; and their value was thus aſcertained by law: "If a farmer hath no mead, he ſhall pay two caſks of ſpiced ale, or four caſks of common ale, for one caſk of mead." By this law, a caſk of ſpiced ale, nine palms in height, and 18 palms in diameter, was valued at a ſum of money equal in efficacy to 7l. 10s. of our preſent money; and a caſk of common ale, of the ſame dimenſions, at a ſum equal to 3l. 15s. This is a ſufficient proof, that even common ale in this period was an article of luxury among the Welch, which could only be obtained by the great and opulent. Wine ſeems to have been quite unknown even to the kings of Wales, in this period, as it is not ſo much as once mentioned in their laws; though Giraldus Cambrenſis, who flouriſhed about a century after the conqueſt, acquaints us, that there was a vineyard in his time at Maenarper, near Pembroke, in South Wales.

Ale was the favourite liquor of the Anglo-Saxons and Danes, as it had been of their anceſtors the ancient Germans. Before their converſion to Chriſtianity, they believed that drinking large and frequent draughts of ale was one of the chief felicities which thoſe heroes enjoyed who were admitted into the hall of Odin.

There are various ſorts of ale known in Britain, particularly *pale* and *brown*; the former is brewed from malt ſlightly dried; and is eſteemed more viſcid than the latter, which is made from malt more highly dried or roaſted. Pale ale brewed with hard waters, as thoſe of ſprings and wells, is judged the moſt wholeſome, in regard the mineral particles tend to prevent the cohe-ſions of thoſe drawn from the grain, and enable them to paſs the proper ſecretions the better; ſofter waters, as thoſe of rivers, and rain, ſeem better ſuited to draw out the ſubſtance of high-dried malts, which retain many ingenious particles, beſt abſorbed in a ſmooth vehicle. In Staffordſhire, they have a ſecret of fining ale in a very ſhort time. Plot conjectures it to be done by adding alum, or vinegar, in the working.

Ale is prepared various ways, and of various ingredients, as of wheat, rye, millet, oats, barley, the berries of the quick-bean, &c. Some have found that the juice which bleeds from the birch or ſycamore is of great uſe on this occaſion, applied inſtead of water. It makes one buſhel of malt go as far as four in the common way.

ALE-CONNER, an officer in the city of London, whoſe buſineſs is to inſpect the meaſures of the public houſes. There are four of them: and they are choſen by the common-hall of the city.

ALE *Houſes* muſt be licenſed by juſtices of the peace, who take recognizances of the perſons licenſed, and of their ſureties, viz. 10l. each, that they will not ſuffer unlawful gaming, nor other diſorderly practices in their houſes. Every perſon, excepting thoſe who ſell *ale* in fairs, neglecting to procure a licence, is liable to a penalty of 40s. for the firſt offence, 4l. for the ſecond, and 6l. for the third, with all coſts. The licence is granted on the firſt of September, or within twenty days after, at a general meeting of juſtices for the diviſion to which he belongs, upon his producing a certificate to his character, unleſs, by living in a city or town-corporate, this laſt circumſtance is diſpenſed with, and continues in force for one year only. Ale-houſe keepers, ſelling ale ſhort meaſure, are liable to a penalty not exceeding 40s. and not leſs than 10s. and likewiſe to a fine of 10s. for permitting tippling, &c.

ALEXANDRIAN *Copy*, is a manuſcript, conſiſting of four volumes, in a large quarto ſize, which contain the whole Bible in Greek, including the Old and New Teſtament, with the Apocrypha, and ſome ſmaller pieces, but not quite complete. This manuſcript is now preſerved in the Britiſh Muſeum. It was ſent as a preſent to King Charles I. from Cyrillus Lucaris, patriarch of Conſtantinople, by Sir Thomas Rowe, ambaſſador from England to the Grand Signior, about the year 1628. Cyrillus brought it with him from Alexandria, where, probable, it was written. In a ſchedule annexed to it, he gives this account: that it was written, as tradition informed them, by Thecla, a noble Egyptian lady, about thirteen hundred years ago, not long after the council of Nice. But this high antiquity, and the authority of the tradition to which the patriarch refers, have been diſputed; nor are the moſt accurate biblical writers agreed about its age. Grabe thinks that it might have been written before the end of the fourth century; others are of opinion, that it was not written till near the end of the fifth century, or ſomewhat later. Thoſe who are deſirous of further information concerning it, may conſult the Prolegomena of Mills, Wetſtein, and Grabe.

ALEXIPHARMIC, in medicine, expreſſes that property which a remedy, either ſimple or compound, hath to reſiſt or deſtroy every thing of a poiſonous or malignant nature. The word is derived from αλεξω, *arceo*, *I expel*, and φαρμακον, *poiſon*.

Alexipharmic medicines, in general, contain a great number of volatile parts, and ſuch as render the maſs of blood fluid. The greateſt part of them are aromatic and pungent to the taſte. Among the reſt, it is true, there are ſome acid plants and juices; but theſe are only reckoned in the number, on account of their uſe in malignant and colliquative fevers. Alexipharmics chiefly act by exciting, or increaſing a diaphoreſis or perſpiration; by which the noxious matter is thrown off. See SUDORIFIC.

Alexipharmics, whether ſimple or compound, are alſo eſteemed preſervatives againſt malignant and peſtilential fevers: but they are to be uſed with caution; ſome of them being only proper in condenſations, and others only in colliquations of the blood. It is dangerous to adminiſter alexipharmics to young people of plethoric habits, without previous evacuations; and Celſus adviſes only to promote a ſweat, when the marks of one approaching are evident.

Alexipharmics are deemed proper correctors of Opium, when it produces ſickneſs, nauſeas, &c. They are alſo ſerviceable in thoſe diſeaſes which proceed from external cold, and obſtructed perſpiration; as catarrhs, rheumatiſms, fluxes, coughs, and glandular tumours. Alexipharmics make a large claſs of medicines; but the principal ones are theſe: 1. Of the animal kingdom, hartſhorn, bezoars, and the bones and teeth of different animals. 2. Of the vegetable kingdom, the leaves and flowers of all the aromatic plants, eſpecially ſuch as are umbelliferous. 3. Of the mineral kingdom, the different preparations of antimony, the dulcified ſpirit of vitriol with alcohol.

ALGÆ, in botany, Flags, or Flaggers, conſtitute the third Order of the twenty-fourth Claſs. See the Syſtem, Sect. V. and Plate 6.

A NEW SYSTEM OF ALGEBRA.

INTRODUCTION.

ALGEBRA is one of the principal or fundamental branches of mathematical learning, and as in alphabetical order it makes the firſt mathematical ſyſtem in this work, we ſhall here give a ſhort account of Mathematics in general.

Mathematics comprehend all thoſe arts and ſciences which treat of numbers and magnitude, and are diſtinguiſhed under two general heads. That part which relates to numbers only, is called Arithmetic; and that which regards magnitude, whether it be with reſpect to length, breadth, depth, motion, force, &c. comes under the deſcription of Geometry.

Alſo Mathematics are either pure or mixed. Pure, when ſimply applied in inveſtigating and demonſtrating the properties of abſtract numbers and magnitudes of all ſorts; and mixed, when applied to particular ſubjects, as Aſtronomy, Geography, Optics, Mechanics, Hydroſtatics, Fortification, Navigation, Gunnery, &c.

In every age and country, where learning has prevailed, the Mathematical Sciences have been eſteemed as poſſeſſing the moſt extenſive and valuable ſhare of human knowledge.

By Mathematics we are inſtructed in the purſuit of truth, which alone is the object of knowledge, and evidence is the certain mark or criterion of truth; and this conſiſts in the perception of the agreement or diſagreement of ideas formed in the mind by things natural, according as they themſelves agree or diſagree with each other.

Truth is one, ſimple, uniform, invariable thing; always conſiſtent with itſelf, and wants nothing to commend it but its own native evidence; while its oppoſite falſhood, is infinitely various, inconſiſtent, and contradictory. As truth is what all judicious men admire; and error, what every one hates, that is not blinded, or biaſſed by ſelf-intereſt; ſo the Mathematician finds it neceſſary to be cautious not to aſſent to the verity of any premiſes, propoſition, or concluſion, which may attend his enquiries, unleſs the ſame ſhall ſtamp a full and certain conviction in his mind by the force of undeniable evidence. It is evidence alone that can gain his aſſent, or remove his doubts; and when that appears, his mind is charmed; and, having accompliſhed his wiſhes, he deſires nothing further. In Mathematics, truth appears eminently conſpicuous, and ſhines in its greateſt luſtre. In other ſciences it is either ſelf-evident (which abates the pleaſure it would otherwiſe contribute to the mind) or elſe it ſo faintly appears under obſcurity, that falſhood is frequently obtruded in lieu thereof; and even truth alone viewed through ſuch a gloomy medium, will hardly be known as ſuch; the mind will remain unſatisfied, and be left in doubts, conjectures, and uncertainties. From this conſideration, and the great utility of the Mathematics, we may eſtimate how much they are ſuperior to every other ſpecies of human knowledge.

The manner in which Mathematicians proceed is, by firſt laying down as a foundation, certain evident principles, or ſuch as cannot be denied, and from theſe making a gradual progreſs by ſteps ſo connected or linked with each other, and diſpoſed in ſuch order, as will enable the underſtanding to perceive their connection and agreement, and by that means infallibly lead to a true concluſion; for all the parts being as it were locked together by truth, the laſt reſult, though derived from a proceſs of whatever length, muſt be equally true.

By this method, aſſiſted by ſuitable obſervations, Mathematicians have penetrated into the depths of knowledge, and as it were into the very receſſes of nature; and have made ſuch extraordinary and unexpected diſcoveries, as have excited the admiration of the world, and filled it with aſtoniſhment.

All that beautiful analogy, and that harmonious connection and conſiſtency, which conſtitutes the quinteſſence of the Mathematical Sciences, is loſt in the other ſciences; and, without doubt, this is one main reaſon why greater improvements have been made in thoſe, than in all the other ſciences united together.

Oppoſed to true reaſoning, as above deſcribed, is that of falſhood and error; the cauſes of which are various and many; ſuch as the following, viz. the want of faculties or learning; defects of memory; want of due reflection; not tightly connecting the ſeveral ſteps; truſting too much to the ſenſes; giving way to paſſions, appetites, and prejudices imbibed; ſelf-intereſt; errors of education; wrong ſtating the queſtion; not underſtanding the terms; want of proofs; following vulgar received opinions and weak authorities; precipitancy of judgment, &c. But few of theſe intrude on Mathematicians. The Mathematician watches his proceedings with the moſt ſtrict jealouſy, nor will he draw concluſions but from infallible proofs, or attempt the reſolution of any caſe without ſufficient and proper data.

From Mathematics, therefore, the mind reaps theſe general advantages: 1ſt. the accuſtoming of it to attention; for they make the mind attentive by entertaining it with a great variety of truths delightful and evident (though at firſt not obvious); truth being the ſame to the underſtanding as muſic to the ear, or beauty to the eye; only with this ſuperior excellence, that here, the object and faculty are more ſpiritual, the delight more pure, and each free from the regret, turpitude, laſſitude, and intemperance, that too commonly attend ſenſual pleaſures:

2. Forming in the mind a habit of clear, demonſtrative, and methodical reaſoning. For by accuſtoming ourſelves to reaſon cloſely about quantity, we acquire a habit of doing ſo in other things. Geometry and Analytics afford the beſt model for imitation to arrive at truth in enquiries of almoſt every kind. Their methods of inveſtigating and demonſtrating truths by definitions of words agreed upon, by ſelf-evident truths, and propoſitions that have been already demonſtrated, is practicable in other ſubjects, though not always to the ſame perfection, the natural defect of evidence in the things themſelves perhaps not admitting of it; but it is always imitable to a very conſiderable degree, and thoſe writers who keep the neareſt to the methods of Mathematicians, are the moſt conciſe, intelligent, inſtructive, and free from abſurdities.

It is ſurpriſing to ſee what ſuperficial, and inconſequential reaſonings ſatisfy a great part of mankind. A piece of wit, a ſimile, a jeſt, or quotation of an author, paſſes for mighty argument. This weakneſs has made many the ſport of orators, poets, and men of wit. Such looſeneſs and incongruities may indeed afford diverſion to the fancy, but they are not the office of the underſtanding.

3d. Mathematical knowledge adds a manly vigour to the mind, and frees it from prejudice, credulity, and ſuperſtition. This it does two ways, firſt, by accuſtoming us to examine, and not take things upon truſt; ſecond, by giving us a clear and extenſive knowledge of the ſyſtem of the world, and thereby creating in us the moſt profound reverence of the Almighty, and freeing us from thoſe mean and narrow thoughts which ignorance and ſuperſtition are apt to beget.

The utility alſo that Mathematical Sciences are of in affairs of life is unſpeakable. By Mathematics we are enabled to keep juſt and regular accounts, to caſt up, and calculate immenſe ſums, and ſettle all our tranſactions with one another; to meaſure all kinds of ſurfaces and ſolids, and diſtances and altitudes inacceſſible; to divide lands and eſtates; to build houſes, &c. for the convenience and enjoyment of life; to erect fortifications, and make fire-arms and other inſtruments to defend us from enemies; to conſtruct ſhips, and by the help of wind and ſails, and the rules of art, to ſail upon the ocean and traffic with foreign nations; to invent various ſorts of inſtruments for weighing and meaſuring the ſeveral commodities of commerce; to contrive innumerable engines for raiſing and removing bodies of prodigious magnitude; and for various other purpoſes, ſuch as clocks, watches, jacks, pumps, &c. &c. to make dials for regulating time; to deſcribe the ſeveral countries of the earth, and repreſent them by maps, charts, &c. to take account of the ſtars; to meaſure the magnitude and diſtances of the planets, to explain the laws of their motion, and aſcertain the bounds of their courſes; to make proper inſtruments for improving the ſight, and ſo to magnify ſmall bodies which are imperceptible to the naked eye, that they become viſible and conſpicuous, and to cauſe remote inviſible bodies to appear to us large and diſtinct; to aſcertain the ſituation of many great bodies and various ſyſtems of the univerſe; and to admire the wiſdom and omnipotence of that Being who brought them into exiſtence; nay, time would fail in enumerating half the uſes and advantages of Mathematical learning. No words can fully expreſs the praiſes of that Science which explores not only the earth and ſeas, but alſo the upper regions; declaring, long before they happen, the time of eclipſes, and other extraordinary phenomena, of the ſun, moon, ſtars, planets, and comets. Through which alſo we can refer back to various ancient epochas and remarkable events, with preciſion, and thereby rectify the errors of former chronologers and hiſtorians.

The cultivation, therefore, of theſe admirable and ſublime ſciences is a thing of the utmoſt importance, and ought to be conſidered as the principal part of every liberal and well-regulated plan of education. They are the guide of our youth, the perfection of our reaſon, and the baſis of every great and noble undertaking. For a further account of the riſe and progreſs of the Mathematics, ſee the Article MATHEMATICS, in the Alphabet.

Having ſaid thus much upon Mathematics in general, I ſhall return to that particular branch thereof which is the ſubject of this ſyſtem, namely, Algebra.

Algebra is one of the moſt uſeful branches of Mathematics, and may be juſtly conſidered as a key to all the reſt. Geometry delights us by the ſimplicity of its principles and the elegance of its demonſtrations: Arithmetic is confined in its object, and partial in its application; but Algebra is general and comprehenſive, and may be ſucceſsfully applied in all poſſible enquiries, where proper data can be eſtabliſhed.

This noble art, however, is by many diſregarded on account of the pretended dryneſs of the ſubject, and the difficulties which ſeem to attend many of its operations. That the fundamental parts of every ſcience are dull and unentertaining, is a truth not to be denied; but then what is obtained with difficulty, is remembered with eaſe; and what is purchaſed with pain, is poſſeſſed with pleaſure. A few years of early and aſſiduous application never fails of procuring us the reward of our induſtry; and who is there that knows the advantages of this great art or ſcience, that would judge his time miſpent, or his labours uſeleſs?

It

ALGEBRA.

It lends its aid to all the other ſciences, and that in their utmoſt perplexities and diſtreſs; when all their own rules and methods fail, when an anſwer to the caſe in hand would be ſought in vain any other way, Algebra, after the moſt ſubtle manner and quick diſpatch, unwinds the clew of difficulties, and furniſhes the artiſt with a theorem ſerving not only for the caſe then before him, but for every other of a ſimilar nature.

Algebra is therefore an art or ſcience which teaches in a general manner to ſolve the moſt difficult Problems, and to diſcover and inveſtigate Propoſitions and Theorems in any particular branch of ſcience, by comparing, with one another, the relation of the abſtract quantities therein concerned.

It is indeed in itſelf an art truly ſublime, and of an unlimited extent; for though the nature of the ſubject, to which it is applied, ſhould be ever ſo complex; and the quantities concerned ſhould be ever ſo much entangled, yet it affords ſurpriſing means of ſurmounting the utmoſt difficulties, and by a curious and careful purſuit through the moſt intricate labyrinths, of attaining to the anſwer ſought.

In this art letters or ſymbols are ſubſtituted in the place of numbers, by which it obtains an eminent advantage over mere arithmetical operations; becauſe there, the numbers become, as it were, metamorphoſed and changed into others; whereas here, the quantities are preſerved diſtinct, viſible, and unchanged, from which general rules are drawn for anſwering all queſtions of a like nature with that under conſideration.

On account of its extent and uſefulneſs it has been named UNIVERSAL MATHEMATICS, UNIVERSAL ARITHMETIC, and, by way of eminence, *Ars Magna*, or the GREAT ART. It is alſo called *Specious Arithmetic*, the *Analytic Art*, &c. And from its wonderful diſpatch and brevity, and uſe of ſymbols, it may likewiſe, with propriety, be termed MATHEMATICAL STENOGRAPHY.

HISTORY.

The firſt inventor of this noble art is not certainly known: however, it is highly probable the ancients had ſome ſort of Analyſis, whereby they found out moſt of their excellent Theorems; for it is hardly poſſible to conceive that they could have hit upon them otherwiſe; and indeed there are ſome examples of it in Euclid, at leaſt in *Theon upon Euclid*, who ſays that the art was firſt communicated by Plato: and hence Plato is by many eſteemed the inventor. There are alſo inſtances of it in *Pappus*, and the effects thereof are diſcoverable in *Archimedes*, *Apollonius*, and others, though they appear to have ſtudiouſly diſguiſed it.

Some aſſert that this art was in uſe among the Arabs much earlier than among the Greeks; and ſuppoſe that the Arabs borrowed it from the Perſians, who alſo, it is conjectured, learned it of the Indians. It is further aſſerted, that it was firſt introduced into Europe by means of an emigration of the Arabs into Spain, about the beginning of the twelfth century; whence many are of opinion, it came into England before Diophantus, (who wrote profeſſedly on the art, about the end of the third century) was known among us. Wherefore M. d'Herbelot, and others, are of opinion, that Algebra takes its name from Gebar, a celebrated philoſopher, chymiſt, and mathematician, whom the Arabs call Giaber, and who is ſuppoſed to have been the inventor. Others from *gefr*, a kind of parchment made of the ſkin of a camel, whereon Ali and Giafer Sadek wrote, in myſtic characters, the fate of Mahometaniſm, and the grand events that were to happen till the end of the world. But others, perhaps with as great probability, derive it from *geber*; a word whence, by prefixing the article *al*, we have formed *algebra*; which is pure Arabic, and properly ſignifies the reduction of fractions to a whole number. However, the Arabs, it is to be obſerved, never uſe the word *algebra* alone, to expreſs what we mean by it; but always add to it the word *macabelah*, which ſignifies oppoſition and compariſon: thus *algebru-almacabelah*, is what we properly call *algebra*. Diophantus's Treatiſe conſiſted of thirteen books, ſix of which were tranſlated from the Greek into Latin, and publiſhed by Xylander in 1575. He is recorded to be the firſt Grecian who wrote on the ſubject. His works only treat of indeterminate Problems.

In 1494, Lucas Pacciolus, or Lucas de Burgo, a Minorite friar, publiſhed at Venice a Treatiſe of Algebra in Italian. This author mentions Leonardus Piſanus, and ſome others, of whom he had learned the art, but we have none of their writings. He eſtabliſhes the received opinion that Algebra came originally from the Arabs, and takes no notice of Diophantus, which makes it probable that that author's works were not then known in Europe. Pacciolus's Treatiſe goes no farther than Quadratic Equations.

Stefelius, Scipio Ferreus, Cardan, and Tartagilla, ſucceeded each other, and gave ſome ſolutions of Cubic Equations. Next came Bombelli, Nunninus, Romus, Schoner, Salignac, Clavius, and ſome others; but none of them went beyond Quadratics. About the year 1590, Viete publiſhed his Syſtem of Algebra, wherein he gave an ingenious method of extracting the Roots of Equations by approximation, which has ſince been greatly improved by Newton, Raphſon, Halley, Simpſon, and Emerſon. In 1631, Oughtred and Harriot publiſhed their Treatiſes, both of which were well received.

In 1657, Des Cartes publiſhed his geometry, wherein he made uſe of the literal calculus and the Algebraic rules of Harriot; and as Oughtred in his Clavis, and Marin Ghetaldus, in his books of mathematical compoſition and reſolution, publiſhed in 1630, applied Vieta's Arithmetic to Elementary Geometry, and gave the Conſtruction of Simple and Quadratic Equation; ſo Des Cartes applied Harriot's method to the higher Geometry, explaining the nature of Curves by Equations, and adding the Conſtructions of Cubic, Biquadratic, and other higher Equations.

Des Cartes rule for conſtructing Cubic and Biquadratic Equations, was farther improved by Thomas Baker, in his *Clavis Geometrica Catholica*, publiſhed in 1684; and the foundation of ſuch conſtructions, with the application of Algebra to the Quadratures of Curves, queſtions *de maximis et minimis*, the centrobaryc method of Guildinus, &c. was given by R. Sluſius, in 1668; as alſo by Fermat in his *Opera Mathematica*, Roberval in the *Mem. de Mathem. et de Phyſique*, and Barrow in his *Lect. Geomet.* In 1708, Algebra was applied to the laws of chance and gaming, by R. de Montmort: and ſince by De Moivre and James Bernoulli.

The elements of the art were compiled and publiſhed by Kerſey, in 1671; wherein the ſpecious Arithmetic and the nature of Equations, are largely explained, and illuſtrated by a variety of examples: the whole ſubſtance of Diaphantus is here delivered, and many things added concerning Mathematical compoſition and reſolution from Ghetaldus. The like has been ſince done by Prieſtet in 1694, and by Ozanam in 1703: but theſe authors omit the application of Algebra to Geometry; which defect is ſupplied by Guiſnec, in a French treatiſe expreſsly on the ſubject publiſhed in 1704, and l'Hopital in his Analytical Treatiſe of the Conic Sections, in 1707.

The immortal Engliſh Philoſopher, Sir Iſaac Newton, publiſhed his *Arithmetica Univerſalis* in the year 1707, which abounds in ſelect examples, and contains ſeveral Rules and Methods invented by the author. Algebra has ſince been applied to a world of knowledge, ſurpaſſing all the wiſdom of the ancients, namely, the conſideration and calculus of Infinites, called generally the Doctrine of Fluxions. It is alſo named *Analyſis of Infinites*; and the *Calculus Differentialis*.

Of a modern date the number of Algebraical authors is almoſt incredible. I muſt, however, with deference to the hoſt, name thoſe whom I think the moſt intelligent and uſeful, viz. Saunderſon, Ward, Simpſon, Emerſon, and Maclaurin; but, as a ſchool-book, the Treatiſe of Bonnycaſtle is well adapted. He is exceedingly methodical, and elegant in his text; and ſo indeed he is in every thing that he has committed to the preſs.

Having, in as brief a manner as I was able, given an hiſtoric view of the riſe and progreſs of this art, I ſhall proceed to ſhew the rudiments thereof, by treating on the ſeveral methods whereby Algebraical Operations are principally performed.

I am well aware that the application of Algebra preſents a wide field to the man of ſcience, as well as to the young artiſt, who thirſts for knowledge; ſo that it becomes neceſſary to obſerve that thoſe voluminous matters cannot be expected within the limits appointed in this Dictionary of Arts and Sciences, eſpecially where unintereſted prolixity is exploded. Notwithſtanding its limits, I am perſuaded the ſtudent will here find the fundamentals of the art ſufficiently treated of, to enable him, in all caſes, to make the application, and to read with pleaſure thoſe authors who have written more extenſively on the ſubject.

SECTION I. DEFINITIONS.

I. As, according to this art, Problems are computed by the means of letters and other characters, ſo it is to be obſerved, that the firſt letters of the Alphabet, as *a*, *b*, *c*, *d*, &c. are uſually put for known quantities; and the laſt, as *v*, *x*, *y*, *z*, for quantities unknown, which are always aſſumed as if they were really given or known, and are thus managed in the proceſs according to the rules of art, till at length either the unknown quantities themſelves, or certain powers or roots thereof, are found equal to ſome given quantities; and ſo they become known alſo.

II. The ſign + *(plus)* denotes *addition*. Thus $a+b$, ſignifies *b* added to *a*. This is called a *poſitive* or an *affirmative* ſign; and quantities to be added, are ſtyled *poſitive* or *affirmative* quantities.

III. The ſign — *(minus)* denotes *ſubtraction*. Thus $a-b$, ſignifies *b* ſubtracted from *a*. This is called a *negative* ſign; and quantities to be ſubtracted, are named *negative* quantities.

IV. Like ſigns are either all +, or all —: Unlike ſigns are + and —.

V. The ſign of *equality* =, is placed between the two quantities to denote them equal, Thus $a=b$, ſhews that *a* and *b*, are equal to each other.

VI. $\times$, Is the ſign of *multiplication*. So $a \times b$; $b \times c \times d$, denote the product of *a* and *b*, and of *b*, *c*, and *d*, reſpectively: but

but the product of simple quantities is commonly expressed by merely joining or annexing the letters; so the products of the above quantities are ab and bcd. Sometimes the product is denoted by putting a point between each quantity, as $b.\overline{c-d}$ denotes b multiplied by $c-d$.

VII. $\div$, Is the sign of *division*. Hence $a \div b$, signifies a divided by b; but the same is generally written in the manner of a fraction. Thus, $\frac{a}{b}$, and $\frac{a-b}{c+d}$, denote a divided by b, and $a-b$ divided by $c+d$ respectively.

VIII. $\backsim$, Is put between two quantities to denote their difference; as $a \backsim b$ signifies the difference between a and b, but without shewing which is the greater or less quantity.

IX. $\sqsubset$ or $\rangle$ are signs of *majority*, and $\sqsupset$ or $\langle$ are signs of *minority*. Thus $a \sqsubset b$ shews that a is greater than b, and $a \sqsupset b$ shews that it is less than b.

X. $\surd$, Is the sign of *radicality*, and of itself denotes the *square root*. The *cube root*, *biquadrate root*, &c. are expressed by writing a 3 or 4, &c. over it. Thus $\surd a$, $\sqrt[3]{a}$, and $\sqrt[4]{a}$, denote the square root, cube root, and biquadrate root of a respectively.

XI. $\mathfrak{S}$, Is the sign of *involution*, as $\mathfrak{S}$ 2, signifies involved to the square; $\mathfrak{S}$ 3, involved to the cube, &c.

XII. $\mathfrak{U}$, Is a sign of *evolution*, $\mathfrak{U}$ 2, signifies the square root, $\mathfrak{U}$ 3, the cube root, &c.

XIII. The *power of a quantity* is its square, cube, biquadrate, &c. and the figure or letter which is put over a quantity to denote the same, is named the *index*, *exponent*, or *dimension*, or such quantity. Thus a^2, a^3, and a^4, denote the square, cube, and biquadrate of a respectively; or, which is the same, the second, third, and fourth power of a; and the figures, 2, 3, and 4, are the indices or exponents, &c. of a. Sometimes the power of a quantity is shewn by repetitions of the letter. Thus $a\,a$ is the same as a^2; and $a\,a\,a$, the same as a^3, &c.

XIV. *Like quantities* are those that consist of the same letters, as a, $3a-4a$. Also bb, $3bb-7bb$; and $2abc, -5abc$, &c.

XV. *Unlike quantities* consist of different letters, or of the same letters differently repeated; as a, b, $2c, -3d$; or as a, $2aa$, $-5aaa$.

XVI. *Simple quantities* are those which consist of one term only; as $4b$, $3a^2$, $15dcc$, &c.

XVII. *Compound quantities* are those which consist of several terms, as $a+b$, $3a-5c$, $a+2b-3c$, &c.

XVIII. A *line*, or *vinculum*, drawn over several quantities, a, b, c, &c. denote them to be esteemed a compound quantity, as $\overline{a+b-c}$.

XIX. The *coefficient* of a quantity is the number prefixed to it; as, $5a$, where 5 is the coefficient, and signifies that a is multiplied by 5.

XX. A *binominal quantity* is one consisting of two terms; as $a+b$; a *trinomial*, of three terms, as $a+b+c$; a *quadrimonial*, of four terms, as $a+b+c+d$, &c.

XXI. A *residual quantity* is a binomial, where one of the terms is negative.

XXII. A *rational quantity* is that which has no radical sign.

XXIII. A *surd* is a quantity that has not a proper root, as the square root of b, $(\surd b)$, the cube root of bb $(\sqrt[3]{bb})$, &c.

XXIV. An *equation* is the mutual comparing of things equal to one another, the sign of equality being put between them. A Dependent Equation is that which may be deduced from some others. An Independent Equation cannot be produced from the others. A Pure Equation contains but one power of the unknown quantity, as a *simple question*, a *pure quadratic*, a *pure cubic*, &c. An Affected Equation contains several powers of the unknown quantity, and is denominated according to the highest power in it, as an *affected quadratic*, an *affected cubic*, an *affected biquadratic*. Moreover, a Simple Equation contains only the simple quantity itself; a Quadratic, a quantity of two dimensions; a Cubic, a quantity of three dimensions, &c.

Note also, that the Roots of Quantities are frequently expressed by fractional Exponents, as $a^{\frac{1}{2}}$ denote the Square Root of a; $a^{\frac{1}{3}}$, the Cube Root of a; $a^{\frac{1}{4}}$, the Biquadrate Root of a, &c. Also $a^{\frac{2}{3}}$ denotes the Cube Root of a^2; $a^{\frac{3}{4}}$, the Biquadrate Root of a^3, &c. Likewise $::$ is the sign of disjunct Proportion; and $\dot{:}\dot{:}$ of continued Proportion, or geometrical Progression.

These explications premised, I shall lay down the following Axioms, and then proceed to Algebraical Operations.

AXIOM 1. If equal quantities be added to equal quantities, the sums will be equal. 2. If equal quantities be taken from equal quantities, the remainders will be equal. 3. If equal quantities be multiplied by equal quantities, the products will be equal. 4. If equal quantities be divided by equal quantities, the quotients will be equal. 5. The equal powers or roots of equal quantities are equal. 6. Quantities severally equal to a third quantity are equal to one another. 7. The whole is equal to all its parts taken together.

SECTION II.

PRIMARY ALGEBRAICAL OPERATIONS.

ART. I. *To add several Quantities together.*

Rule. 1. If the quantities are like, and have like signs, add together the coefficients, and to the sum prefix the same sign, subjoining the common quantity. 2. If the quantities are like, but have unlike signs, take the difference between the sum of the affirmative coefficients, and the sum of the negative ones, and thereto prefix the sign of the greater sum, annexing also the proper quantity. 3. But if the quantities are all unlike, with unlike signs, write them down one after another, prefixing to each its proper sign.

EXAMPLES.

$12ab$	$11a^2b+3cd^2$	$-25x^3y^3-x^4$
$5ab$	$7a^2b+5cd^2$	$-37x^3y^3-3x^4$
$7ab$	$10a^2b+7cd^2$	$-54x^3y^3-5x^4$
Sum $24ab$.	Sum $28a^2b+15cd^2$	Sum $-116x^3y^3-9x^4$

$-2aa-7bcd+dd$	$+15a^2-3a+db$	
$+7aa-20bcd-dd$	$-4c^2+ad-5db$	
$+3aa+6bcd$	$+dc-5a+d^2$	
Sum $+8aa-21bcd$ *	Sum $+15a^2-4c^2+dc-8a+ad-4db+d^2$	

N. B. Where there is no coefficient prefixed to a quantity, it is understood that the coefficient is 1; and where there is no sign prefixed, the quantity is affirmative. The above rule being almost self-evident, a further illustration is unnecessary.

ART. II. *To subtract Algebraical Quantities.*

Rule. Change the sides of the quantities to be subtracted, and then the whole together as in addition.

EXAMPLES.

From $5a^2b-cd$	From $3a^2-2a+cd-d^2-f^2$
Take $-3a^2b+2cd$	Take $-2a^2-5a-3ab-2d^2$
Ramained. $8a^2b-3cd$	Remained. $5a^2+3a+cd+3ab+d^2-f^2$

This Rule requires but little demonstration, since it is easy to conceive, that to subtract, or take away, a decrement, is the same as to add an equal increment. If we take away $-b$ from $a-b$, there remains a; and if we add $+b$ to $a-b$, the sum is likewise a. Therefore, in *general*, the subtracting of a negative quantity is equivalent to the adding of its positive value.

ART. III. *To multiply Algebraical Quantities.*

Rule. Multiply each term of the multiplier into every term of the multiplicand, viz. the coefficients into the coefficients, and the letters into the letters, by placing them together like letters in a word; and prefix $+$ to like signs, and $-$ to unlike signs. The sum of all will be the product sought.

EXAMPLES.

Multiply $3a$	Multiply $-7a^2$	Multiply $-4cd^2$
by $5b$	by $-5c^2$	by $+8a^2$
Product $15ab$	Product $+35a^2c^2$	Product $-32cd^2a^2$

Multiply $5a+3b$	Multiply a^2+ab-b^2
by $2a+b$	by $a-b$
$10aa+6ab$	$a^3+a^2b-ab^2$
$+5ab+3bb$	$-a^2b-ab^2+b^3$
Prod. $10aa+11ab+3bb$	Prod. a^3 * $-2ab^2+b^3$

SCHOLIUM. That every term of the multiplicand must be multiplied by every term of the multiplier is unnecessary to enlarge upon, being similar to what is practised in common arithmetic, and that like signs give $+$ and unlike signs $-$ in the product, may be proved thus.

I. Let a negative quantity be multiplied by an affirmative one; then, since the negative quantity must be so often taken as there are units in the affirmative quantity, and since also the sum of any number of like negatives will be negative, it is plain that in this instance the product will be negative. Also here, if the multiplicand be made the multiplier, and the multiplier become the multiplicand, that is, if an affirmative quantity be multiplied by a negative one, this implies that the affirmative quantity must be so often subtracted as there are units in the negative one, and the sum of any number of negatives being negative, it is plain the product in this instance also will be negative.

II. Let an affirmative quantity be multiplied by an affirmative quantity; now, since the former is to be so often taken as there are units in the latter, and the sum of affirmatives is affirmative, in this case therefore the product will be affirmative. The conclusion will be the same, though the multiplicand be made the multiplier.

III. Let a negative quantity be multiplied by a negative quantity. Here the negative multiplicand is to be subtracted as often as there are units in the multiplier; but to subtract a quantity having a negative sign, is the same as to add that quantity with an affirmative sign. Therefore the result, in this case, will be affirmative; and it will be the same when the multiplicand is made the multiplier, and the multiplier the multiplicand. Therefore, *generally*, like signs produce *plus*; and unlike signs, *minus*.

ART. IV. *To divide one Quantity by another.*

Rule I. In simple quantities, which will divide without a remainder, divide the coefficient by the coefficient, and place the answer in the quotient, annexing thereto those letters of the dividend

vidend which are not found in the Divisor, and observing that like signs produce +, and unlike signs —.

EXAMPLES.

Divisor.	Dividend.	Quotient.	Divisor.	Dividend.	Quotient.
$3ab)$	$21abcd$	$(7cd$	$-5a^2b)$	$25a^3b^3d$	$(-5ab^2d$
	$21abcd$			$25a^3b^3d$	
	0			0	

Rule II. In compound quantities, divide the first term of the dividend by the first term of the divisor (the quantities being first ranged in due order, according to the dimensions of some letter) and place the result in the quotient. Multiply the whole divisor by the quotient, and subtract it from the dividend, to which bring down the next term in the dividend, and repeat the operation as in common arithmetic till the work is done.

EXAMPLES.

$2b-3c)\ 38baa-12caa\ (4aa$
$\quad 8baa-12caa$
$\quad 0$

$a+b)\ a^2-b^2\ (a-b$
$\quad a^2+ab$
$\quad -ab-b^2$
$\quad -ab-b^2$
$\quad 0$

$3a-b)\ 3a^3-12a^2-ba^2+10ab-2b^2\ (a^2-4a+2b$
$\quad 3a^3$
$\quad -12a^2 \quad -ba^2$
$\quad -12a^2 \quad +10ab$
$\quad \quad +4ab$
$\quad \quad +6ab-2b^2$
$\quad \quad +6ab-2b^2$
$\quad \quad 0$

SCHOLIUM I. The truth of the Rule, that like signs give plus in the quotient, and unlike signs minus, will appear from this consideration, that the divisor, multiplied by the quotient, must always produce the proper dividend; which, upon trial, it will be found, cannot be, but when that rule is strictly observed.

SCHOLIUM II. It often happens that the divisor will not exactly divide the dividend, in which case it will be proper to place the dividend over the divisor, in form of a fraction, throwing out such letters as are found in all the terms of the dividend and divisor. Thus, if the dividend is $ax+x^2$, and the divisor $ax-x^2$, the quotient will be $\frac{ax+x^2}{ax-x^2}=\frac{a+x}{a-x}$.

It is also observable, that any power of a quantity is divided by any other power of that quantity, by subtracting the exponent of the divisor from the exponent of the dividend.

Thus $\frac{5a^7}{a^3}=5a^{7-3}=5a^4$. And $\frac{16b}{12b^3}=\frac{16b^{1-3}}{12}=\frac{16b^{-2}}{12}=\frac{4b^{-2}}{3}$; and this expression is also equal to $\frac{4}{3b^2}$; for it is evident, from what has been said, that an affirmative power, in the denominator, makes (if transferred) a negative one in the numerator, and consequently a negative power in the numerator, is transferable to an affirmative one in the denominator.

SECTION III.

OF FRACTIONS, INVOLUTION, AND EVOLUTION.

ART. I. *Rules for managing Algebraic Fractions.*

The Rules here are precisely the same as those of Vulgar Fractions in Arithmetic, and therefore it would be superfluous to enumerate them, as it is presumed that those who attempt Algebra are at least well versed in arithmetical operations; and if in any instance the reader should not perfectly recollect them, he will find ample satisfaction by referring to the rules given for fractions in our NEW SYSTEM OF ARITHMETIC. However, that there may not be the least defection in the present system, a few Examples follow by way of exercises.

EXAMP. I. Let $\frac{a}{b}$ be reduced to a fraction, whose denominator is $b-c$. Here $\frac{a}{b}\times\overline{b-c}=a-\frac{ac}{b}$, and $\frac{a-\frac{ac}{b}}{b-c}$ is the fraction required.

EXAMP. II. Let the mixt quantity $a-\frac{b}{c}$ be reduced to a fraction. Here $\frac{ca-b}{c}$ is the fraction required.

EXAMP. III. Let $\frac{bd-b^2}{d}$ be reduced to a mixt quantity. Here, by dividing $bd-b^2$ by d, the quotient will be b, and the remainder will be $-b^2$; and therefore the answer will be $-\frac{b^2}{d}$.

EXAMP. IV. What is the greatest common divisor of $\frac{ad+d^2}{b^2a+b^2d}$?

ANSW. $a+d$, and therefore $\frac{d}{b^2}$ is the fraction in its lowest terms.

EXAMP. V. Reduce $\frac{a}{b}$, $\frac{c}{d}$, and $\frac{e}{f}$, to fractions of the same value, having one common denominator.

ANSW. $\frac{adf}{bdf}$, $\frac{cbf}{bdf}$, and $\frac{edb}{bdf}$ are the fractions required: so, in like manner, if it were required to add $\frac{a}{b}$, $\frac{c}{d}$, and $\frac{e}{f}$, together, their sum would be $\frac{adf+cbf+edb}{bdf}$.

In the same way the sum of $\frac{\overline{m+n}^a}{\overline{d+e}^c}$ and $\frac{d+e}{m+n}$ will be found $=\frac{\overline{m+n}^{c+a}}{\overline{d+e}^c}\times\frac{\overline{d+e}^c}{\overline{m+n}^c}$.

Also $\frac{a+b}{d}-\frac{b^2}{a}=\frac{a^2+ab-bd^2}{ad}$.

And $\frac{m}{a^2+bc}-\frac{a^2+bc}{m^2}=\frac{m^3-\overline{a^2+bc}^2}{m^2a^2+m^2bc}$.

Again, $\frac{5x^2}{y^3}$, multiplied by $\frac{4y^5}{3x^4}=\frac{5x^2\times4y^5}{3x^4\times y^3}=\frac{20x^2y^5}{3x^4y^3}=\frac{20y^2}{3x^2}$ the product.

And $\frac{\overline{a-b}^2}{cd}$ divided by $\frac{d^3}{a-b^n}=\frac{a-b^{n+2}}{cd^4}$. The operations of any other fractions are equally easy.

ART. II. *Involution; or To find the Square, Cube, Biquadrate, &c. of any given Quantity.*

Rule. Multiply the quantity into itself as often as the index contains units, less one, and the last product will be the power required; or, which is equivalent thereto, and in many cases is more convenient, multiply the index of the quantity by the index of the power, and you will have the answer, due regard being had to the signs.

EXAMPLES.

If a be the Root then
a^2=Square
a^3=Cube
a^4=Biquadrate
a^5=5th Power

$b+c$ Root
$b+c$
b^2+bc
$+bc+c^2$
$b^2+2bc+c^2$=Square
$b+c$
$b^3+2b^2c+bc^2$
$b^2c+2bc^2+c^3$
$b^3+3b^2c+3bc^2+c^3$=Cube

If
$-2a^2b^2$
be the root then

$+4a^4b^4$ =Square
$-8a^6b^6$ =Cube
$+16a^8b^8$ =4th Powr
$-32a^{10}b^{10}$ =5th Powr

$b-c$ Root
$b-c$
b^2-bc
$-bc+c^2$
$b^2-2bc+c^2$ Square
$b+c$
$b^3-2b^2c+bc^2$
$+b^2c+2bc^2-c^3$
$b^3-3b^2c+3bc^2-c^3$ Cube

It is observable that, in raising a binomial, where one of the quantities is negative, as in the instance above $b-c$, the terms in every power are + and — alternately. The operation, indeed, is only continued to the 3d power, but the observation is universal; and even a young beginner in the art, by continuing the multiplication, will easily raise the quantity to any higher power.

In raising trinomials, quadrinomials, &c. it will render the work less tedious to divide the root into two parts, taking but one term into one of the parts, and assuming some other letter in lieu of the rest; by which means the quantity will be reduced to a binomial, which being raised to the required power, the answer will be obtained by replacing, instead of the assumed letter, its proper value.

Thus if $b+c+d$ is to be raised to the third power, assume $b+c=a$, and so the trinomial $b+c+d$ is changed into the binomial $a+d$. Then $\overline{a+d}^3=a^3+3a^2d+3ad+d^3=\overline{b+c}^3+3d\times\overline{b+c}^2+3d^2\times\overline{b+c}+d^3$. But $\overline{b+c}^3=b^3+3b^2c+3bc^2+c^3$; and $3d\times\overline{b+c}^2=3d^2\times b^2+2bc+c^2=3db^2+6dbc+3dc^2$, also $3d^2\times\overline{b+c}=3d^2b+3d^2c$. Therefore $\overline{b+c}^3+3d\times\overline{b+c}^2+3d^2\times\overline{b+c}+d^3=b^3+3b^2c+3bc^2+c^3+3db^2+6dbc+3dc^2+3d^2b+3d^2c+d^3$=the cube of $b+c+d$, which was to be effected.

In fractional quantities, the numerator and denominator must each be involved to the required power, by which a new fraction will be obtained, exhibiting that power of the fraction given.

Thus the 3d Power of $\frac{a^2}{b}=\frac{a^6}{b^3}$; the Square of $\frac{a+b}{d+c}=\frac{a^2+2ab+b^2}{d^2+2dc+c^2}$; the 5th Power of $\frac{am}{b^2}\frac{cn}{d^n}=\frac{a^5m^5c^{5n}}{b^{10}d^{5n}}$; and the nth Power of $\frac{x^{n+1}}{a+b}=\frac{x^{nn+n}}{a+b^n}$.

What

ALGEBRA.

What has been delivered on this head is ſufficient for ſhewing how to involve Algebraic Quantities to any Power, whether they are ſimple, compound, or fractional. I cannot, however, cloſe the article without introducing the BINOMIAL THEOREM, which, for theſe purpoſes, of all methods, is the moſt uſeful, conciſe, and elegant; and will be a laſting ornament to the name of its renowned inventor, the incomparable Sir ISAAC NEWTON. The Theorem is as follows: Let n denote any number at pleaſure, and let $a+b$ be a binomial, then the nth Power thereof will be

$$a^n + n a^{n-1} b + \frac{n.n-1}{2} a^{n-2} b^2 + \frac{n.n-1.n-2}{2.3} a^{n-3} b^3 + \frac{n.n-1.n-2.n-3}{2.3.4} a^{n-4} b^4 + \frac{n.n-1.n-2.n-3.n-4}{2.3.4.5} a^{n-5} b^5 + \frac{n.n-1.n-2.n-3.n-4.n-5}{2.3.4.5.6} a^{n-6} b^6, \text{ \&c.}$$

the law of continuation being manifeſt. And the nth power of $a-b$ will be expreſſed in the ſame manner, only the ſigns of the 2d. 4th, 6th, &c. terms muſt be negative. The uſe of this Theorem will be evident from the following Example.

Let $a+b$ be involved to the 3d Power. Here the Index is 3, which muſt be placed inſtead of n in the Theorem, and the firſt term will be a^3; the ſecond $a^{3-1}\,b = 3a^2 b$; the third $\frac{3\times 2}{2} a^{3-2} b^2 = 3ab^2$; the fourth, $\frac{3\times 2\times 1}{2\times 3} a^{3-3} b^3 = b^3$; and the fifth and following terms will be found equal to nothing. Therefore, collecting theſe four terms together, the third power of $a+b$ is $a^3+3a^2b+3ab^2+b^3$.

N. B. The coefficients increaſe till the indices of the two letters a and b become equal or change values, when they return or decreaſe again, after the ſame order, ſo that having found the coefficients of half the term, the reſt become known alſo.

ART. III. *Evolution; or, To find the Roots of given Powers.*

Rule I. In ſimple quantities extract the root of the coefficient for a new coefficient, and divide the index of the letters by the index of the power, and you will have the root ſought.

Thus, the Square Root of $16x^2 = 4x^{\frac{2}{2}} = 4x$; the Cube Root of $27x^3 = 3x^{\frac{3}{3}} = 3x$; the Square Root of $5a^2 x^6 = a^{\frac{2}{2}} x^{\frac{6}{2}} \sqrt{5} = ax^3\sqrt{5}$; the Biquadrate Root $81\,a^4 x^8 = 3a^{\frac{4}{4}} x^{\frac{8}{4}} = 3ax^2$; and ſo for any others.

Rule II. To find the Root of Compound Quantities, range the terms after the dimenſions of ſome letter, ſo that the higheſt power thereof may ſtand firſt in order, and the reſt follow according to their ſeveral ranks; then take the root of the firſt term, and place it in the quotient, and, if it be the Square or Cube Root, ſubtract the ſquare or cube thereof from the firſt term, bringing down two or three of the next terms (accordingly as the caſe ſhall be the ſquare or cube root) for a dividend; then proceed to find a diviſor, and in all reſpects to carry on the work agreeable to the rules given for extracting the Square and Cube Roots in our New Syſtem of ARITHMETIC. But if it be the Root of a higher Power that is wanted, proceed according to the GENERAL RULE for extracting the Roots of all Powers, as delivered in our ſaid New Syſtem.

EXAMPLES.

Let the Square Root of $36x^4+108x^2+81$ be required.

Operation.

Root.

$36x^4+108x^2+81\ (6x^2+9$

$36x^4$

$12x^2+9)\ +108x^2+81$

$+108x^2+81$

What is the Cube Root of $x^3-6x^2y+12xy^2-8y^3$?

Root

$x^3-6x^2y+12xy^2-8y^3\ (x-2y$

x^3

$3x^2-6xy+4y^2)\ -6x^2y+12xy^2-8y^3$

$-6x^2y+12xy^2-8y^3$

What is the Square Root of $x^2+4xy+4y^2-2xz-4yz+z^2$?

Root

$x^2+4xy+4y^2-2xz-4yz+z^2\ (x+2y-z$

x^2

$2x+2y\ |\ 4xy+4y^2$

$4xy+4y^2$

$2x+4y-z)\ -2xz-4yz+z^2$

$-2xz-4yz+z^2$

Note. Here three terms are brought down, which, at firſt ſight, appears rather contrary to the Rule; but the reaſon is, the two terms $-2xz$ and $4yz$ are conſidered but as one term, becauſe z in the *ſame power* is found in both of them, and they might have been expreſſed in one term. Thus $-2xz-4yz = -2x-4y\times z$; ſo that $-2x-4y$ may be conſidered as a coefficient to z.

What is the 4th Root of $16a^4-96a^3b+216a^2b^2-216ab^3+81b^4$?

Root

$16a^4-96a^3b+216a^2b^2-216ab^3+81b^4\ (2a-3b$

$16a^4$

$32a^3)\ -96a^3b$

$-96a^3b\ (-3b$

$16a^4-96a^3b+216a^2b^2-216ab^3+81b^4$

SCHOLIUM. The Root may ſometimes be diſcovered by extracting the Roots of all the Simple Powers, or terms in the given quantity, and connecting the Roots by the ſigns + and −, according as it ſhall appear to agree with the caſe. Thus in the laſt Example the 4th Root of $16a^4$ is $2a$, and of $81b^4$ is $3b$, and by connecting them with the ſign −, viz. $2a-3b$, you have the Root required.

It is alſo obſervable, that the even Root of any affirmative quantity, as the 2d, 4th, 6th, &c. may be either + or −; and the odd Root of any quantity, as the 3d, 5th, 7th, &c. will have the ſame ſign as the quantity itſelf. The even Root of a negative quantity is impoſſible, for if it had a Root its ſign muſt be either + or −; but all the even powers of any Root, whether affirmative or negative, are affirmative; and therefore no Root involved an even number of times can produce a negative Power, and of conſequence a negative Power can have no Root.

If a fractional quantity is to be evolved, the Roots of the numerator and denominator make the numerator and denominator of the Root of ſuch Fraction. Thus the Square Root of $\frac{4a^2}{36b^4} = \frac{\sqrt{4a^2}}{\sqrt{36b^4}} = \frac{2a}{3b^2} = \frac{a}{3b^2}$; and the Cube Root of $\frac{27a^6}{64x^3} = \frac{\sqrt[3]{27a^6}}{\sqrt[3]{64x^3}} = \frac{3a^2}{4x}$

It frequently happens that the quantity given to be extracted has not a perfect Root, and then the Root is called a Surd; and in that caſe it can be no otherways expreſſed than by either inſerting the quantity with its proper radical ſign, or throwing it into an infinite Series. Thus the Square Root of a can be expreſſed no otherways than by $\sqrt{a}$, or $a^{\frac{1}{2}}$; the Cube Root of $b^2 = \sqrt[3]{b^2}$ or $b^{\frac{2}{3}}$; the Cube Root of $\frac{a^2b}{c^3} = \sqrt[3]{\frac{a^2b}{c^3}} = \left|\frac{a^2b}{c^3}\right|^{\frac{1}{3}} = \frac{a^{\frac{2}{3}}\,b^{\frac{1}{3}}}{c^{\frac{3}{3}}}$

and the Square Root of $a^2+b^2 = \sqrt{a^2+x^2} =$ (by the common Rule of Extraction) $a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5} - \frac{5x8}{128a^7}$, &c.

The ſeveral ways of managing Surds will be particularly handled in the next Section.

SECTION IV. SURD QUANTITIES.

I have ſaid before, that a Surd is the Root of ſuch a quantity as cannot be perfectly extracted: however, it will ſometimes happen in algebraic operations, that a Root cannot be exhibited in rational quantities, which nevertheleſs is not a Surd in itſelf, but may be perfectly expreſſed in numbers, by ſubſtituting, inſtead of the literal characters, its proper value.

Thus $\sqrt{a^2+x^2}$ cannot be perfectly extracted in algebraic terms; but if the value of a be 3, and the value of x be 4, then $a^2=9$, and $x^2=16$, and the Surd becomes $\sqrt{9+16}=\sqrt{25}=5$; a rational number. Whence a Surd, ſtrictly ſpeaking, is ſuch a quantity as is not commenſurable by the ſcale of rational numbers.

Again, Surds, though incommenſurable with rational quantities, may, notwithſtanding, be commenſurate among themſelves.

Thus $\sqrt{2}$, $3\sqrt{2}$, and $5\sqrt{2}$, are each incommenſurate to any rational number; but, with regard to themſelves, they are in the perfect ratio of their coefficients 1, 3, and 5, reſpectively. This being premiſed, I ſhall proceed to the Algorithm of Surd Quantities.

ART. I. *To reduce a rational Quantity to the Form of a Surd.*

Rule. Multiply the index of the quantity by the index of the Surd, and over the quantity ſo produced place the radical ſign, and it will be the form required.

Thus, let 3 be reduced to the form of $\sqrt{\ }5$. By the Rule $3^1\times 2$, or $3^2=9$, and $\sqrt{9}$ is the form required.

Again, let a^3 be reduced to the form of $\sqrt[4]{\ }b$. Here $a^3\times 1 = a^3$, and $\sqrt[4]{a^3}$ is the required form.

In like manner, $a+b$ reduced to the form of $\sqrt{c\,d}$, is $\sqrt{\overline{a+b}}$, or $\sqrt{a^2+2ab+b^2}$; and $\frac{a}{b\sqrt{d}}$ reduced to the form of $\sqrt{e}$, is $\sqrt{\frac{a^2}{b^2 d}}$

ART. II. *To reduce Quantities of different Indices to other equivalent ones, which ſhall have one given Index.*

Rule. Divide the indices of the quantities by the given Index, and the quotients will be the new indices for thoſe quantities. Then over the ſaid quantities, with their new indices, place the given Index, and they will be the equivalent values required.

EXAMPLE.

EXAMP. Let $12^{\frac{1}{2}}$ and $9^{\frac{1}{3}}$ be reduced to equal quantities, having the common Index $\frac{1}{6}$. Here $\frac{1}{2}+\frac{1}{6}=\frac{3}{6}=$ the Index of the first quantity; and $\frac{1}{3}+\frac{1}{6}=\frac{2}{6}$, = the Index of the second quantity: therefore $\overline{12^3}^{\frac{1}{6}}$ and $\overline{9^2}^{\frac{1}{6}}$ are the quantities required.

Alſo, if $a^{\frac{1}{2}}$ and $b^{\frac{2}{3}}$ are to be reduced to the common Index $\frac{1}{6}$, they will be found $=\overline{a^3}^{\frac{1}{6}}$ and $\overline{b^4}^{\frac{1}{6}}$ reſpectively; and ſo for any others.

ART. III. *To reduce Quantities of different Indices to other equivalent ones, having the leaſt common Index.*

Rule. Reduce the Indices of the given quantities to a common denominator, in the leaſt terms.

EXAMP. Reduce $a^{\frac{1}{n}}$ and $b^{\frac{1}{m}}$ to the leaſt common Index.

Here $\frac{1}{n}$ and $\frac{1}{m}$ reduced to a common denominator are $\frac{m}{mn}$ and $\frac{n}{nm}$; and therefore $a^{\frac{m}{mn}}$ and $b^{\frac{n}{mn}}$ are the expreſſions required, or, which are the ſame, $\sqrt[mn]{a^m}$, and $\sqrt[mn]{b^n}$.

Alſo, $\sqrt{a+b}$, and $\sqrt[3]{x^2+y^2}$, will in like manner be found $\overline{a+b}^{\frac{2}{4}}$ and $x^2+y^2\Big|^{\frac{2}{6}}$, or $\sqrt[4]{\overline{a+b}^2}$ and $\sqrt[6]{x^2+y^2}^2$, or $\overline{a^3+3a^2b+3ab^2+b^3}\Big|^{\frac{2}{6}}$ and $x^4+2x^2y^2+y^4\Big|^{\frac{2}{6}}$.

ART. IV. *To reduce a Surd to its moſt ſimple Terms.*

Rule. Divide by the greateſt power contained in it, and place the root before the quotient, with the radical ſign between them.

Thus let $\sqrt{32}$ be reduced to its moſt ſimple terms. Here 16 is the greateſt ſquare number that will divide 32; the diviſion being made the quotient is 2; therefore $4\sqrt{2}$ is the Surd required.

Let $\overline{81a^2b}\Big|^{\frac{1}{2}}$ be propoſed. Here $81a^2$ is the greateſt ſquare; its root is $9a$; and the quotient is b. Therefore $9a\sqrt{b}$ is the Surd in its moſt ſimple terms.

Again, let $\overline{\frac{64a^3b^3}{27b-27a}}\Big|^{\frac{1}{2}}$ be given. This is $=\overline{\frac{64a^3b^3\times a}{27b-27a}}\Big|^{\frac{1}{2}}=\frac{4ab}{3}\sqrt{\frac{a}{b-a}}$; and thus for any other.

ART. V. *To find whether Surds are commenſurable or not.*

Rule. Reduce them to the leaſt common index; and the quantities, if fractional, to a common denominator, except when like terms are commenſurable. Then divide them by the greateſt common diviſor, (or by ſuch a one as will give one quotient rational,) and if both the quotients are rational, the Surds are commenſurable; but if otherwiſe, they are incommenſurable.

EXAMP. Let $\sqrt{27}$ and $\sqrt{12}$ be propoſed. Theſe have already one common index, and are equal to $\sqrt{3\times9}$ and $\sqrt{3\times4}$ reſpectively. Divide by 3, and the quotients are $\sqrt{9}$ and $\sqrt{4}$; that is, 3 and 2; and therefore they are commenſurable.

Again, let $\sqrt{48}$ and $\sqrt{6}$ be propoſed. Here, by dividing by 6, the quotients are $\sqrt{8}$, and $\sqrt{1}$ or 1, and therefore they are incommenſurable.

Alſo, if $\overline{\frac{b}{c}}\Big|^{\frac{1}{2}}$ and $\overline{\frac{c}{b}}\Big|^{\frac{1}{2}}$ be propoſed, theſe are reduced to $\overline{\frac{b^3}{c^3}}\Big|^{\frac{1}{2}}$ and $\overline{\frac{c^3}{b^3}}\Big|^{\frac{1}{2}}$, and theſe again to $\overline{\frac{b^3}{c^2\,b^3}}\Big|^{\frac{1}{2}}$ and $\overline{\frac{c^3}{c^2\,b^3}}\Big|^{\frac{1}{2}}$. Divide by $\frac{1}{c^2\,b^3}$, and the quotients are $\overline{b^3}\Big|^{\frac{1}{2}}$ and $\overline{c^3}\Big|^{\frac{1}{2}}$. Wherefore they are incommenſurable. Furthermore, if $\overline{x^4+x^2y^2}\Big|^{\frac{1}{2}}$ and $\overline{x^2y^2+y^4}\Big|^{\frac{1}{2}}$ be propoſed, divide theſe quantities by x^2+y^2, and the quotients are $\sqrt{x^2}$ and $\sqrt{y^2}$, or x and y. Hence the quantities are commenſurable. Theſe inſtances are ſufficient to point out the method of performing all other ſimilar caſes.

ART. VI. *To add and ſubtract Surd Quantities.*

Rule. Reduce quantities with unlike indices into thoſe of like indices; and bring fractions to a common denominator, or elſe to others that have rational denominators or numerators; then reduce the quantities to their ſimpleſt terms (by Art. IV.) and if the Surd part be the ſame in all, annex it to the Sum or Difference with the ſign ($\times$) of Multiplication.

If the Surd part is not the ſame in all, the quantities can only be added or ſubtracted by connecting them together with the ſigns $+$ or $-$.

EXAMP. Let $\sqrt{18}$ and $\sqrt{50}$ be added together. Here $\sqrt{18}=\sqrt{9\times2}=3\sqrt{2}$; and $\sqrt{50}=\sqrt{25\times2}=5\sqrt{2}$, and the ſum $=\overline{3+5}\times\sqrt{2}=8\sqrt{2}=\sqrt{128}$.

Let $\sqrt{4a}$ and $\sqrt[3]{a^2}$ be added. Here $\sqrt{4a}=\sqrt[4]{16a^2}=2\sqrt[4]{a^2}$. And $\sqrt[4]{a^2}=\sqrt[4]{a^4\times a^2}=a\sqrt[4]{a^2}$. Therefore their ſum $=\overline{a+2}\times\sqrt[4]{a^2}=\overline{a+2}\times\sqrt{a}$. In like manner, if it had been required to have ſubtracted $\sqrt{4a}$ from $\sqrt[3]{a^2}$, the remainder would have been $a-2\times\sqrt{a}$. Alſo, if $\sqrt[3]{a^2}-\sqrt{a^3}+\sqrt{7}$ is added to $2\sqrt[3]{a^2}+\sqrt{a}-\sqrt{3}$, the ſum is $3\sqrt[3]{a^2}-\sqrt{a^3}+\sqrt{7}+\sqrt{a}-\sqrt{3}$; but if ſubtracted therefrom, the remainder is $\sqrt[3]{a^2}+\sqrt{a^3}-\sqrt{3}+\sqrt{a^3}-\sqrt{7}$.

If $\sqrt{\frac{4}{25}}$ is added to $\sqrt{\frac{64}{25}}$ the ſum is $\sqrt{\frac{36}{25}}+\sqrt{\frac{28}{25}}=\sqrt{\frac{4\times9}{25}}+\sqrt{\frac{4\times7}{25}}=5\sqrt{\frac{4}{25}}+6\sqrt{\frac{4}{25}}=5+6\times\sqrt{\frac{4}{25}}=11\sqrt{\frac{4}{25}}$; but if ſubtracted, the remainder is $6-5\times\sqrt{\frac{4}{25}}=\sqrt{\frac{4}{25}}$. The proceedure is the ſame for any other quantities.

ART. VII. *To multiply and divide Surds.*

Rule. Reduce the Surds to the ſame index; and the product or quotient of the rational quantities being annexed to the product or quotient of the Surds, will give the product or quotient required.

EXAMP. Let $2\sqrt{2}$ be multiplied by $3\sqrt{3}$. Here the Surds have already the ſame index. Therefore $2\times3\times\sqrt{2\times3}=6\sqrt{6}$ is the Product required. Let $a^{\frac{1}{2}}$ be multiplied by $b^{\frac{1}{3}}$. Here $a^{\frac{1}{2}}=\overline{a^3}^{\frac{1}{6}}$, and $b^{\frac{1}{3}}=\overline{b^2}^{\frac{1}{6}}$; and their product is $\overline{a^3\,b^2}^{\frac{1}{6}}$.

Let $x^{\frac{1}{2}}+2y^{\frac{1}{3}}$ be multiplied by $5yx^{\frac{1}{2}}$. Here $x^{\frac{1}{2}}$ (the firſt term) $\times5yx^{\frac{1}{2}}=\overline{1\times5y}\times\sqrt{xx}=5yx$; alſo the ſecond term $+2y^{\frac{1}{3}}=2\sqrt[6]{y^2}$, and $5yx^{\frac{1}{2}}=5\sqrt[6]{y^6\,x^3}$, and their product $=+2\times5\times\sqrt[6]{y^2\times y^6\,x^3}=+10\sqrt[6]{y^8\,x^3}$, and therefore the whole product is $5yx+10\sqrt[6]{y^8\,x^3}$. If both quantities are compound, the operation will be equally eaſy, due regard being paid as well to the inſtructions in ART. III. as to the Rule here given.

Let $a-a\sqrt{x}$ be multiplied by $b-b\sqrt{x}$. Here the product by b is $ab-ab\sqrt{x}$; and the product by $-b\sqrt{x}=-ab\sqrt{x}+abx$, and their ſum is $ab-2ab\sqrt{x}+abx$, the anſwer ſought.

So in diviſion, if $a^{\frac{1}{2}}$ be divided by $y^{\frac{1}{3}}$, the quotient will be $\overline{\frac{a^3}{y^2}}\Big|^{\frac{1}{6}}$; alſo $\frac{3x^{\frac{1}{3}}y^{\frac{1}{m}}}{4a^{\frac{1}{n}}}$ divided by $\frac{5y^n}{3b}$ $=\frac{5b\times3\sqrt[mn]{x^m\,y^n}}{4a\times2\sqrt[mn]{y^n\,x^m}}=\frac{15b}{8a}\times\sqrt[mn]{\frac{x^m\,y^n}{y^{mn}\,x^{mn}}}$; and the like for any other; obſerving, in compound quantities, to divide each term in the dividend by the whole diviſor, and connect the quotients with the ſigns $+$ or $-$, as the caſe ſhall be; and further, that the dividing of each ſeparate term by the compound diviſor, is the ſame as multiplying it by the reciprocal thereof.

Thus, if any ſingle term, as $x^{\frac{1}{2}}$ is divided by a compound term, as $x^{\frac{1}{2}}+y^{\frac{1}{2}}$, it is the ſame thing as if it was multiplied by $\frac{1}{x^{\frac{1}{2}}+y^{\frac{1}{2}}}$, and therefore the quotient is $\overline{\frac{x^3}{x^3+y^3}}\Big|^{\frac{1}{2}}$.

N. B. A fraction is changed into its reciprocal by making the numerator the denominator, and the denominator the numerator.

SCHOLIUM. With regard, however, to compound Surds, it will not often happen that any advantage can be derived by the above mode of proceeding. Wherefore it will be proper to try to carry on the diviſion in the ſame form as was ſhewn for compound rational quantities, which ſometimes may be done with great facility. When this fails, the quotient can only be expreſſed by writing the diviſor under the dividend in manner of a fraction.

ART. VIII. *Involution and Evolution of Surd Quantities.*

Are performed by multiplying (if it is a ſimple Surd) the Index of the Quantity by the Index of the Power to which it is to be involved, or by the Fraction expreſſing the Root to which it is to be evolved, and where there is a rational part, its proper Power or Root muſt be prefixed thereto. Thus, the Square of $a\sqrt{x}=a^2\times x^{\frac{1}{2}\times2}=a^2\times x^{\frac{2}{2}}=a^2\times x^1=a^2x$. The Cube of $a\sqrt{x}=a^1\times x^{\frac{1}{2}\times3}=a^3\times x^{\frac{3}{2}}=a^3\,x^{\frac{1}{2}}$, or $a^3\sqrt{x^1}$.

Alſo the Cube Root of $\overline{a+x}^{\frac{3}{4}}=\overline{a+x}^{\frac{3}{4}\times\frac{1}{3}}=\overline{a+x}^{\frac{1}{4}}$; and the Biquadrate Root of $81x=3^{\frac{4}{4}}x^{\frac{4}{4}}=3^1x^1$, or $3\sqrt[4]{x}$.

SCHOLIUM. Here no difference is made between Roots and Powers, ſave that the Indices of Powers are whole Numbers, but thoſe of Roots, Fractions.

Hence, in many caſes, both Involution and Evolution may be performed at one operation. For inſtance, if it is required to involve $\overline{a+x}^{\frac{1}{2}}$ to the 5th Power, and then to extract the Cube Root thereof, it will be done at once, by multiplying the exponent $\frac{1}{2}$ by $\frac{5}{3}$; and ſo the anſwer is $\overline{a+x}^{\frac{5}{6}}$.

Therefore the Indices of Powers and Roots, thus entangled, may with propriety be deemed fractional powers; and hence, in *general*,

general, $x^{\frac{n}{r}}$ raised to the $\frac{m}{m}$th power is $x^{\frac{n}{r}\times\frac{m}{m}}=x^{\frac{nm}{rm}}$.

Compound Surds are involved and extracted as integers or rational quantities, due regard being had to the operations of Simple Surds.

In cases of Evolution, where the Root of Compound Surds cannot be found, it muſt be denoted by a line or vinculum drawn over the whole, together with the proper radical ſign or index.

Operations of theſe kinds may be much facilitated by aſſuming, inſtead of Surds, ſome rational quantities or letters to repreſent them; and by having recourſe to the Binomial Theorem, given in Art. II. Sect. III. were n may be taken to denote any power, either whole or fractional; and ſo it may be made applicable to caſes of Evolution as well as of Involution; and having by this means obtained the terms of the required power (which, if fractional, will commonly be an infinite ſeries) the Surds may be reſtored in lieu of the aſſumed letters, obſerving to raiſe the Indices of the Surds in each term of the Power denoted to the Indices of their ſubſtitutes.

It was obſerved in Art. II. Sect. III. that when the quantity to be involved is a reſidual, viz. when one of the terms are negative, as $a-b$, the terms of any power thereof will be $+$ and $-$ alternately; and in Binomials, where both the terms are negative; that all the terms, of whatever power, will be affirmative: this, however is to be underſtood within this limit, namely, when the power of the quantity to be involved is affirmative.

When the power is negative, as $\overline{a+b}^{-n}$, or $\overline{a-b}^{-n}$; in the firſt caſe, all the terms in the odd places will be affirmative, and thoſe in the even places negative; but in the latter caſe, all the terms will be affirmative.

N. B. A quantity with a negative power is equal to its reciprocal with an affirmative power. Thus $\overline{a\pm b}^{-n}=\frac{1}{\overline{a\pm b}^{n}}$.

This follows from what was obſerved in the Scholium of Article IV. Sect. II.

There are other methods of extracting Surd Quantities, though I believe the caſes, to which they may be applied, will not frequently occur in practice; but, that nothing may be wanting to render the rudiments of this Syſtem as complete as poſſible, I ſhall lay down another rule, which I have ſometimes had recourſe to, and found uſeful.

It is this, if $B+C$ be a binomial or reſidual Surd, then $\sqrt{B+C}=\sqrt{\frac{B+\sqrt{B^2-C^2}}{2}}\pm\sqrt{\frac{B-\sqrt{B^2-C^2}}{2}}$.

The uſe whereof is this: Let $3+\sqrt{5}$ be a binomial, whoſe ſquare root is required. Here the firſt term $B=3$, and $C=\sqrt{5}$. Then $\sqrt{B^2-C^2}=\sqrt{9-5}=\sqrt{4}=2$ and $\sqrt{\frac{B+\sqrt{B^2-C^2}}{2}}=\sqrt{\frac{3+2}{2}}=\sqrt{\frac{5}{2}}=\sqrt{\frac{10}{4}}=\frac{1}{2}\sqrt{10}$.

Likewiſe $\sqrt{\frac{B-\sqrt{B^2-C^2}}{2}}=\sqrt{\frac{3-2}{2}}=\sqrt{\frac{1}{2}}=\sqrt{\frac{1}{4}}=\frac{1}{2}\sqrt{2}$. The required Root is $2\sqrt{10}+\frac{1}{2}\sqrt{2}$. If the given quantity had been $3-\sqrt{5}$, the anſwer would have been $2\sqrt{10}-\frac{1}{2}\sqrt{2}$.

N. B. In this Rule B muſt always be the greater Quantity.

SECTION V. OF INFINITE SERIES.

ART. I. *To find the Value of a Fraction in an infinite Series.*

Rule. Divide the numerator by the denominator, as in common diviſion, and continue the operation as far as ſhall be thought neceſſary. In many caſes, after a few terms are had in the quotient, the law by which it converges will be diſcovered, and ſo any number of terms be ſupplied at pleaſure.

EXAMPLES.

Let $\frac{1}{1+x^2}$ be thrown into an infinite ſeries.

$1+x^2\big)1\ \big(\ 1-x^2+x^4-x^6+x^8-$ &c.

$1+x^2$

$-x^2$

$-x^2-x^4$

$+x^4$

$+x^4+x^6$

$-x^6$

$-x^6-x^8$

$+x^8$

$+x^8+x^{10}$

$-x^{10}$

Let $\frac{ax}{a-x}$ be expreſſed by an infinite ſeries.

$a-x\big)\ ax\ \big(\ x+\frac{x^2}{a}+\frac{x^3}{a^2}+\frac{x^4}{a^3}$, &c.

$ax-x^2$

$+x^2$

$+x^2-\frac{x^3}{a}$

$+\frac{x^3}{a}$

$+\frac{x^3}{a}-\frac{x^4}{a^2}$

$+\frac{x^4}{a^2}$

$+\frac{x^4}{a^2}-\frac{x^5}{a^3}$

$+\frac{x^5}{a^3}$

In both of theſe ſeries, after a few terms are found, the law of continuation is manifeſt.

SCHOLIUM. It will, however, ſometimes be difficult to come at the ſeries by this mode, by reaſon of the coefficients; and then it will be convenient to aſſume a ſeries with unknown coefficients to repreſent it; which being multiplied or involved, as the queſtion requires, and the quantities of the ſame dimenſion being put equal to each other, Equations will be had, from which the coefficients may be eaſily determined. But this will be better underſtood after we have treated of Equations; wherefore, though I ſhall give an inſtance of it here, the reader may paſs over this, and the remaining part of the Section, till he knows perfectly how to manage Equations.

The method is this: Suppoſe $\frac{1}{a-x}$ be the given quantity. Let the aſſumed ſeries be $A+Bx+Cx^2+Dx^3+Ex^4$, &c. $=\frac{1}{a-x}$. Multiply both by $a-x$, and there will be $1=aA+aBx+aCx^2+aDx^3+aEx^4$, &c.

$-\ \ Ax-Bx^2-Cx^3-Dx^4$, &c.

and by equating the coefficients of the ſame powers of x, $aA=1$, $aB-A=0$, $aC-B=0$, $aD-C=0$, $aE-D=0$, &c. Hence in the firſt equation, $A=\frac{1}{a}$; in the ſecond, $B=\frac{A}{a}=\frac{1}{a^2}$; in the 3d, $C=\frac{B}{a}=\frac{1}{a^3}$; in the 4th, $D=\frac{C}{a}=\frac{1}{a^4}$; and in like manner $E=\frac{1}{a^5}$. Therefore $\frac{1}{a-x}$ brought to a ſeries is $\frac{1}{a}+\frac{x}{a^2}+\frac{x^2}{a^3}+\frac{x^3}{a^4}+\frac{x^4}{a^5}+$, &c.

ART. II. *To involve an infinite Series to any given Power.*

Rule. Subſtitute the particular letters or numbers in the given ſeries inſtead of thoſe in the following general form.

$z^m\times\overline{a+bx+cx^2+dx^3+ex^4}^{\,m}=z^m\times$ into

$+a^m$

$+\frac{mbA}{a}.x$

$+\frac{2mcA+\overline{m-1}.bB}{2a}.x^2$

$+\frac{3mdA+\overline{2m-1}.cB+\overline{m-2}.bC}{3a}.x^3$

$+\frac{4meA+\overline{3m-1}.dB+\overline{2m-2}.cC+\overline{m-3}.bD}{4a}.x^4$

$+\frac{5mfA+\overline{4m-1}.eA+\overline{3m-2}.dC+\overline{2m-3}.cD+\overline{m-4}.bE}{5a}.x^5$

$+$ &c. &c. &c.

where A, B, C, D, E, &c. are the coefficients of the terms immediately preceding thoſe wherein they firſt appear; and the law of continuation is evident.

EXAMP. Required the ſquare of $1+x+x^2+x^3+x^4+$, &c. Here $z=1$, $a=1$, $b=1$, $c=1$, $d=1$, &c. and $m=2$, which values being put in the general ſeries in lieu of the letters, it becomes $1+\frac{2A}{1}x+\frac{4A+B}{2}x^2+\frac{6A+3B+C}{3}x^3+\frac{8A+5B+2C-D}{4}x^4$, &c. Then the firſt term A, being 1, the 2d is $2x$, and B, its coefficient, is 2; the 3d term is $3x^2$, and C, its coefficient, is 3; and ſo on for the reſt. And the ſquare of the given ſeries is $1+2x+3x^2+4x^3+5x^4$, &c. If it was required, inſtead of ſquaring the ſeries, to extract the ſquare root thereof, the proceſs would be juſt the ſame, only m in-

ſtead of being $=a$, would be $=1$, and in that caſe the ſeries would become $1+\frac{1}{2}Ax+\frac{A-\frac{1}{4}B}{2}x^2+\frac{A+0-C}{3}x^3+\frac{2A+\frac{1}{4}B-C-\frac{1}{8}D}{4}x^4$, &c. and hence, $1+\frac{1}{2}x+\frac{1}{8}x^2+\frac{5}{16}x^3+\frac{35}{128}x^4$, &c.

Various examples might have been given to have illuſtrated this rule, but it is apprehended the above is ſufficient to ſhew its general uſe.

Article III.

To revert an infinite Series; or, To find the Root of ſuch a Series.

Rule I. If the ſeries conſiſts of all the powers of z, as $Az+Bz^2+Cz^3+Dz^4+Ev^5$, &c. $=y$, then ſubſtitute the values of the coefficients, A, B, C, D, &c. in the following form, for the root.

$$z=\frac{1}{A}y-\frac{B}{A^3}y^2+\frac{2BB-AC}{A^5}y^3+\frac{5ABC-A^2D-5B^3}{A^7}y^4+\frac{14B^4-21AB^2C+6A^2BD+3A^2C^2-A^3E}{A^9}y^5+\frac{-42B^5+84A^2B^3C-28A^3B^2D-28A^3BC+7A^4BE}{A^{11}}+\frac{7A^3CD-A^4F}{A^{11}}y^6, \text{ &c.}$$

For put $z=ay+by^2+cy^3+dy^4$, &c. Then

$$\begin{aligned} zz&= aay^2+2aby^3+bby^4, \text{ &c.}\\ &\quad +2ac,\\ z^3&= a^3y^3+3a^2by^4, \text{ &c.}\\ z^4&= a^4y^4, \text{ &c.}\\ &\text{&c.} \end{aligned}$$

Whence

$$\left.\begin{aligned} Az &= Aay+Aby^2+Acy^3+Ady^4, \text{ &c.}\\ +Bz^2 &= Ba^2y^2+2Baby^3+Bbby^4, \text{ &c.}\\ &\quad +2Bac\\ +Cz^3 &= Ca^3y^3+3Ca^2by^4, \text{ &c.}\\ +Dz^4 &= Da^4y^4, \text{ &c.}\\ &\text{&c.} \end{aligned}\right\}=y$$

Then making the homologous powers equal, $Aay=y$, and $a=\frac{1}{A}$. And $Ab+Ba^2=0$, or $b=\frac{-B}{A^3}$. Likewiſe $Ac+2Bab+Ca^3=0$, and $c=\frac{2BB-AC}{A^5}$. In like manner $Ad+Bbb+2Bac+3Ca^2b+Da^4=0$, whence $D=\frac{5ABC-A^2D-5B^3}{A^7}$, and ſo on.

Examp. Let $z=x+\frac{xx}{2}+\frac{x^3}{3}+\frac{x^4}{4}+\frac{x^5}{5}$, &c. to find x in a ſeries of z. Here $z=x$, $y=z$, $A=1$, $B=\frac{1}{2}$ $C=\frac{1}{3}$, $D=\frac{1}{4}$, $E=\frac{1}{5}$, &c. and $x=\frac{1}{1}z-\frac{1}{2}z^2+\frac{\frac{1}{2}-\frac{1}{3}}{1}z^3+\frac{5\times\frac{1}{6}-\frac{1}{4}-5\times\frac{1}{8}}{1}z^4$, &c. $=z=\frac{1}{2}z^2+\frac{1}{6}z^3=\frac{1}{24}z^4+\frac{1}{120}z^5$, &c. $=z=\frac{zz}{1.2}+\frac{z^3}{2.3}=\frac{z^4}{2.3.4}+\frac{z^5}{2.3.4.5}$, &c. that is, $x=z=\frac{z}{2}A=\frac{z}{3}B=\frac{z}{4}C=\frac{z}{5}D$, &c. where A, B, C, &c. are the foregoing terms with their ſigns.

Rule II. If the ſeries conſiſts of the odd powers of z, as $Az+Bz^3+Cz^5+Dz^7$, &c. $=y$, ſubſtitute the values of the coefficients A, B, C, &c. into the following form, which will give the root.

$$z=\frac{1}{A}y-\frac{B}{A^4}y^3+\frac{3BB-AC}{A^7}y^5+\frac{8ABC-A^2D-12B^3}{A^{10}}y^7+\frac{55B^4-55AB^2C+10A^2BD+A^2C^2-A^3E}{A^{13}}y^9, \text{ &c.}$$

For put $z=ay+by^3+cy^5+dy^7$, &c. Then

$$\begin{aligned} z^3&= a^3y^3+3a^2by^5+3a^2cy^7\\ &\quad +3abb\\ z^5&= a^5y^5+5a^4by^7\\ z^7&= a^7y^7\\ &\text{&c.} \end{aligned}$$

And

$$\left.\begin{aligned} Az &= Aay+Aby^3+Acy^5+Ady^7, \text{ &c.}\\ +Bz^3 &= Ba^3y^3+3Ba^2by^5+3Ba^2cy^7\\ &\quad +3Babb\\ +Cz^5 &= Ca^5y^5+5Ca^4by^7\\ +Dz^7 &= Da^7y^7 \end{aligned}\right\}=y.$$

Then equating the coefficients of like terms, $Aa=1$, $Ab+Ba^3=0$, $Ac+3Ba^2b+Ca^5=0$, $Ad+3Ba^2c+3Bab^2+5Ca^4b+Da^7=0$, &c. whence $a=\frac{1}{A}$, $b=-\frac{Ba^3}{A}=-\frac{B}{A^4}$.

Likewiſe $c=\frac{3BB-AC}{A^7}$, $d=\frac{8ABC-A^2D-12B^3}{A^{10}}$, &c.

Examp. Suppoſe $y+\frac{y^3}{2.3dd}+\frac{3y^5}{2.4.5d^4}+\frac{3.5y^7}{2.4.6.7d^6}+$, &c. $=a$, to find y. Here $z=y$, $y=a$, $A=1$, $B=\frac{1}{2.3dd}$, $C=\frac{3}{2.4.5d^4}$, $D=\frac{3.5}{2.4.6.7d^6}$, &c. Then $y=a-\frac{1}{2.3dd}a^3+\frac{1}{2.2.3d^4}-\frac{3}{2.4.5d^4}\times a^5+\frac{1}{2.5}-\frac{5}{2.4.2.7}-\frac{1}{2.3.3}\times\frac{a^7}{d^6}$, &c. $=a-\frac{1}{2.3dd}a^3+\frac{1}{2.3.4.5d^4}a^5-\frac{1}{2.3.4.5.6.7d^6}a^7+$, &c.

Rule III. When the ſeries conſiſt of any powers of z denoted by m and n, as $Az^m+Bz^{m+n}+Cz^{m+2n}+Dz^{m+3n}+Ez^{m+4n}$, &c. $=y$, then ſubſtitute the values of the coefficients, A, B, D, &c. into this form, for the root or value of z.

Put $v=\frac{y}{A}$. Then

$$z=v^{\frac{1}{m}}-\frac{B}{mA}v^{\frac{1+n}{m}}+\frac{m+1+2n}{2mmAA}BBv^{\frac{1+2n}{m}}-\left\{\frac{2mm+9mn+9nn+3m+6n+1}{6m^3A^3}B^3+\frac{m+3n+1}{mmA^2}BC-\frac{D}{mA}\right\}v^{\frac{1+3n}{m}}, \text{ &c.}$$

For put $z=v^{\frac{1}{m}}+bv^{\frac{1+n}{m}}+cv^{\frac{1+2n}{m}}+dv^{\frac{1+3n}{m}}+$, &c. Then dividing the given ſeries by A, we have $z^m+\frac{B}{A}z^{m+n}+\frac{C}{A}z^{m+2n}$, &c. $=\frac{y}{A}=v$. Whence by involution,

$$\left.\begin{aligned} z^m &= v+mbv^{\frac{m+n}{m}}+mcv^{\frac{m+2n}{m}}+m.\frac{m-1}{2}bbv^{\frac{m+2n}{m}}, \text{ &c.}\\ \frac{B}{A}z^{m+n} &= \frac{B}{A}\times v^{\frac{m+n}{m}}+m+n.bv^{\frac{m+2n}{m}}, \text{ &c.}\\ \frac{C}{A}z^{m+2n} &= \frac{C}{A}\times v^{\frac{m+2n}{m}}, \text{ &c.}\\ \frac{D}{A}z^{m+3n} &=, \text{ &c.} \end{aligned}\right\}=v.$$

Then equating the coefficients, $mb+\frac{B}{A}=0$, and $b=\frac{-B}{mA}$. And $mc+m.\frac{m-1}{2}bb+m+n\frac{bB}{A}+\frac{C}{A}=0$, and $c=\frac{m+1+2n}{2m^2A^2}BB-\frac{2AC}{2mA}$, &c.

Note. In all theſe Rules I have only purſued theſe ſeries to a few terms; to have gone farther would have taken up too much room: but the method is viſible.

Examp. Suppoſe $\frac{1}{1}x+\frac{1}{2}x^2+\frac{1}{3}x^3+\frac{1}{4}x^4+\frac{1}{5}x^5$, &c. $=y$. Here $z=x$, $v=y$, $A=\frac{1}{1}$, $B=\frac{1}{2}$, $C=\frac{1}{3}$, $D=\frac{1}{4}$, &c. and $m=2$, $n=1$. Whence $x=v^{\frac{1}{2}}-\frac{1}{3}v^{\frac{2}{2}}+\frac{3BB-4AC}{8AA}v^{\frac{3}{2}}$, &c. $=v^{\frac{1}{2}}-\frac{1}{3}v+\frac{1}{2.18}v^{\frac{3}{2}}+\frac{1}{270}v^2$, &c.

Coroll. The reverted ſeries will always be of the ſame form as the given ſeries; otherwiſe they are not convertible into one another.

SECTION VI. OF EQUATIONS.

An Equation is the mutual comparing of two equal quantities differently expreſſed with the ſign of ($=$) equality between them: thus $a+b=c-d$ is an Equation, ſhewing the equality of the quantities $a+b$, and $c-d$. See Definition XXIV.

Article I.

To turn proportional Quantities into Equations, and the contrary.

Rule. Multiply the extremes together for one ſide of the Equation, and the two means together for the other ſide thereof; or, in geometrical progreſſions, when there are but three terms, ſquare the middle term for the other ſide of the Equation. If Equations are to be turned into proportions, the procedure is juſt the reverſe, for each of the Equations muſt be divided into two factors, and thoſe produced from one ſide of the Equation muſt be made the extremes; and ſo thoſe of the other ſide will be the two means. Thus if the proportion $a:d::c:x$ be given, the Equation derived from it will be $ax=dc$. Again, if the Equation $ab+ac=ca-de$ be given, it may be transformed into theſe proportions, as $a:1::ca-de:b+c$; or as $a:ca-de::1:b+c$; or as $b-c:1::ca-de:a$; or as $b+c:ca-de::1:a$; or as $1:a::b+c:ca-de$, or as $1:b+c::a:ca-de$; or

$d:c$; or as, $ca=de : b+c :: a+b : c+d$; or as $ca=de : a+b :: b+c : c+d$. For the Equation divides into $a\times b+c=1\times ca=de$, and the factors of each ſide may be made the means or extremes at pleaſure, and alſo each factor may be either of ſuch means or extremes; for by multiplying together the means and the extremes of any of theſe proportions according to the Rule, the given Equation will be produced, which ſhews that their relation with each other has been preſerved.

ART. II. *To reduce an Equation.*

When Algebraical Queſtions are brought to an Equation, it muſt be ſo ordered that the quantity ſought may ſtand clear on the firſt ſide of the Equation, and the known quantities on the other ſide. To effect which obſerve the following directions. 1ſt. When any quantity is alike concerned on both ſides of the Equation it muſt be thrown out of both. Thus if $5x+5y=4c-d+5y$. Here $+5y$ being rejected from both ſides, the Equation becomes $5x=4c-d$: the reaſon of this is evident from Axiom the 2d. When the known and unknown quantities are both on one ſide, tranſpoſe any of them to the contrary ſide, and change its ſign. Thus is $4y+3b=ax-dy$. Then if y be the quantity ſought $-dy$ may be brought to the firſt ſide of the Equation, and $+3b$ may be carried to the ſecond ſide of the Equation, by changing their ſigns, and hence it becomes $4y+dy=ax-3b$. This is the ſame as adding $-3b+4y$ (or ſubtracting $+3b-4y$) to both ſides of the Equation; therefore, by Axioms 1. and 2. the equality is preſerved. 3d. If there be fractions in the Equation, multiply both ſides of the denominators, and it will be freed therefrom.

EXAMP. Let $\frac{a^2}{b}+c=\frac{da}{c}$. Here both ſides being multiplied by b and c (or bc) it becomes $ca^2+bc^2=bda$. This proceſs is founded on Axiom 3.

4th. When any quantity is multiplied into both ſides of the Equation (or into the higheſt term of the unknown quantity) divide the whole Equation thereby.

EXAMP. $5bx^3=3bc$. Here divide the Equation by b, and it becomes $5x^3=3c$: again divide it by 5, and x^3 will be equal to $\frac{3c}{5}$. The truth of this appears from Axiom the 4th.

5th. If the unknown quantity is affected with a ſurd, tranſpoſe the reſt of the terms, and then involve each ſide according to the index of the ſurd. Thus if $\sqrt{x^2+ax}+d=c$, by tranſpoſing d we have $\sqrt{x^2+ax}=c-d$, and by ſquaring both ſides $x^2+ax=c^2-2cd+d^2$, and ſo the Equation is freed from ſurds. This is plain from Axiom the 5th.

6th. When the ſide containing the unknown quantity is a pure power (or if being affected it has a rational root) then extract the root on both ſides of the Equation. Thus if $x^2=b^2+ac$, then $x=\sqrt{b^2+ac}$, which, if b, c, and d are known quantities, may be extracted in numbers, and thence the value of x will be known. So likewiſe if $x^2+6x+9=25c$, by taking the ſquare root we have $x+3=\pm\sqrt{25c}$, and by tranſpoſing 3, $x=\pm\sqrt{25c}-3=\pm 5\sqrt{c}-3$.

N. B. All theſe methods are to be uſed as occaſion requires, till the Equation be duly cleared.

EXAMPLES.

EXAMP. I. What is the value of x in this Equation $24+4x+16=68=12x$? Here $+24$ and $+16$ in the firſt ſide of the Equation being tranſferred to the other ſide, and $=8x$ in the ſecond ſide of the Equation being tranſferred to the firſt ſide, it will ſtand thus $=4x+12x=68-24=16$, viz. (by collecting the terms, See Ax 7.) $8x=28$, and by dividing both ſides by 8, $x=\frac{28}{8}=\frac{7}{2}$.

EXAMP. II. What is the value of x in this Equation $ax+b^2=\frac{ax^2+ac^2}{a+x}$? Here, by multiplying both ſides $a+x$, we have $a^2x+ab^2+ax^2+b^2x=ax^2+ac^2$, whence (by tranſpoſition) $a^2x+ax^2+b^2x-ax^2=ac^2-ab^2$, viz. (by expunging ax^2, it being concerned with both $+$ and $-$) $a^2x+b^2x=ac^2-ab^2$, and dividing both ſides of the Equation, by a^2+b^2, we have $x=\frac{ac^2-ab^2}{a^2+b^2}$.

EXAMP. III. Let $\sqrt{a^2+x^2}=\sqrt[3]{b^3+x^3}$ be given to find x. Here by raiſing both ſides of the Equation to the 4th power $a^4+2a^2x^2+x^4=b^4+x^4$, and by tranſpoſition, &c. $2a^2x^2=b^4-a^4$, and dividing by $2a^2$, $x^2=\frac{b^4-a^4}{2a^2}$ hence $x=\sqrt{\frac{b^4-a^4}{2a^2}}$.

EXAMP. IV. Let $x=\sqrt{c^2+x\sqrt{b^2+x^2}}-c$. Here $x+c=\sqrt{c^2+x\sqrt{b^2+x^2}}$, which ſquared gives $x^2+2cx+c^2=c^2+x\sqrt{b^2+x^2}$, or $x^2+2cx=x\sqrt{b^2+x^2}$; and (dividing by x) $x+2c=\sqrt{b^2+x^2}$, which ſquared gives $x^2+4cx+4c^2=b^2+x^2$. By tranſpoſition, $4cx=b^2-4c^2$ and (dividing by $4c$) $x=\frac{b^2-4c^2}{4c}$.

ARTICLE III.

To exterminate an unknown Quantity out of ſeveral Equations.

Rule. If the quantity has but one dimenſion in the Equations, ſeek the value of the quantity to be expelled in two Equations, and put thoſe values equal to each other; or having found the value in one Equation, ſubſtitute it in lieu of ſuch quantity in the reſt of the Equations. Proceed thus with another unknown quantity. But if the quantity to be exterminated be of ſeveral dimenſions, find the value of its higheſt power in two Equations; then if the coefficients are not the ſame, multiply the leſs ſo that it may become equal to the greater. Then put theſe values equal to each other, and there will come out a new Equation, with a leſs power of the unknown quantity: and by repeating the operation, the quantity will at length be taken away.

EXAMPLES.

EXAMP. I. Given $7x-5y=28$, and $3x+5y=55$ to find x and y. 1ſt. Let y be exterminated. In the firſt Equation the value of y is $\frac{7x-28}{5}$, which is found by tranſpoſition and diviſion. In the ſecond Equation its value (in like manner) is found $=\frac{55-3x}{4}$. Theſe being put equal to each other, we have $\frac{7x-28}{5}=\frac{55-3x}{4}$, an Equation wherein only x is concerned. Multiply this Equation by 4 and 5 (or by their product $=20$) or, which is the ſame thing, multiply the numerators and denominators croſs wiſe, and we have $28x-112=275-15x$. By tranſpoſition $43x=387$, and by diviſion, $x=\frac{387}{43}=9$; which ſubſtituted in either of the given Equations inſtead of x, the value of y then will appear. Thus if it be ſubſtituted in the ſecond Equation, $27+4y=56$, and by tranſpoſition and diviſion $y=\frac{55-27}{4}=7$.

EXAMP. II. Let it be required to find the values of x, y, and z, in the three following Equations, viz. $x+y=17$; $x+z=18$; and $y+z=19$. Here, by ſubtracting the firſt Equation from the ſecond (in order to exterminate x) we have $z-y=1$, and this added to the third Equation, y is alſo exterminated; and there is found $2z=20$, and conſequently $z=10$, and $y\,(=z-1)=9$, and $x\,(=17-y)=8$.

EXAMP. III. Let there be given $x+y=a$; and $x^2+y^2=b$ to expunge x. Here by the firſt Equation $x=a-y$, and therefore $x^2=a^2-2ay+y^2$, which being wrote in the other Equation inſtead of x^2 we have $a^2-2ay+y^2+y^2=b$; viz. $a^2-2ay+2y^2=b$; and therefore $y^2-ay=\frac{b-a^2}{2}$, a Quadratic Equation, wherein y is the only unknown quantity.

ART. IV. *Of the Nature and Compoſition of Equations, containing different Dimenſions of the ſame unknown Quantity.*

In the laſt Article I have ſhewn the method of freeing Equations from any unknown quantity, whereby two or more Equations are reduced to one, containing only one unknown quantity, the value of which, when it is a ſimple Equation, I have alſo ſhewn how to find; but it will often happen that the remaining quantity will be of ſeveral different dimenſions in the Equation, and then ſuch Equation is called a Quadratic, a Cubic, Biquadratic, &c. according to the dimenſions of the higheſt power. To manage Equations of this kind, ſo as to diſcover the Root or value of the unknown Quantity concerned, will be treated of in the following Articles of this Section, after having here explained the nature and compoſition of ſuch Equations.

All Equations may be conſidered as compounded of thoſe of a lower order: thus if $x-b=0$, which is a ſimple Equation, be ſquared, there ariſes $x^2-2bx+b^2=0$, a Quadratic; if cubed, we have $x^3-3bx^2+3b^2x-b^3=0$, a Cubic Equation; &c. It is, however, but ſeldom that Equations occur in this regular form, for the coefficients of the terms will generally be greater or leſs than are aſſigned by the involution of one quantity $x-b$, and therefore in general a Quadratic is a compound, derived from $x-b$, $\times x-c$; a Cubic from $x-b\times x-c\times x-d$; a Biquadratic from $x-b\times x-c\times x-d\times x-e$, or from a Quadratic ſquared, &c. But the letters b, c, d, &c. may be affirmative, or ſome may be affirmative and others negative, whereby different ſigns will be produced in the Equations anſwerable to all Caſes.

In an Equation of this ſort, the whole being equal to nothing, it is obvious that at leaſt ſome or other of the factors $x-b$, $x-c$, $x-d$, &c. ſhould be equal to nothing; or the Equation (which is their product) could not be ſo. It is alſo evident, that any ſuch Equation may be divided by its factors till there remains only one factor; and as each of the inferior Equations obtained by ſuch diviſion muſt ſtill be equal to nothing, whatever factor was the diviſor, it follows that each of theſe factors are themſelves equal to nothing; and therefore b, c, d, e, &c. exhibit ſo many different values of x, with contrary ſigns; and hence every Equation has as many Roots as there are dimenſions of the unknown quantity in its higheſt power; and where b, c, d, e, &c. are found negative, x is affirmative; and where any of theſe are affirmative, x is negative.

ſtead of being $=z$, would be $=1$, and in that caſe the ſeries would become $1+\frac{1}{2}Ax+\frac{A-\frac{1}{2}B}{2}x^2+\frac{A+0-C}{3}x^3+\frac{2A+1B-C-\frac{1}{2}D}{4}x^4$, &c. and hence, $1+\frac{1}{2}x+\frac{1}{8}x^2+\frac{5}{16}x^3+\frac{35}{128}x^4$, &c.

Various examples might have been given to have illuſtrated this rule, but it is apprehended the above is ſufficient to ſhew its general uſe.

ARTICLE III.

To revert an infinite Series; or, To find the Root of ſuch a Series.

Rule I. If the ſeries conſiſts of all the powers of z, as $Az+Bz^2+Cz^3+Dz^4+Ez^5$, &c. $=y$, then ſubſtitute the values of the coefficients, A, B, C, D, &c. in the following form, for the root:

$$z=\frac{1}{A}y-\frac{B}{A^3}y^2+\frac{2BB-AC}{A^5}y^3+\frac{5ABC-A^2D-5B^3}{A^7}y^4+\frac{14B^3-21AB^2C+6A^2BD+3A^3C^2-A^4E}{A^9}y^5+\frac{-42B^4+84AB^2C-28A^2B^2D-28A^3BC+7A^4BE}{A^{11}}+\frac{7A^3CD-A^4F}{}y^6, \text{ \&c.}$$

For put $z=ay+by^2+cy^3+dy^4$, &c. Then

$$\begin{aligned} zz &= aay^2+2aby^3+bby^4, \text{ \&c.}\\ &\quad +2ac,\\ z^3 &= a^3y^3+3a^2by^4, \text{ \&c.}\\ z^4 &= a^4y^4, \text{ \&c.}\\ &\text{\&c.} \end{aligned}$$

Whence

$$\left.\begin{aligned} Az &= Aay+Aby^2+Acy^3+Ady^4, \text{ \&c.}\\ +Bz^2 &= Ba^2y^2+2Baby^3+Bby^4, \text{ \&c.}\\ &\quad +2Bac\\ +Cz^3 &= Ca^3y^3+3Ca^2by^4, \text{ \&c.}\\ +Dz^4 &= Da^4y^4, \text{ \&c.}\\ &\text{\&c.} \end{aligned}\right\}=y$$

Then making the homologous powers equal, $Aay=y$, and $a=\frac{1}{A}$ And $Ab+Ba^2=0$, or $b=\frac{-B}{A^3}$. Likewiſe $Ac+2Bab+Ca^3=0$, and $c=\frac{2BB-AC}{A^5}$. In like manner $Ad+Bbb+2Bac+3Ca^2b+Da^4=0$, whence $D=\frac{5ABC-A^2D-5B^3}{A^7}$; and ſo on.

EXAMP. Let $z=x+\frac{xx}{2}+\frac{x^3}{3}+\frac{x^4}{4}+\frac{x^5}{5}$, &c. to find x in a ſeries of z. Here $z=x$, $y=z$, $A=1$, $B=\frac{1}{2}$ $C=\frac{1}{3}$, $D=\frac{1}{4}$, $E=\frac{1}{5}$, &c. and $x=\frac{1}{1}z-\frac{1}{2}z^2+\frac{\frac{1}{2}-\frac{1}{3}}{1}z^3+\frac{5\times\frac{1}{6}-\frac{1}{4}-5\times\frac{1}{8}}{1}z^4$, &c. $=z-\frac{1}{2}z^2+\frac{1}{6}z^3-\frac{1}{24}z^4+\frac{1}{120}z^5$, &c. $=z-\frac{zz}{1.2}+\frac{z^3}{2.3}-\frac{z^4}{2.3.4}+\frac{z^5}{2.3.4.5}$, &c. that is, $x=z-\frac{z}{2}A-\frac{z}{3}B-\frac{z}{4}C-\frac{z}{5}D$, &c. where A, B, C, &c. are the foregoing terms with their ſigns.

Rule II. If the ſeries conſiſts of the odd powers of z, as $Az+Bz^3+Cz^5+Dz^7$, &c. $=y$, ſubſtitute the values of the coefficients A, B, C, &c. into the following form, which will give the root.

$$z=\frac{1}{A}y-\frac{B}{A^4}y^3+\frac{3BB-AC}{A^7}y^5+\frac{8ABC-A^2D-12B^3}{A^{10}}y^7+\frac{55B^4-55AB^2C+10A^2BD+5A^3C^2-A^3E}{A^{13}}y^9, \text{ \&c.}$$

For put $z=ay+by^3+cy^5+dy^7$, &c. Then

$$\begin{aligned} z^3 &= a^3y^3+3a^2by^5+3a^2cy^7\\ &\quad +3abb\\ z^5 &= a^5y^5+5a^4by^7\\ z^7 &= a^7y^7\\ &\text{\&c.} \end{aligned}$$

And

$$\left.\begin{aligned} Az &= Aay+Aby^3+Acy^5+Ady^7, \text{ \&c.}\\ +Bz^3 &= Ba^3y^3+3Ba^2by^5+3Ba^2cy^7\\ &\quad +3Babb\\ +Cz^5 &= Ca^5y^5+5Ca^4by^7\\ +Dz^7 &= Da^7y^7 \end{aligned}\right\}=y.$$

Then equating the coefficients of like terms; $Aa=1$, $Ab+Ba^3=0$, $Ac+3Ba^2b+Ca^5=0$, $Ad+3Ba^2c+3Babb+5Ca^4b+Da^7=0$, &c. whence $a=\frac{1}{A}$, $b=-\frac{Ba^3}{A}=-\frac{B}{A^4}$

Likewiſe $c=\frac{3BB-AC}{A^7}$, $d=\frac{8ABC-A^2D-12B^3}{A^{10}}$, &c.

EXAMP. Suppoſe $y+\frac{y^3}{2.3m}+\frac{3y^5}{2.4.5m^2}+\frac{3.5y^7}{2.4.6.7m^3}+$, &c. $=u$, to find y. Here $u=y$, $y=u$, $A=1$, $B=\frac{1}{2.3m}$, $C=\frac{3}{2.4.5m^2}$, $D=\frac{3.5}{2.4.6.7m^3}$, &c. Then $y=u-\frac{1}{2.3m}u^3+\frac{1}{2.2.3m^2}-\frac{3}{2.4.5m^2}\times u^5+\frac{1}{2.5}-\frac{3.5}{2.4.2.7}+\frac{1}{2.3.3}\times\frac{u^7}{m^3}$, &c. $=u-\frac{1}{2.3m}u^3+\frac{1}{2.3.4.5m^2}u^5-\frac{1}{2.3.4.5.6.7m^3}u^7+$, &c.

Rule III. When the ſeries conſiſts of any powers of z denoted by m and n, as $Az^m+Bz^{m+n}+Cz^{m+2n}+Dz^{m+3n}+Ez^{m+4n}$, &c. $=y$, then ſubſtitute the values of the coefficients, A, B, D, &c. into this form, for the root or value of z.

Put $v=\frac{y}{A}$. Then $v=v^{\frac{1}{m}}-\frac{B}{mA}v^{\frac{1+n}{m}}+\frac{m+1+2n}{2mmAA}BB-\frac{2mAC}{}v^{\frac{1+2n}{m}}-\frac{2mm+9mn+9nn+3m+6n+1}{6m^3A^3}B^3+\frac{m+3n+1}{mmA^2}BC-\frac{D}{mA}\Big\}v^{\frac{1+3n}{m}}$, &c.

For put $z=v^{\frac{1}{m}}+bv^{\frac{1+n}{m}}+cv^{\frac{1+2n}{m}}+dv^{\frac{1+3n}{m}}+$, &c. Then dividing the given ſeries by A, we have $z^m+\frac{B}{A}z^{m+n}+\frac{C}{A}z^{m+2n}$, &c. $=\frac{y}{A}=v$. Whence by involution,

$$\left.\begin{aligned} z^m &= v+mbv^{\frac{m+n}{m}}+mcv^{\frac{m+2n}{m}}, \text{ \&c.}\\ &\quad +m.\frac{m-1}{2}bb\\ \frac{B}{A}z^{m+n} &= \frac{B}{A}\times:v^{\frac{m+n}{m}}+\overline{m+n}.bv^{\frac{m+2n}{m}}, \text{ \&c.}\\ \frac{C}{A}z^{m+2n} &= \frac{C}{A}\times:v^{\frac{m+2n}{m}}, \text{ \&c.}\\ \frac{D}{A}z^{m+3n} &=, \text{ \&c.} \end{aligned}\right\}=v.$$

Then equating the coefficients, $mb+\frac{B}{A}=0$, and $b=\frac{-B}{mA}$

And $mc+m.\frac{m-1}{2}bb+\overline{m+n}.\frac{bB}{A}+\frac{C}{A}=0$, and $c=\frac{m+1+2nn}{2m^2}BB-\frac{2m}{}AC$, &c.

Note. In all theſe Rules I have only purſued theſe ſeries to a few terms; to have gone farther would have taken up too much room: but the method is viſible.

EXAMP. Suppoſe $\frac{1}{1}xx+\frac{1}{2}x^3+\frac{1}{3}x^4+\frac{1}{4}x^5$, &c. $=y$. Here $z=x$, $v=2y$, $A=\frac{1}{2}$, $B=\frac{1}{3}$, $C=\frac{1}{4}$, $D=\frac{1}{5}$, &c. and $m=2$, $n=1$. Whence $x=v^{\frac{1}{2}}-\frac{1}{3}v^{\frac{2}{2}}+\frac{5BB-4AC}{8AA}v^{\frac{3}{2}}$ &c. $=v^{\frac{1}{2}}-\frac{1}{3}v+\frac{1}{2.18}v^{\frac{3}{2}}+\frac{1}{270}v^2$, &c.

Coroll. The reverted ſeries will always be of the ſame form as the given ſeries; otherwiſe they are not convertible into one another.

SECTION VI. OF EQUATIONS.

An Equation is the mutual comparing of two equal quantities differently expreſſed with the ſign of ($=$) equality between them: thus $a+b=c-d$ is an Equation, ſhewing the equality of the quantities $a+b$, and $c-d$. See Definition XXIV.

ARTICLE I.

To turn proportional Quantities into Equations, and the contrary.

Rule. Multiply the extremes together for one ſide of the Equation, and the two means together for the other ſide thereof; or, in geometrical progreſſions, when there are but three terms, ſquare the middle term for the other ſide of the Equation. If Equations are to be turned into proportions, the procedure is juſt the reverſe, for each of the Equations muſt be divided into two factors, and thoſe produced from one ſide of the Equation muſt be made the extremes; and ſo thoſe of the other ſide will be the two means. Thus if the proportion $a:d::c:x$ be given, the Equation derived from it will be $ax=dc$. Again, if the Equation $ab+ac=ca-de$ be given, it may be transformed into theſe proportions, as $a:1::ca-de:b+c$; or as $a:ca-de::1:b+c$; or as $b-c:1::ca-de:a$; or as $b+c:ca-de::1:a$; or as $1:a::b+c:ca-de$, or as $1:b+c::a:ca-de$; or

da; or as, $ca=da$: $b+e$ :: a : d; or as $ca=da$ :: $b+e$: d. For the Equation divides into $a\times b+e=d\times ca=da$, and the factors of each ſide may be made the means or extremes at pleaſure, and alſo each factor may be either of ſuch means or extremes; for by multiplying together the means and the extremes of any of theſe proportions according to the Rule, the given Equation will be produced, which ſhews that their relation with each other has been preſerved.

ART. II. *To reduce an Equation.*

When Algebraical Queſtions are brought to an Equation, it muſt be ſo ordered that the quantity ſought may ſtand clear on the firſt ſide of the Equation, and the known quantities on the other ſide. To effect which obſerve the following directions. 1ſt. When any quantity is alike concerned on both ſides of the Equation it muſt be thrown out of both. Thus if $5x+5y=4x=d+5y$. Here $+5y$ being rejected from both ſides, the Equation becomes $5x=4x=d$: the reaſon of this is evident from Axiom the 3d. When the known and unknown quantities are both on one ſide, tranſpoſe any of them to the contrary ſide, and change its ſign. Thus is $4y+3b=ax=dy$. Then if y be the quantity ſought $=dy$ may be brought to the firſt ſide of the Equation, and $+3b$ may be carried to the ſecond ſide of the Equation, by changing their ſigns, and hence it becomes $4y+dy=ax-3b$. This is the ſame as adding $-3b+4y$ (or ſubtracting $+3b-4y$) to both ſides of the Equation; therefore, by Axioms 1, and 2. the equality is preſerved. 3d. If there be fractions in the Equation, multiply both ſides of the denominators, and it will be freed therefrom.

EXAMP. Let $\frac{a^2}{b}+c=\frac{da}{c}$. Here both ſides being multiplied by b and c (or bc) it becomes $cx^2+bc^2=bda$. This proceſs is founded on Axiom 3.

4th. When any quantity is multiplied into both ſides of the Equation (or into the higheſt term of the unknown quantity) divide the whole Equation thereby.

EXAMP. $5bx^3=3bc$. Here divide the Equation by b, and it becomes $5x^3=3c$: again divide it by 5, and x^3 will be equal to $\frac{3c}{5}$. The truth of this appears from Axiom the 4th.

5th. If the unknown quantity is affected with a ſurd, tranſpoſe the reſt of the terms, and then involve each ſide according to the index of the ſurd. Thus if $\sqrt{x^2+ax}+d=c$, by tranſpoſing d we have $\sqrt{x^2+ax}=c-d$, and by ſquaring both ſides $x^2+ax=c^2-2cd^2+d^2$, and ſo the Equation is freed from ſurds. This is plain from Axiom the 5th.

6th. When the ſide containing the unknown quantity is a pure power (or if being affected it has a rational root) then extract the root on both ſides of the Equation. Thus if $x^2=b^2+ac$, then $x=\sqrt{b^2+dc}$, which, if b, c, and d are known quantities, may be extracted in numbers, and thence the value of x will be known. So likewiſe if $x^2+6x+9=25c$, by taking the ſquare root we have $x+3=\pm\sqrt{25c}$, and by tranſpoſing 3, $x=\pm\sqrt{25c}-3=\pm 5\sqrt{c}-3$.

N. B. All theſe methods are to be uſed as occaſion requires, till the Equation be duly cleared.

EXAMPLES.

EXAMP. I. What is the value of x in this Equation $24-4x+10=60-12x$? Here $+24$ and $+10$ in the firſt ſide of the Equation being tranſferred to the other ſide, and $-8x$ in the ſecond ſide of the Equation being tranſferred to the firſt ſide, it will ſtand thus $-4x+12x=60-24-10$, viz. (by collecting the terms, See Ax 7.) $8x=26$, and by dividing both ſides by 8, $x=\frac{26}{8}=3\frac{1}{4}$.

EXAMP. II. What is the value of x in this Equation $ax+b^2=\frac{ax^2+ac^2}{a+x}$. Here, by multiplying both ſides $a+x$, we have $a^2x+ab^2+ax^2+b^2x=ax^2+ac^2$, whence (by tranſpoſition) $a^2x+ax^2+b^2x-ax^2=ac^2-ab^2$, viz. (by expunging ax^2, it being concerned with both $+$ and $-$) $a^2x+b^2x=ac^2-ab^2$, $+ab^2$, and dividing both ſides of the Equation, by a^2+b^2, we have $x=\frac{ac^2-ab^2}{a^2+b^2}$.

EXAMP. III. Let $\sqrt{a^2+x^2}=\sqrt{b^4+x^4}$ be given to find x. Here by raiſing both ſides of the Equation to the 4th power $a^4+2a^2x^2+x^4=b^4+x^4$, and by tranſpoſition, &c. $2a^2x^2=b^4-a^4$, and dividing by $2a^2$, $x^2=\frac{b^4-a^4}{2a^2}$ hence $x=\pm\sqrt{\frac{b^4-a^4}{2a^2}}$.

EXAMP. IV. Let $x=\sqrt{c^2+x\sqrt{b^2+x^2}}-c$. Here $x+c=\sqrt{c^2+x\sqrt{b^2+x^2}}$, which ſquared gives $x^2+2cx+c^2=c^2+x\sqrt{b^2+x^2}$, or $x^2+2cx=x\sqrt{b^2+x^2}$; and (dividing by x) $x+2c=\sqrt{b^2+x^2}$, which ſquared gives $x^2+4cx+4c^2=b^2+x^2$. By tranſpoſition, $4cx=b^2-4c^2$ and (dividing by $4c$) $x=\frac{b^2-4c^2}{4c}$.

ARTICLE III.

To exterminate an unknown Quantity out of ſeveral Equations.

Rule. If the quantity has but one dimenſion in the Equations, ſeek the value of the quantity to be expelled in two Equations, and put thoſe values equal to each other; or having found the value in one Equation, ſubſtitute it in lieu of ſuch quantity in the reſt of the Equations. Proceed thus with another unknown quantity. But if the quantity to be exterminated be of ſeveral dimenſions, find the value of its higheſt power in two Equations; then if the coefficients are not the ſame, multiply the leſs ſo that it may become equal to the greater. Then put theſe values equal to each other, and there will come out a new Equation, with a leſs power of the unknown quantity: and by repeating the operation, the quantity will at length be taken away.

EXAMPLES.

EXAMP. I. Given $7x=5y=28$, and $3x+5y=55$ to find x and y. 1ſt. Let y be exterminated. In the firſt Equation the value of y is $\frac{7x=28}{5}$, which is found by tranſpoſition and diviſion. In the ſecond Equation its value (in like manner) is found $=\frac{55-3x}{4}$. Theſe being put equal to each other, we have $\frac{7x-28}{5}=\frac{55-3x}{4}$, an Equation wherein only x is concerned. Multiply this Equation by 4 and 5 (or by their product $=20$) or, which is the ſame thing, multiply the numerators and denominators croſs wiſe, and we have $28x-112=275-15x$. By tranſpoſition $43x=387$, and by diviſion, $x=\frac{387}{43}=9$; which ſubſtituted in either of the given Equations inſtead of x, the value of y then will appear. Thus if it be ſubſtituted in the ſecond Equation, $27+4y=56$, and by tranſpoſition and diviſion $y=\frac{55-27}{4}=7$.

EXAMP. II. Let it be required to find the values of x, y, and z, in the three following Equations, viz. $x+y=17$; $x+z=18$; and $y+z=19$. Here, by ſubtracting the firſt Equation from the ſecond (in order to exterminate x) we have $z-y=1$, and this added to the third Equation, y is alſo exterminated; and there is found $2z=20$, and conſequently $z=10$, and $y\,(=z-1)=9$, and $x\,(=17-y)=8$.

EXAMP. III. Let there be given $x+y=a$; and $x^2+y^2=b$ to expunge x. Here by the firſt Equation $x=a-y$, and therefore $x^2=a-y\,|^2$, which being wrote in the other Equation inſtead of x^2 we have $a-y\,|^2+y^2=b$; viz. $a^2-2ay+y^2+=b$; and therefore $y^2-ay=\frac{b-a^2}{2}$; a Quadratic Equation, wherein y is the only unknown quantity.

ART. IV. *Of the Nature and Compoſition of Equations, containing different Dimenſions of the ſame unknown Quantity.*

In the laſt Article I have ſhewn the method of freeing Equations from any unknown quantity, whereby two or more Equations are reduced to one, containing only one unknown quantity, the value of which, when it is a ſimple Equation, I have alſo ſhewn how to find; but it will often happen that the remaining quantity will be of ſeveral different dimenſions in the Equation, and then ſuch Equation is called a Quadratic, a Cubic, Biquadratic, &c. according to the dimenſions of the higheſt power. To manage Equations of this kind, ſo as to diſcover the Root or value of the unknown Quantity concerned, will be treated of in the following Articles of this Section, after having here explained the nature and compoſition of ſuch Equations.

All Equations may be conſidered as compounded of thoſe of a lower order: thus if $x-b=0$, which is a ſimple Equation, be ſquared, there ariſes $x^2-2bx+b^2=0$, a Quadratic; if cubed, we have $x^3-3bx^2+3b^2x-b^3=0$, a Cubic Equation; &c. It is, however, but ſeldom that Equations occur in this regular form, for the coefficients of the terms will generally be greater or leſs than are aſſigned by the involution of one quantity $x-b$, and therefore in general a Quadratic is a compound, derived from $x-b$, $\times x-c$; a Cubic from $x-b\times x-c\times x-d$; a Biquadratic from $x-b\times x-c\times x-d\times x-e$, or from a Quadratic ſquared, &c. But the letters b, c, d, &c. may be affirmative, or ſome may be affirmative and others negative, whereby different ſigns will be produced in the Equations anſwerable to all Caſes.

In an Equation of this ſort, the whole being equal to nothing, it is obvious that at leaſt ſome or other of the factors $x-b$, $x-c$, $x-d$, &c. ſhould be equal to nothing; or the Equation (which is their product) could not be ſo. It is alſo evident, that any ſuch Equation may be divided by its factors till there remains only one factor; and as each of the inferior Equations obtained by ſuch diviſion muſt ſtill be equal to nothing, whatever factor was the diviſor, it follows that each of theſe factors are themſelves equal to nothing; and therefore b, c, d, e, &c. exhibit ſo many different values of x, with contrary ſigns; and hence every Equation has as many Roots as there are dimenſions of the unknown quantity in its higheſt power; and where b, c, d, e, &c. are found negative, x is affirmative; and where any of theſe are affirmative, x is negative.

negative. By multiplying the factors or Roots together, under different signs, it is obſervable, that when b, c, d, &c. are all negative, or, which is the ſame thing, when all the values of x are affirmative, the ſigns in the Equation run + and — alternately; but when there is a negative Root, one affirmative quantity will follow another; wherefore there will be as many affirmative roots in the Equation as there are changes of the ſigns from + to —, and from — to +, and all the reſt will be negative.

Theſe obſervations, however, are only applicable when all the Roots are poſſible. A Root is impoſſible, or imaginary, when b, c, d, &c. denote the Square, or other even Root, of a negative quantity; and when an Equation is wholly derived from ſuch Roots, it is an impoſſible Equation; if there be one poſſible Root, the Equation will admit of one poſſible anſwer. But in applying Algebra, there will frequently be other limitations peculiar to the ſubject, whereby but one Root only will be capable of ſatisfying the enquiry, even when the reſt of the Roots are both poſſible and affirmative

From the multiplication of the Roots, or Factors, it is further evident, and worthy of notice, that the coefficient of the ſecond term is the ſum of all the Roots with contrary ſigns; the coefficient of the third term is equal to the ſum of the Rectangles of thoſe Roots, or of all the products that can poſſibly ariſe by compounding them two and two: the coefficient of the fourth term is equal to the ſum of all the products that can poſſibly ariſe by the combination of them three and three, &c. and ſo on; and the laſt term is always equal to the product of all the Roots with contrary ſigns.

Theſe things being premiſed, I proceed to ſhew how to find the Roots of Equations, and ſhall begin with Quadratics.

ART. V. *Reſolution of Quadratic Equations.*

The following eaſy, conciſe, and comprehenſive method of ſolving Quadratic Equations, I believe is not in any other Treatiſe on the Subject; its advantage, however, over every other mode, will at once be obvious to thoſe who are the leaſt converſant in Algebra.

If it be a pure Quadratic, as $x^2 = b^2$, or $x^2 - b^2 = 0$, it is produced from the Rectangle of $x-b$ and $x+b$, and therefore it has one Root affirmative and the other negative; and the affirmative Root is equal in number to the negative Root. The Root in this caſe is had by extracting the Square Root of the number denoted by b^2. Thus if $x^2 + = 576$, then $x = \pm\sqrt{576} = \pm 24$.

All other Quadratics are comprehended under ſome or other of the following forms, viz. $x^2 + 2bx = \pm d = 0$; or $x^2 - 2bx \pm d = 0$; or $2bx - x^2 \pm d = 0$; and this laſt form by tranſpoſing (or changing the ſigns) becomes the ſame as the ſecond form, ſave that the affirmative Roots are changed into negative ones, and the negative ones into affirmative ones; wherefore it will be ſufficient to conſider the two other forms as applicable to all; and in attempting their ſolution, it will be more commodious to tranſpoſe d, and then they will ſtand thus: $x^2 + 2bx = \pm d$, and $x^2 - 2bx = \pm d$. Now if to each of theſe Equations we add $+b^2$, (the ſquare of $\frac{1}{2}$ the coefficient of the ſecond term) we ſhall have in the former caſe $x^2 + 2bx + b^2 = \pm d + b^2$; and in the latter, $x^2 - 2bx + b^2 = \pm d + b^2$; and by extracting the Square Roots, the Equations become $x + b = \sqrt{\pm d + b^2}$, and $x - b = \sqrt{\pm d + b^2}$ reſpectively; and x in the former caſe $= \sqrt{\pm d + b^2} - b$, and in the latter $= \sqrt{\pm d + b^2} + b$, which expreſſions give the affirmative values of x: but the Square Roots of the above Equations may alſo be $= -x - b = -\sqrt{\pm d + b^2}$, and $-x + b = -\sqrt{\pm d + b^2}$ reſpectively; and therefore x in the former caſe $= -\sqrt{\pm d + b^2} + b$, and in the latter $= -\sqrt{\pm d + b^2} - b$. That is, if B be put $= \sqrt{\pm d + b^2}$ where d is + or —, according as it is + or — in the ſecond ſide of the given Equation, then, in the firſt caſe, where $x^2 + 2bx = \pm d$, the values of $\pm x$ are $\pm B \mp b$, where b is — or +, according as x is affirmative or negative; and in the ſecond caſe, where $x^2 - 2bx = \pm d$, the values of $\pm x$ are $\pm B \pm b$, where b is + or —, as x is + or —.

EXAMPLES.

EXAMP. I. Let $x^2 + 6x = 2295$ required x. Here $b = 3$, and $2295 = +d$; and $\sqrt{+d + b^2} = \sqrt{2295 + 9} = 48 = B$, and $\pm B \mp b = \pm 48 \mp 3 = +45$ and -51 for the two values of x.

EXAMP. II. Let $x^2 - 6x = 1755$ be given to find the values of x. Here $b = 3$, and $1755 = +d$, and $\sqrt{+d + b^2} = 42 = B$, and $\pm x = \pm B \mp b = \pm 42 \mp 3 = +45$ and -39, the values ſought.

EXAMP. III. Let $x^2 - 11x = -28$. Here $b = 5\frac{1}{2}$, and $-28 = -d$; alſo $b^2 = 30\frac{1}{4}$. and $\sqrt{-d + b^2} = \sqrt{-28 + 30.25} = \sqrt{2.25} = 1.5 = B$; and $\pm B \pm b = \pm 1.5 \pm 5.5 = +7$ and $+4$ the two values of x, which in this caſe are both affirmative.

EXAMP. IV. Let $24x - x^2 = 135$, required x. This Equation being wholly tranſpoſed $x^2 - 24x = -135$. Here $b = 12$; and $-135 = -d$. and $\sqrt{-d + b^2} = \sqrt{-135 + 144} = \sqrt{9} = 3 = B$; and $\pm B + b = \pm 3 + 12 = +15$ and -9 the two Roots; but the Equation having been tranſformed, the ſigns muſt be changed, and ſo $+9$ and -15 are the Roots required. When d is negative, and greater than b^2, the Roots are impoſſible.

EXAMP. V. Given $x^2 - 10x = -32$. Here $b = 5$, and $-32 = -d$, and $B = \sqrt{-d + b^2} = \sqrt{-32 + 25} = \sqrt{-7}$. and therefore the Roots are impoſſible, and the Equation is an impoſſible Equation.

ART. VI. *To increaſe or diminiſh the Roots of an Equation.*

Rule. For the unknown quantity ſubſtitute a new letter;—the given increment, or + the given decrement; and ſubſtitute the powers thereof in the Equation inſtead of the unknown letter.

EXAMPLE.

Let the Roots of this Equation $x^3 + x^2 - 10x + 8 = 0$ be increaſed by 2. Let $x + 2 = z$, or $z - 2 =$, then $x^3 = \overline{z-2}^3$; $x^2 = \overline{z-2}^2$, and $-10x = -10 \times z - 2 = -10z + 20$, then the powers of x being actuallly involved, and the ſeveral terms collected, we have $x^3 + x^2 - 10x + 8 = z^3 - 5z^2 - 2z + 24 = 0$, where the roots of z are greater than thoſe of x by 2.

SCHOLIUM. By this Rule all the negative Roots of an Equation may be made affirmative, by increaſing them with a proper quantity.

ARTICLE VII.

To multiply or divide the Roots of an Equation by a given Quantity.

Rule. Aſſume a new letter, and divide or multiply it by the given number, and ſubſtitute its powers in the Equation inſtead of the unknown quantity.

EXAMPLE.

Let the Roots of the Equation $x^3 - 2x + \sqrt{3} + 0$ be divided by $\sqrt{3}$. Here by putting $x = y\sqrt{3}$, and ſubſtituting it in lieu of x in the given Equation, there ariſes $3y^3\sqrt{3} - 2y\sqrt{3} + \sqrt{3} = 0$. =(by dividing by $\sqrt{3}$) $3y^3 - 2y + 1 = 0$, for the Equation required.

Hence by this Rule fractions or ſurds may be taken out of an Equation; by dividing the new letter by the common denominator; or by multiplying the new letter by the Surd quantity.

ART. VIII. *To complete a deficient Equation.*

Rule. Increaſe or diminiſh the Roots of the Equation by ſome given quantity, as ſhewn in Art. VI.

EXAMP. Let $x^3 + x - 3 = 0$. Here the Equation is deficient, the 2d term being wanting. Suppoſe $z + 1 = x$, then $x^3 = z^3 + 3z^2 + 3z + 1$; this added to x $(= x + 1) - 3$, we have $z^3 + 3z^2 + 4z - 1 = 0$, a complete Equation, in which the roots are each leſs by 1 than in the given Equation.

ART. IX. *To take away any Term out of an Equation.*

Rule. Take a new letter for the root, to which add an unknown quantity, and ſubſtitute this ſum and the powers thereof in the given Equation; then any term, or any of thoſe quantities wherein the new letter is of the ſame power, being put into an Equation, and made equal to nothing, will give the value of the unknown quantity, which being put into the Equation with the new letter, the power of the new letter, which was ſo equated, will vaniſh.

EXAMPLES.

Suppoſe $x^4 - 3x^3 + 3x^2 - 5x - 2 = 0$. Put $y + e = x$

Then $x^4 =$	y^4	$+4y^3e$	$+6y^2e^2$	$+4ye^3$	$+e^4$
$-3x^3 =$		$-3y^3$	$-9y^2e$	$-9ye^2$	$-3e^3$
$+3x^2 =$			$+3y^2$	$+6ye$	$+3e^2$
$-5x =$				$-5y$	$-5e$
$+2 =$					$+2$

Then, if the ſecond term is to be taken away, we have $4y^3e - 3y^3 = 0$; and dividing by y^3, $4e - 3 = 0$, or $e = \frac{3}{4}$, which, if ſubſtituted in the room of e, the ſecond term will vaniſh: if the 3d term is to be taken away, we have $6y^2e^2 - 9y^2e + 3y^2 = 0$, and dividing by y^2, $6e^2 - 9e + 3 = 0$, from which Quadratic Equation e may be determined: in like manner the 4th term may be taken away by ſolving a Cubic Equation; the 5th by ſolving a Biquadratic, &c.

SCHOLIUM. From the above proceſs it appears, that when the ſecond term is to be taken away, the value of e is obtained by dividing the coefficient of that term by the index of the higheſt power in the given Equation, ſeeing that the coefficient of the ſecond term of the nth power of a Binomial is n. And this is the moſt uſeful caſe, the reſt being too tedious to be of real ſervice in finding the roots.

ART. X. *To reſolve or extract the Root of a Cubic Equation.*

Rule. Take away the ſecond term of the Equation as by the laſt Article, and then it will be in this form, $x^3 + ax = b$, and this general expreſſion $\sqrt[3]{\frac{b}{2} + \sqrt{\frac{b^2}{4} + \frac{a^3}{27}}} - \sqrt[3]{\frac{\frac{1}{2}a}{\frac{b}{2} + \sqrt{\frac{b^2}{4} + \frac{a^3}{27}}}}$ will give the value of x.

EXAMP. Let $y^3 + 3y^2 + 9y = 13$. Here, to deſtroy the 2d Term, put $x - 1 = y$, ſo ſhall $\overline{x-1}^3 + 3\overline{x-1}^2 + 9\overline{x-1} = 13$, or (by involving the terms, &c.) $x^3 + 6x = 20$. Therefore $a = 6$, and $b = 20$; and theſe values ſubſtituted in the above form, we have $\sqrt[3]{10 + \sqrt{100 + 8}} - \frac{2}{\sqrt[3]{10 + \sqrt{100 + 8}}} = \sqrt[3]{20.392} - \frac{2}{\sqrt[3]{20.392}} = 2.732 - .732 = 2 = x$, but $x - 1 = y$, by ſubſtitution, and therefore $y = 1$.

SCHOLIUM. The above Rule will as equally hold good when b and a are either or both of them negative. But when a is negative, and $\frac{1}{27}a^3$ is greater than $\frac{1}{4}b^2$, the Equation by this Rule will be impoſſible, except when the Surd Cubic Root can be extracted; for then the irrational quantities in different parts of the Equation will deſtroy one another, and vaniſh. But this Rule is only calculated to ſolve Equations comprehending one real Root, and two impoſſible ones. It is generally known by the name of *Cardan's* Rule; but M. de Montucla, in his Hiſtory of Mathematics, has proved that *Cardan* was not the inventor of it. *Scipio Ferreus*, and *Nicholas Tartalea*, did each diſcover it, independently of one another, and at or about the ſame time.

I might further lay down particular rules for the accurate ſolution of Biquadratic and other higher Equations; but they are all more curious than uſeful; and the method of approximating the Roots of Equations, of which I ſhall treat in the next Article, has the deſerved pre-eminence above all others, as well on account of its diſpatch, as of its elegance and univerſality.

ART. XI. *To approximate the Roots of Equations in general.*

Rule. Chooſe ſome number at pleaſure to denote the unknown quantity, and apply it to the given Equation, by which it will be diſcovered whether ſuch number be too big or too little. If it widely differs from the true value, try another number that approaches nearer; and, by a few trials in this manner, a number will ſoon be found that approaches pretty near the true value. Then aſſume ſome letter, as v, to denote the defect or exceſs of the number ſo found, and put that number $+$ or $-$ v inſtead of the unknown quantity in the Equation, by which a new Equation will be had, affected only with v, and known quantities; wherein all the terms that contain two or more dimenſions of v may be rejected as inconſiderable in reſpect of the reſt. This done, the value of v will be found by a ſimple Equation, which, added to or ſubſtracted from the ſaid number, according as it was taken too little or too big, will give a number ſtill nearer the truth. With this number and the letter v proceed as before, to find another value of v, which muſt be applied as above; repeat the operation till the quantity, which was unknown, be determined to a ſufficient degree of accuracy.

EXAMPLE.

Let $x^3 + 24x = 587814$, to find x. By a few trials it will be found that x is ſomething above 80; therefore let $80 + v = x$; then $x^3 = 512000 + 19200v + 1680v^2 + v^3$, and $24x = 1920 + 24v$. Therefore (rejecting thoſe terms affected with v^2 and v^3, $513920 + 19224v = 587914$, and $v = \frac{587914 - 513920}{19224} = \frac{73994}{19224} = 3.8$: this added to 80 gives 83.8 for the approximate value of x: this being ſubſtituted in the Equation, it will be found too great; therefore, for another operation, take $83.8 - v = x$, and $x^3 = 588480.472 - 21067.32v$, and $24x = 2011.2 - 24v$, and conſequently $590491.672 - 21091.32v = 587914$, and $v = \frac{2577.672}{21091.32} = 0.1222$ nearly. Hence $x = 83.8 - 0.1222 = 83.6778$. true to five figures, and the 6th being only too much by two.

The operation repeated, will give the anſwer true to eleven figures. But when five or ſix figures of the Root have been obtained, and ſtill more exactneſs is requiſite, it will ſhorten the operation to ſeek a correction for v inſtead of one for the whole Root, which will be had by ſubſtituting the laſt value of $v +$ or $=$ (new) v, inſtead of the laſt v in the Equation, including all the powers of the laſt v; but (in the Equation thence ariſing) rejecting thoſe of new v as before.

Thus, in the laſt Example, the whole Equation including the terms affected with v^2 and v^3 is $513920 + 19224v + 1680v^2 + v^3 = 587914$, or $19224v + 1680v^2 + v^3 = 73994$, and in this Equation putting $3.8 = v$ inſtead of v, and rejecting the terms of v^2 and v^3 as before, a correction will be obtained for the laſt found v, which will give the anſwer as above. In like manner a ſecond or a third, &c. correction may be found to any degree of accuracy. This Rule doubles the number of figures true in the Root at each operation. If the term wherein v^2 is found to be retained, v will be had by ſolving a Quadratic, and then treble the number of figures will be had each time; wherefore, if the firſt figure only be taken true, nine or ten figures will be had at two operations.

From this principle may be deducted various Theorems for ſolving particular Equations, as well as general formulas adapted to all, of which I will give an inſtance or two, and then conclude the Article.

Let r be a number taken near to the true Root; and v (as before) $=$ its exceſs or defect. Now if $x^2 + bx = c$ be a quadratic, then $r \pm v = x$, and $x^2 = \overline{r \pm v}^2 = r^2 \pm 2rv + v^2$; and $bx = br \pm bv$; hence $r^2 + br \pm 2r + b \times v + v^2 = c$, and by tranſpoſition and diviſion $v = \frac{c - r^2 - br}{\pm 2r + b + v}$, which is a general formula for all quadratics, obſerving that when b is negative in the given Equation, that is, when the 2d term is negative, then $-br$ in the numerator becomes $+br$, and $+b$ in the denominator become $-b$: alſo, if the given Equation be $x^2 = c$, then $b = 0$, and thoſe terms wherein it is concerned, will vaniſh, and the expreſſion will be $\frac{c - r^2}{\pm 2r + v}$ which is the common Rule for extracting the Square Root, only it is uſual to take r leſs than juſt, and ſo the negative ſign is excluded from the denominator. To give an Example of this method,

Let $x^2 + 6x = 61495 = c$. Here by trial it will be found that x is above 200: therefore let $200 = r$; then $-b = r - 1200$; and $c - r^2 - br = 20295$. The method of performing the diviſion is as follows:

OPERATION.

$$\begin{array}{l} 2r + b = 406 \\ v' = 40 \\ 2r + b + v' = 446 \end{array} \Big) \begin{array}{l} 20295 \\ 1784 \\ 2455 \\ 2155 \end{array} \Big(\begin{array}{l} 45 = v, \text{ and } r + v = 200 - 45 = 245 = x. \\ \\ \\

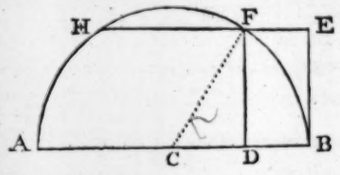
SECTION VI.
CONSTRUCTION OF EQUATIONS.

When in the Solution of an Equation ſtrict accuracy is not required, the anſwer may be determined geometrically, by drawing right lines or curves after ſuch a manner, as, by their interſections, ſhall limit and determine its Roots: but ſince the extraction of Roots by approximation has been brought to ſuch perfection, ſo that either a few, or as many figures as one pleaſes, may be readily obtained, Geometrical Conſtructions have, in a great meaſure, been laid aſide, particularly in Equations of high dimenſions, where recourſe muſt be had to the Conic Sections, and other Curves ſtill more difficult to delineate; as the trouble in ſuch caſes would be almoſt infinite, and at laſt fail of producing a correct anſwer.

I ſhall therefore only give the conſtruction of Quadratic and Cubic Equations, which may be done without much pains by means of a Circle, paſſing over thoſe of the higher orders, as well as thoſe of ſimple Equations, for which no preciſe Rule can be given; but the methods will be different according as the unknown quantity is differently entangled with others, and the aſſiſtance alſo of Geometrical Propoſitions, too various to enumerate here, are frequently called in.

ART. I. *To conſtruct Quadratic Equations.*

PROBLEM 1. To extract the Square Root, or to find Root or ſide of a given Square, as x in this Equation, $x^2 = nm$. Rule. The given quantity being divided into two factors, as n take AD = one factor (n) and AB = the other (m;) divide AB equally in c, and from thence as a center deſcribe the ſemicircle AFB; erect from D, a perpendicular to AB, and DF will be equal to x; for by the Property of the Circle, AD ($=n$) × DBx ($=m$) = FD^2, and therefore DF $= x$.



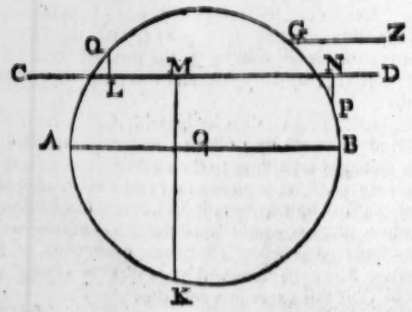
PROB. 2. To conſtruct a Quadratic of this form, $x^2 \pm bx = cd$. Rule. Find the Side of a Square equal to the rectangle cd by the laſt Problem, which call n, then from any point C in a line AB drawn at pleaſure, ſet off, to the right, CD = $\frac{1}{2}b$, b is affirmative: but to the left if b is negative; erect a perpendicular from D, and take DF = n, then from C as a center, with the Radius CF deſcribe the Circle AFB, ſo will BD and DA be the two Roots, that to the righthand of D being affirmative, and that to the left negative.

PROB. 3. To conſtruct a Quadratic Equation of this kind, namely, $x^2 \pm xb = -nn$. Rule. Here the given Quantity $-nn$ being divided into two equal factors (but of contrary affections) by Problem 1, namely, $+n$ and $-n$, let a circle be deſcribed from any point C as a centre in the right line AB: with the radius = $\frac{1}{2}b$, erect a perpendicular at B, on the right, if it be $+b$ (but, at A on the left of it is $-b$;) take BE = n; through E draw EFH parallel to AB, interſecting the Circle in F and H, ſo will EF and EH be the two roots required, which if they lie towards the right of E are affirmative; but if towards the left, they are negative.

N. B. If the parallel does not cut the circle or touch it, the Equation is impoſſible.

ART. II. *To conſtruct Cubic Equations.*

Let the Equation be $x^3 \pm px^2 \pm qx = r$; to conſtruct which, obſerve this Rule, with the Radius $\frac{2}{3}\sqrt{p, -3q}$, deſcribe the Circle BGAK (as in the following figure) drawing the diameter AB and CD parallel thereto, above or below the ſame, at the diſtance of $\frac{1}{2}p$, according as p is + or −; then draw ZG parallel to AB, and above or below it at the diſtance of $\frac{9r - pq}{p^2 - 3q} + \frac{2}{3}p$, as the ſame diſtance ſhall be an affirmative or negative quantity; cutting the Circle in G. Alſo take the arch BP = $\frac{1}{3}$ BG, and let PQ, QK and KP divide the whole Circle into three equal parts. Let fall the perpendiculars QL, KM and BN upon the line CD, and they will be the Roots of the Equation; thoſe which are affirmative being above the line, but thoſe which are negative below it.



SCHOLIUM. This method ſuppoſes all the Roots real, and therefore, when $3q$ is greater than p^2 (which will be the caſe where there are impoſſible Roots) the conſtruction is impoſſible. Likewiſe, if $p = 0$, OB will be $= \frac{1}{3}\sqrt{-3q}$, and CD will coincide with AB, and the diſtance ZC from AB $= -\frac{3r}{q}$; and if q is affirmative, the caſe is impoſſible.

SECTION VII.
LIMITS OF EQUATIONS, INDETERMINATE PROBLEMS, &c.

ART. I. *To find the Limits of Equations.*

When an Equation contains ſeveral unknown quantities, it will admit of an infinite number of Solutions, if both fractional and negative numbers are admitted; for all of them, except one, may be taken at pleaſure, and their value being aſſigned and ſubſtituted in the Equation, that ſingle quantity will be determined. However, ſometimes queſtions are ſo propoſed as not only to exclude negative quantities, but fractional quantities alſo; and an Equation under ſuch circumſtances will be confined to a determinate number of Solutions; for the unknown quantities will have certain limits or bounds, without which, if they be taken, they will not anſwer the condition of the caſe in hand. To aſſign thoſe limits is the buſineſs of this Article.

CASE I. *When ſeveral unknown Quantities are in one Equation, to find their Limits.*

Rule. Tranſpoſe the negative Quantities to the contrary ſide, that all the terms may be affirmative; then to find the limits of any one quantity, ſuppoſe all the reſt to vaniſh in the Equation, and ſo the value of that one will become determinate, and will be one limit thereof. And to know which limit it is, ſuppoſe the other quantities to increaſe, and become of ſome certain value: then if, by this procedure, the value of the unknown quantity under conſideration increaſes, it is the leaſt limit; but if it decreaſes, it is the greateſt.

This Rule includes fractional Quantities. If, however, fractional Quantities are to be excluded, then, inſtead of ſuppoſing the other Quantities to vaniſh, put each of them = 1, and an Equation will be had from which the limit of the remaining quantity will be determined as before. Proceed in the ſame manner to find the limits of the reſt of the unknown Quantities.

EXAMP. Let $4x + 5y = 67$, to find the limits of x and y, including fractions. Let $y = 0$, or be ſuppoſed = to vaniſh, and then $4x = 67$, and $x = 16\frac{3}{4}$. Now let y be ſuppoſed = to ſome quantity, and then it is plain, that while y increaſes, x decreaſes; therefore $16\frac{3}{4}$ is the greater limit; whence x is leſs than $16\frac{3}{4}$.

If $x = 0$, then $5y = 67$, and $y = 13\frac{2}{5}$. If now x be ſuppoſed to increaſe, it is plain y will decreaſe, and therefore $13\frac{2}{5}$ is the greater limit of y. Whence y is leſs than $13\frac{2}{5}$; and the leſs limit of both x and y is 0.

Again, let the ſame be propoſed, excluding fractions; then to find a limit for x, put $y = 1$, and the Equation becomes $4x + 5 = 67$; or $4x = 62$, $x = 15\frac{1}{2}$, its greater limit; viz. x is leſs than $15\frac{1}{2}$. Alſo by putting $x = 1$, we have $5y + 4 = 67$, or $5y = 63$, and $y = 12\frac{3}{5}$; and hence y is leſs than $12\frac{3}{5}$; the leſs limit of both x and y is 1, viz. neither x nor y can be leſs than 1.

CASE II. *When Three or more unknown Quantities are in two Equations, to determine their Limits.*

Rule. Having pitched upon a quantity to be limited, expunge one of the other quantities, and there will be had one limiting Equation. Then do the ſame with another unknown quantity, and there will be had another limiting Equation; from each of which Equations find a limit for the quantity pitched on.

EXAMP. Let $v + y + z = 56$, and $32x + 20y + 16z = 1232$, to limit x. Firſt. In order to exterminate y, multiply the firſt Equation by 20, and there will be $20x + 20y + 20z = 1220$. Subſtract this from the ſecond Equation, and $12x - 4z = 112$. Then (excluding fractions) the leſs limit of x in this Equation is $9\frac{4}{7}$.

Again, to exterminate z, multiply the firſt Equation by 16, and ſubſtract the product from the ſecond Equation, and you will have $16x + 4y = 336$. And the greater limit of x in this Equation, is $20\frac{1}{4}$. Hence x is greater than $9\frac{4}{7}$, and leſs than $20\frac{1}{4}$. In like manner may y and z be limited; and ſo alſo for any other Equation.

SCHOLIUM. When the numbers are ſought by two Equations, all the values of each of them, in whole numbers, make three ſeries of Arithmetical Progreſſion, taken within their proper limits.

ART. II. *Of indeterminate Problems.*

LEMMA. Let $\frac{ax \pm b}{c}$ be an Algebraic Fraction in its loweſt terms; x being indeterminate, and a, b, and c, being given whole numbers; then the leaſt integer for the value of x, that will alſo cauſe the value of the ſaid Fraction to be an integer, will be found by the following method.

Divide the denominator (c) by the coefficient (a) of the indeterminate quantity; alſo divide the diviſor by the remainder, and the laſt diviſor, again, by the laſt remainder, and ſo on till an unit only remains. Write down all the quotients in a line as they

they follow, under the first of which write an unit, and under the second write the first; then multiply these two together; and having added the first term of the lower line (or an unit) to the product, place the sum under the third term of the upper line; multiply in like manner the next two corresponding terms of the two lines together, and having added the second term of the lower to the product, put down the result under the fourth term of the upper one. Proceed on in this way till you have multiplied by every number in the upper line. Then multiply the last number thus found by the absolute quantity (b) in the numerator of the given fraction, and divide the product by the denominator; so shall the remainder be the true value of x required, provided that the number of terms in the upper line be even, and the sign of b be negative; or that the number be odd, and the sign of b be affirmative; but if the number of terms be even, and the sign of b be affirmative, or *vice versa*, then the difference between the said remainder and the denominator of the fraction will be the true answer.

N. B. In this method it is supposed that a is less than c, and that they are prime to each other; for were they to admit of a common measure, whereby b is not divisible, no integer could be assigned for x, so as to give the value of $\frac{ax+b}{c}$ an integer.

EXAMP. Let the given quantity be $\frac{71x+10}{89}$, then the operation will stand as below.

71) 89 (1	1	3	1		Quotients
18) 71 (3	1	1	4	5	
17) 18 (1				10 = b	
1				50 *Product.*	

Now if the Product (50) be divided by 89, the remainder is 50, which is therefore = the least value of x.

QUEST. I. Required the least whole number, which, being divided by 17, shall leave a remainder of 7; but, if divided by 26, the remainder shall be 13? Here let x = the quotient by 17, and then will $17x+7$ = the number sought: also, since this number, when 13 is subtracted from it, is divisible by 26, it follows, that $\frac{17x+7-13}{26}$ or $\frac{17x-6}{26}$ must be a whole number, from which fraction x will be found by the above lemma = 8; and consequently $17x+7=143$ is the number sought.

QUEST. II. Given $24x-13y=16$ to find the least value of x and y in whole numbers. Here by transposing $-13y$, and dividing by 24, we have $x=\frac{13y+16}{24}$; and by the lemma, the least value of y in the fraction = 8: and therefore the least value of $x=5$.

QUEST. III. How many different ways is it possible to pay 100*l*. in guineas and pistoles only; a guinea being 21*s*. and a pistole 17*s*? Put x = number of guineas, and y = number of pistoles; then $21x+17y=(100\times 20)=2000$ by the question; and therefore $x=\frac{2000-17y}{21}=95+\frac{5-17y}{21}$, = a whole number; and therefore (by transposition) $\frac{17y-5}{21}$ is also a whole number; whence by the lemma, the least value of y is 4; and therefore the corresponding or greatest value of $x=92$. Now to find the least value of x and the greatest value of y, take the value of y in terms of x; and $y=\frac{2000-21x}{17}=117-x-\frac{4x+11}{17}=$ a whole number; and therefore $\frac{4x-11}{17}=$ a whole number, and by the lemma, the least value of x is 7, and the corresponding or greatest value of $y=109$: now since the several values of x are, as is evident, in an arithmetical progression, whose common difference is 17, and those of y in a like progression, whose common difference is 21, the intermediate values of x and y are easily determined, and are as under:

$x=92,\ 75,\ 58,\ 41,\ 24,\ 7.$
$y=\ 5,\ 26,\ 46,\ 67,\ 88,\ 109.$

N. B. Having found the greatest value of either of the unknown quantities, the least value thereof may be more readily obtained thus: Divide the greatest value by the co-efficient of the other unknown quantity, and the remainder will be the least value. Also the quotient + 1 will be the number of answers.

This however supposes the co-efficients to be prime to each other; and, therefore, when they are not so, the Equation must be reduced by dividing by the greatest common measure.

QUEST. IV. The reckoning of a certain number of men and boys came to 23 shillings; to the defraying of which each man paid 3*s*. 6*d*. and each boy 1*s*. 6*d*. What number of men and boys were there in company?

Let x = the number of men, and y = the number of boys; then $7x+3y=46$ per question, and $x=\frac{46-3y}{7}=6-\frac{3y+4}{7}$ = a whole number; and therefore $\frac{3y-4}{7}$ = a whole number; whence the least value of y is 6, and consequently the greatest value of x is 4; and this, divided by 3, leaves a remainder of 1 for the least value of x, and 13 is the corresponding value of y. Also the quotient $+1=2$, which shews that there are no more ways of paying the reckoning. But as the question supposes a plurality, both of men and boys, the two former numbers only can satisfy the demand. Hence, there were 4 men and 6 boys.

QUEST. V. Required the least integer, which being divided by 4, 5, and 6, there shall remain 1, 2, and 3, respectively.

Here let x = the quotient by 4, then $4x+1$ will be the required number; and, by the second condition of the questions $\frac{4x+1-2}{5}=\frac{4x-1}{5}$ = whole number; then by the lemma $x=4$; and $4x+1=17$ = the least whole number that will answer the two first conditions. Now the least whole number that is divisible by 4 and 5, will (as they are prime to each other) $=4\times 5=20$; then since the required number, by the nature of the question, must be some multiple of 20 increased by 17, it is evident that it may be represented by $20y+17$; and this number, less 3, is also divisible by 6; therefore $\frac{20y+17-3}{6}$ is a whole number; viz. $3y+2+\frac{2y+2}{6}=$ a whole number; and therefore $\frac{2y+2}{6}$, or $\frac{y+1}{3}=$ a whole number; and, by the lemma, the least value of y is 2; and consequently, $20y+17=57$ = the least whole number; which being divided by 4, 5, and 6, respectively, will leave the given remainders 1, 2, and 3. In like manner the method may be extended to any number of divisors and given remainders, by proceeding step by step, till a number is found that will answer the whole; and consequently the same will be applicable in the solution of indeterminate Equations, where three, four, or more quantities, are concerned. But when the number of the unknown quantities exceed the number of Equations by more than one, the limits of the quantities must be found by Art. I. of this Section; and then the values of some unknown quantity must be assumed, at repeated operations, = to the successive numbers between its least and greatest limits; and so all the values of the rest of the unknown quantities will be determined by the preceding methods; viz. for instance, if there be three unknown quantities in one Equation, and if it is found that a quantity cannot exceed 10, nor be less than 1, assume its value = 1, and then the Equation will be reduced to two unknown quantities, to be determined as hath been already shewn. This done, assume its value, = 2, and determine the rest as before: then put 3 for its value, add so on, till at the numbers from its least to its greatest limits are exhausted. The sum of all the answers thus obtained, will exhibit all the possible ways by which the question can be solved.

ART. III. *Of rational Square and Cube Numbers.*

For questions of the following nature no certain rule can be given, but the methods of solving them, as well as those of some others that come under the last Article, rest chiefly in the invention of the Artist, whose penetration and sagacity alone must suggest what steps will be requisite to accomplish the end of his enquiries. On this account, I shall only lay down some general observations, with a few examples by way of illustration.

Observations on Square Numbers.

1st. All even square numbers are divisible by 4, and therefore if a number consists of two even square numbers, it will also be divisible by 4.

2d. Any odd square number, divided by 4, leaves a remainder of 1; and therefore, if a number, consisting of two odd square numbers, be divided by 4, there will be a remainder of 2.

3d. It follows from the above, that if a number, consisting of an even and an odd square number, be divided by 4, there will be a remainder of 1.

4th. Hence also, if any number which is composed of two square numbers, be divided by 4, it cannot leave a remainder of 3; and consequently a number, which is composed of two square numbers, cannot fall within this progression, 3, 7, 11, 15, 19, 23, &c.

5th. Any number ending in 2, 3, 7, or 8, is not a square number.

6th. The sum of any number of terms of the series, 1, 3, 5, 7, 9, 11, &c. beginning with the first, is a square number, whose root is equal to the number of terms.

7th. The difference between any two square numbers is equal to the product of the sum and difference of their roots. Thus, if a and b be the Roots, then $a+b\times a-b=a^2-b^2$; and the same is also equal to the sum of the two roots, together with twice the sum of the roots of all the intermediate square numbers. Thus the difference between 36 and $9=6+3+2\times\sqrt{16}+25=9+18=27$.

In attempting to solve questions of this class, the chief point in view, is to make such assumptions for the Root of the required square or cube, as shall, when involved, cause either the given number, or the highest power of the unknown quantity, to vanish out of the Equation, whereby at length there will be only one dimension of the unknown quantity, and so the question will be solved by reducing the Equation.

EXAMPLES.

EXAMPLES.

QUEST. I. What two ſquare numbers are thoſe, the difference whereof is 57? Here I try to divide 57 into two unequal integer factors, which in any caſe may be done if one of them is taken an unit. But here I find 3 and 19 will do. Hence as the rectangle of the ſum and difference of the roots is equal to the difference of the ſquares = to the rectangle of 3 and 19, I conclude that the ſum of the two roots is 19, and the difference 3: then if x = greateſt root, and y = leſs, $x+y=19$, and $x-y=3$; and adding the two Equations together, and dividing by 2, we have $x=11$, and conſequently $y=8$; or, which is a well known theorem, half the ſum + half difference = greater number, and half ſum − half difference = leſs number. Hence the two ſquare numbers are 121 and 64 reſpectively. If an unit had been taken for one of the factors, then $\frac{57+1}{2}=29$ for the greater root, and $\frac{57-1}{2}=28$, the leſs root, and the ſquare numbers themſelves are 841 and 784 reſpectively, which likewiſe anſwer the conditions of the queſtion.

SCHOLIUM. In order to have the anſwer in whole numbers; if the given difference be an odd number, both the factors muſt be taken odd, which may always be done by means of an unit; and ſo it will always be a poſſible caſe. But if the propoſed difference be an even number, it muſt be divided into factors that are even, or the anſwer will not be had in whole numbers: when it is a poſſible caſe, one of the factors may be 2. By thus dividing the given difference into factors, all the poſſible anſwers will be readily exhibited. If fractional numbers are included, the anſwers will be innumerable.

QUEST. II. To divide a given ſquare number (100) into two other ſquare numbers. Let the given ſquare number (100) $=b^2$ and put x^2 = one of its parts, ſo will b^2-x^2 = the other part, which is alſo a ſquare number. Aſſume this number alſo = $(rx-b)^2$; then theſe values being put equal to each other, and the Equation reduced, $x=\frac{2br}{r^2+1}$; and by ſubſtituting this in lieu of x in the aſſumed value of the other root, viz. $rx-b$, we have $\frac{br^2-b}{r^2+1}$. And hence $\frac{2br}{r^2+1}$, and $\frac{br^2-b}{r^2+1}$, are the roots of the required ſquares; where r may be any number (above 1) taken at pleaſure. Now if the value of b (=10) be reſumed, and r be taken = 2, the roots of the required ſquares will be 8 and 6 reſpectively; and conſequently the ſquare numbers are 64 and 36. If no value of r will give the anſwer in whole numbers, the given ſquare number is not compoſed of two integer ſquares.

QUEST. III. To find a ſquare number, which if multiplied by a known ſquare number (=9) and a given number (288) be added to the product, the reſult ſhall be a ſquare number. Put $9=a^2$; $288=d$; and z^2 = the required number. Then $a^2z^2+d=$ a ſquare number ($=y^2$) per queſtion. Aſſume $v=az=y$, then $y^2=v^2-2vaz+a^2z^2$. Now, putting theſe two values of y^2 equal to each other, viz. $a^2z^2+d=v^2-2vaz+a^2z^2$, and reducing the Equation, we have $z=\frac{v^2-d}{2av}$, where v may be taken at pleaſure: but with this proviſion, if the anſwer is required in whole numbers, that v^2-d, will divide by $2av$. In the above Example take $v=24$, and reſume the values of a (=3) and d (=288,) and z is had = 2; hence $z^2=4$, which numbers anſwers the demands of the queſtion.

QUEST. IV. To divide a given number (25) conſiſting of two known ſquare numbers (16 and 9) into two other ſquare numbers. Put $16=d^2$ and $9=b^2$, and aſſume $ra-d=$ ſide of one ſquare, and $sa-b=$ ſide of the other, then $\overline{ra-d}^2+\overline{sa-b}^2=d^2+b^2$ (per queſtion.) By involution and tranſpoſition $r^2a^2+s^2a^2=2rad+2sab$; and dividing by ar^2+as^2, we have $a=\frac{2rad+2abs}{ar^2+s^2}=\frac{2rd+2bs}{r^2+s^2}$, and this ſubſtituted for a, in the aſſumed expreſſions, $ra-d$, and $sa-b$, they become $\frac{dr^2+2bsr-ds^2}{r^2+s^2}$, and $\frac{2rds+bs^2-br^2}{r^2+s^2}$ for the two roots of the ſquare numbers required. Now, if the values of d and b be reſumed, and r be taken = 2, and $s=1$, we ſhall have $\frac{4}{5}$ and $\frac{3}{5}$ for the roots; and therefore $\frac{16}{25}$ and $\frac{9}{25}$ are the ſquare numbers required.

N. B. r and s may be any numbers whatever, provided r be greater than s, and that their ratio be not as that of d to b, or of $d+b$ to $d+-b$. In Ronayne's Algebra, through taking r leſs than s, and aſſuming $ra+b=$ one of the given ſides, the ſolution to this problem is wrong.

QUEST. V. To find three cube numbers, whoſe ſum may be both a ſquare and a cube number.

Put a, e and y, for their reſpective roots, and $x^3=$ ſum of their cubes; then $a^3+e^3+y^3=x^3$ per queſtion. Aſſume $\frac{x^3}{a^3}v=a=e$, and $x-v=y$; then $a^3+\overline{\frac{x^3}{a^3}v-v}^3+\overline{x^3-v}^3=x^3$; the compound parts of which Equation being involved, and then the whole properly reduced, v is found $=\frac{3a^3x^2}{x^3+a^3}$, where x and a may be taken at pleaſure; and this value of v being ſubſtituted in the aſſumed values of e and y, above ſpecified, they will become known. If $x=1$, and $a=\frac{1}{2}$, then $v=\frac{3}{9}$, whence $e=\frac{3}{9}$, and $y=\frac{2}{9}$, and conſequently the cube numbers are $\frac{1}{729}$, $\frac{343}{729}$, and $\frac{8}{729}$, which fulfil the conditions of the queſtion, their ſum being ($=1$) both a ſquare and a cube number. And by taking different values for x and a, various anſwers may be obtained.

SECTION VII. OF THE MAXIMUM AND MINIMUM OF ALGEBRAIC QUANTITIES.

When a quantity is required to be the greateſt or leaſt poſſible, it is called a *maximum* or *minimum*. And at the time it becomes ſuch, it is at a ſtand, and at that moment neither increaſes nor decreaſes. Therefore to compute it, obſerve this

Rule. Calculate the value of the maximum or minimum two different ways, which is done by increaſing the unknown quantity therein, by an exceeding ſmall part; then theſe values are to be put equal to one another. The ſame muſt be done, if there be ſeveral variable quantities. But go no farther than the firſt power of the ſmall added part. Or,

If the maximum or minimum conſiſts of two parts; compute the exceeding ſmall increment of one, and the decrement of the other; and put them equal to one another.

EXAMP. I. What Fraction is that whoſe Square exceeds its Cube the greateſt poſſible.

Let x be the fraction, then $x^2-x^3=$ max. Take e an exceeding ſmall part to be added to x, then you will alſo have $\overline{x+e}^2-\overline{x+e}^3=$ *max.* that is, $xx+2xe-x^3-3x^2e=$ *max.* Whence $x^2-x^3=xx+2xe-x^3-3x^2e$, and $2xe-3x^2e=0$, or $3x^2e=2xe$, and $3x=2$, or $x=\frac{2}{3}$.

Or thus, Since $x^2-x^3=$ *max.* let e be the ſmall increaſe of x, then $2xe$ is the increment of xx, and $3x^2e$ is the decrement of x^3; therefore $2xe=3x^2e$, and $x=\frac{2}{3}$ as before.

EXAMP. II. To divide a given Quantity into two Parts, that one of the Parts multiplied by the Cube of the other Part; the Product may be a Maximum.

Let a be the quantity, and x one part, and $a-x$ the other part, and e a ſmall additional part to x. Then $x^3\times\overline{a-x}$ or $ax^3-x^4=$ max. $=ax^3+3ax^2e-x^4-4x^3e$. Then $3ax^2e=4x^3e$, and $x=\frac{3}{4}a$, for one part, and $a-x=\frac{1}{4}a$, the other part.

EXAMP. III. To find $a^3-a^2x+x^3$ a minimum, x being unknown.

Put $x+e$ for x. Then $a^3-a^2x+x^3=min.=a^3-a^2x-a^2e+x^3+3x^2e$, and $-a^2e+3x^2e=0$, and $3xx=aa$; whence $x=a\sqrt{\frac{1}{3}}$. Then $a^3-a^3x+x^3\sqrt{\frac{1}{3}}+\frac{1}{3}a^3\sqrt{\frac{1}{3}}=a^3-a^3=a^3\times 1-\frac{2}{3}\sqrt{\frac{1}{3}}$, the minimum.

EXAMP. IV. *Suppoſe* $y^3-2yyx+3yxx=nyx-nxx$, *and* $x-\frac{1}{2}y=max.$

Suppoſe the maximum = m. Then $x=m+\frac{1}{2}y$. This ſubſtituted in the firſt Equation, and reduced, gives $\frac{1}{4}y^3+3m^2y=\frac{1}{2}nyy-mmn$. And $y^3+12mmy-nyy+4mmn=0$. Where m is a fixt quantity. Put $y+e$ for y; then $y^3+12m^2y-nyy+4m^2n=0=y^3+3y^2e+12m^2y+12m^2e-ny^2=2nye+4m^2n=0$, and $3y^2e+12m^2e-2nye=0$, whence $3yy+12m^2-2ny=0$, or $2ny-3yy=12mm$. From this Equation, and $y^3+12m^2y-nyy+4m^2n=0$, the quantities y and m will eaſily be determined.

ART. I. *Given the Sum of the Legs of a right-angled Triangle; to find the Legs, ſo as to contain the greateſt Area poſſible.*

Let a = ſum of the legs, x = one of them; then $x\times a-x$ = twice the area = max. therefore $x+e\times a-x-e=x\times a-x$, that is, $ax-xx-xe+ae-xe=ax-xx$, and $ae-2xe=0$, or $2x=a$, whence $x=\frac{1}{2}a$, and $a-x=\frac{1}{2}a$. Therefore the legs are equal. And therefore when the area is given, the ſum of the legs will be the leaſt, when they are equal.

ART. II. *Given the Area of right-angled Triangle; to find the Sides, when the Perimeter is the leaſt poſſible.*

Let a = area, x = ſum of the legs, v, y = the two legs; then $vv+yy+2vy=xx$, but $vy=2a$, and $vv+yy=xx-2vy=xx-4a$, and the hypothenuſe = $\sqrt{vv+yy}=\sqrt{xx-4a}$; therefore $x+\sqrt{xx-4a}$ = perimeter = minimum, write $x+e$ for x; then $\overline{x+e-4a}^{\frac{1}{2}}=\sqrt{xx+2xe-4a}=\sqrt{xx-4a}+\frac{xe}{\sqrt{xx-4a}}$; whence $x+e+\sqrt{xx-4a}+\frac{xe}{\sqrt{xx-4a}}=x+\sqrt{xx-4a}$, & $e+\frac{xe}{\sqrt{xx-4a}}=0$. And $e\sqrt{xx-4a}=-xe$, and $exx-4ae=xxe$, and $4ae=0$, and $ee=\frac{0}{4a}$, or $e=0$. And therefore ſince the increment of x is nothing, x is a minimum; and when x or the ſum is a minimum, then the legs are equal, by the laſt Article; therefore $v=y=\frac{1}{2}x$, and $\frac{1}{4}xx=2a$, or $x=\sqrt{8a}$.

ART. III. *To find* x^m-x^n *the greateſt poſſible, ſuppoſing* n *greater than* m.

Write $x+e$ for x, then $\overline{x+e}^m=x^m+mx^{m-1}e$, and $\overline{x+e}^n=x^n+nx^{n-1}e$; therefore $\overline{x+e}^m-\overline{x+e}^n=x^m-x^n$; that is, $x^m+mx^{m-1}e-x^n-nx^{n-1}e=x^m-x^n$. And by ſubtraction, $mx^{m-1}e-nx^{n-1}e=0$

$-nx^{n-1}e=0$, or $mx^{m-1}=nx^{n-1}$, or $mx^m=nx^n$. And n being greater than m, we have $nx^{n-m}=m$, and $x^{n-m}=\frac{m}{n}$; whence $x=\sqrt[n-m]{\frac{m}{n}}$.

Having treated of all the neceſſary fundamental parts of this Art, it only remains that we elucidate the ſame, by applying them to the ſolution of ſuch queſtions as occur in the different branches of mathematical education; at the ſame time informing the contributors to this undertaking, that many intereſting matters, wherein Algebra is applied, will be occaſionally interſperſed in the courſe of the Work under their proper heads.

SECTION VIII. ALGEBRAIC QUESTIONS.

QUEST. I. What two numbers are thoſe, whereof the ſum is 108, and the proportion of the leſs to the greater as 5 to 7?

Let x = the great number; then $108-x$ = the leſs. And as $108-x : x :: 5 : 7$ per queſtion. This brought into an Equation by ART. III. Sect. V. we have $5x=756-7x$, and by tranſpoſing $7x$, there is $12x=756$; hence, by dividing by 12, $x=63$, the greater number; and $108-63=45$, the leſs number.

QUEST. II. There are three numbers in arithmetical progreſſion; the common difference is 2; and the product of the ſaid numbers is 960. What are thoſe numbers?

Let x = the middle term of the progreſſion, and then $x+2$, and $x-2$, will be the two other terms: and $x\times x+2\times x-2=960$ per queſtion. The terms being actually multiplied, $x^3-4x=960$; which Equation, ſolved either by ART. X. or XI. Sect. VI. gives $x=10$; and therefore the three numbers are 8, 10, and 12.

QUEST. III. A ſervant bought apples at 6 for a penny, and pears at 5 for two-pence. The number of apples and pears together was an hundred; and the money given for them was 2s. 2d. I demand how many there were of each ſort?

Let a = the number of apples; then $100-a$ will be the number of pears; and as $6 : 1d :: a : \frac{a}{6}$ = price of the apples.

Alſo, as $5 : 2d :: 100-a : \frac{200-2a}{5}$ = price of the pears: then $\frac{a}{6}+\frac{200-2a}{5}$ = 2s. 2d. (= 26d.) per queſtion. This Equation, multiplied by 30, we have $5a+1200-12a=780$. By tranſpoſition, $7a=1200-780=420$; and by diviſion, $a=60$, the number of apples; and $100-60=40$, the number of pears.

QUEST. IV. It is required to divide the number 128 into four ſuch parts, that if the firſt be added to 7, the ſecond ſubtracted from 7, the third multiplied by 7, and the fourth divided by 7, the reſults may be equal among themſelves.

Let v, x, y, and z, be the required parts. Then $v+7=x-7=7y=\frac{z}{7}$, per queſtion. And from the equality of the two firſt, $x=v+14$; from the equality of the firſt and third, $y=\frac{v+7}{7}$; and from the equality of the firſt and fourth, $z=\overline{v+7}\times 7=7v+49$. Therefore (by collecting theſe together) $v+v+14+\frac{v+7}{7}+7v+49=128$. By collecting the terms and tranſpoſition, $9v+\frac{v+7}{7}=65$; and by multiplying this by 7, collecting the terms, tranſpoſing, and dividing, $v=7$; and hence $x=7+14=21$; $y=\frac{7+7}{7}=2$; and $z=7+7\times 7=98$; the ſeveral parts required.

QUEST. V. There are two cubical pieces of marble, and the ſide of one exceeds the ſide of the other by three inches, and the ſolid inches in both are 2457 inches. Of what length is the ſide of each cubical piece?

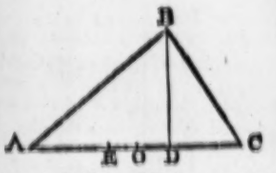
Let the ſide of the leſs be x, then the ſide of the greater will be $x+3$; and $x^3+\overline{x+3}^3=2547$ inches, per queſtion. Hence, $2x^3+9x^2+27x=2430$. This Equation ſolved, $x=9$, and conſequently $y=12$.

QUEST. VI. The ſum of two numbers multiplied by the greater is 110, and their difference multiplied by the leſs is 9, what are thoſe numbers?

Put $110=a$, and $9=b$, and let x and y be the two numbers, whereof x is the greater; then $\overline{x+y}\times x=x^2+xy=a$; and $\overline{x-y}\times xy=xy-y^2=b$, per queſtion.

Again, Put $v=x^2$, and $z=y^2$; ſo will $v+\sqrt{vz}=a$, and $\sqrt{vz}-z=b$; and ſubtracting the latter Equation from the former $v+z=a-b$; hence $z=a-b-v$: by tranſpoſing the former Equation, $\sqrt{vz}=a-v$; and ſquaring both ſides, $vz=a^2-2av+v^2$. Then by ſubſtituting $a-b-v$, in lieu of z, the Equation becomes $av-bv-v^2=a^2-2av+v^2$; and by tranſpoſition and reduction, $v^2-\frac{\overline{a-b}}{2}v=-\frac{a^2}{2}$. In numbers $v^2-160.5v=-6050$; and therefore $v=\sqrt{-6050+0440.0625}+80.25=\sqrt{390.0625}+80.25=19.75+80.25=100$, and $v\pm z=x=10$, the greater number: $z=a-b-v=110-9-100=1$, and therefore $z\pm 1=y$, the leſs number.

QUEST. VII. Let the ſides of the triangle ABC be as follow, viz. AB = 24, AC = 28, and BC = 18; it is required to find the ſegments of the baſe AD and DC, made by a perpendicular let fall from B.



Take AE = DC, and divide AC into two equal parts as at O; then becauſe AE = DC, ED = the difference of the ſegments; and becauſe AO = OC, EO = OD = ½ difference: alſo AO + OD = AD, the greater ſegment = OC + OD; and OC − OD = DC = leſs ſegment. Now put half the difference of ſegments EO or OD = x, and let AB = a, BC = b, and AO or OC = ½ AC = c; ſo will $c+x=$ AD, and $c-x=$ DC. Then, by the Pythagorean Theorem (ſee GEOMETRY) $a^2-\overline{c+x}^2$ (= BD^2) = $b^2-\overline{c-x}^2$; and therefore $a^2-c^2-2cx-x^2=b^2-c^2+2cx-x^2$; viz. $a^2=b^2+4cx$, or $a^2-b^2=4cx$; or, which is the ſame, $\overline{a+b}\times\overline{a-b}=4cx$. This reſolved into a proportion by Article III. Section V. we have as $2c : \overline{a+b} :: \overline{a-b} : 2x$; viz. as the baſe AC is to the ſum of the ſides AB and BC, ſo is the difference of thoſe ſides to ED, the difference of the ſegments of the baſe: a well known Theorem in Trigonometry. Or by taking $4c$ for the firſt term, and x for the laſt, it will be as twice the baſe is to the ſum of the ſides; ſo is the difference thereof to half the difference of the ſegments. Wherefore, in the preſent example, as (AC) 56 : (AB+BC) 42 :: (AB−BC) 6 : $\frac{42\times 6}{56}=\frac{21\times 6}{8}=\frac{21\times 3}{14}=\frac{3\times 3}{2}=4\frac{1}{2}=$ ½ difference of ſegments; then 14 (AO or OC) + $4\frac{1}{2}=18\frac{1}{2}=$ AD, the greater ſegment; and $14-4\frac{1}{2}=9\frac{1}{2}=$ DC, the leſs ſegment.

N. B. The greater ſegment is always adjacent to the greater remaining ſide, and the leſs ſegment is adjacent to the leſs remaining ſide.

QUEST VIII. Having a conical veſſel full of liquor ſtanding upon its leſs end, the radius of which is 20 inches, into which I immerſed a cone of equal baſe and altitude, the convex ſurface whereof is 2827.44, and is equal to the area of the top of the veſſel. Required its content, and the quantity of liquor in ale gallons that overflowed by ſo doing. Let the top diameter of the veſſel be x, and its height y, = alſo the height of the cone; and let $20=a$, and $2827.44=b$. Alſo put $.7854=p$; then $px^2=b$, per queſtion; and therefore $x^2=\frac{b}{p}$. But the reciprocal of $\frac{1}{p}=1.27324$, and therefore $x^2=1.27324\times b=3600$; and $x=\sqrt{3600}=60$ inches, the top diameter of the veſſel.

Alſo (per Menſuration) $\sqrt{\frac{a^2}{4}+y^2}$ = the ſlant ſide of the cone, and $2pa\times\sqrt{\frac{a^2}{4}+y^2}$ = convex ſurface of the cone $=b$; therefore $\sqrt{\frac{a^2}{4}+y^2}=\frac{b}{2pa}$; and $\frac{a^2}{4}+y^2=\frac{b^2}{4p^2a^2}$; and conſequently $y^2=\frac{b^2}{4p^2a^2}-\frac{a^2}{4}$; and $y=\sqrt{\frac{b^2}{4p^2a^2}-\frac{a^2}{4}}=\sqrt{4996.51\times 1.27324}^2=\sqrt{4996.51\times 1.62114}=\sqrt{8100.}=90$, the height of the veſſel, and altitude of the cone.

Then $\overline{20\times 60}+20^3+60^3\times\frac{22}{7}\times .7854=207345.6$ cubic inches, the content of the veſſel, = 735.27 ale gallons. And $\overline{20}^3\times 30\times .7854=9424.8$ cubic inches, the content of the cone, = 33.42 ale gallons, which overflowed by its immerſion.

QUEST. IX. Given the curve ſurface of the ſegment of a ſphere = 1600, and the difference between its ſolid content and that of a cylinder of the ſame diameter and altitude, = 1800; to determine both the diameter and altitude. Let, $x=\frac{1}{2}$ the diameter, and $x=$ the altitude, and let $.7854=p$. Then $\overline{x^2+x^2}\times 4p$ = the curve ſurface of the ſegment, = 1600 (per queſtion.) And $x^2+x^2=\frac{400}{p}$. Alſo, $\overline{3x^2+x^2}\times\frac{2px}{3}=$ its ſolidity; and $4px^2x=$ the ſolidity of the cylinder. (Vide Menſuration.) Therefore $\overline{3x^2+x^2}\times\frac{2px}{3}-4px^2x=1800$ (per queſtion.) Divide by $\frac{2p}{3}$, and $3x^2x+x^2-6x^2=1800\times\frac{3}{2p}=\frac{2700}{p}$; or $x^3-3x^2=\frac{2700}{p}$.

Now from the Equation above, viz. $z^2+x^2=\frac{400}{p}$, we have $z^2=\frac{400}{p}-x^2$, which, substituted in this last Equation, there is $x^3-\frac{1200x}{p}+3x^3=\frac{2700}{p}$, or (by reduction) $x^3-\frac{300x}{p}=\frac{675}{p}$. The reciprocal of $\frac{1}{p}=1.27324$. Therefore the Equation is $x^3-300\times1.27324x=675\times1.27324$; or $x^3-381.972x=859.437$, with cubic Equation, solved, $x=20.5845548$ inches the altitude, and $z^2=\frac{400}{p}-x^2=400\times1.27324-x^2=509.296-423.723616$, &c. $=85.572384$, &c. and $z=\sqrt{85.572384}$, &c. $=9.250534$, and $2z=18.501068$ inches, the required diameter.

QUEST. X. There is a cubical block of marble, whose side in inches is expressed by two digits; the superfices of the block is equal to 864 times the sum of the said digits; and its solidity is equal to 576 times the square of the sum of the said digits; required the dimensions.

Let $x=$ the digit in the tens place, and $y=$ the digit in the place of units, then $10x+y=$ side of the cube, and $\overline{10x+y}^2\times6=864\times\overline{x+y}$; or $10x+y=144\times\overline{x+y}$. Also $10x+y=576\times\overline{x+y}$ per question; and multiplying these Equations croſswise, $10x+y\times576\times\overline{x+y}=144\times\overline{x+y}\times10x+y$. Now dividing both sides by $144\times\overline{x+y}\times10x+y$, we have $x+y\times4=10x+y$, or $4x+4y=10x+y$, and by transposition $3y=6x$, and therefore $y=2x$. This being substituted for y in the former Equation ($10x+y=144\times\overline{x+y}$) there is $10x+2x^2=144\times\overline{x+2x}$, or $144x^2=144\times3x$, and dividing by $144\,x$, we have $x=3$, and $y=2x=6$; and therefore the side of the cube is 36.

QUEST. XI. On what day in the year 1789 was the sun's right ascension equal to the complement of his declination, the obliquity of the ecliptic being 23° 28′?

Let radius $=1$, and the co-tangent of $23°\,28'=2.3035064=a$; also put $z=$ tangent of the declination. Then (per Trignometry) $\frac{1}{\sqrt{1+z^2}}=$ cosine of the declination $=$ sine of the right ascension. But (per ASTRONOMY) as $1:a::z:az=$ sine of right ascension. Therefore $az=\frac{1}{\sqrt{1+z^2}}$ and $a^2z^2=\frac{1}{1+z^2}$; by multiplication, $a^2z^2+a^2z^4=1$; and by division, $z^4+z^2=\frac{1}{a^2}$. Hence (putting $x=z^2$) $x=\sqrt{\frac{1}{a^2}+\frac{1}{4}}-\frac{1}{2}=\sqrt{\frac{a^2+4}{4a}}=\frac{1}{2}=\frac{1}{2a}\sqrt{a^2+4}-\frac{1}{2}$; $=$ (by restoring the value of a, and extracting the root, &c.) $.1622811$; and $\sqrt{x}=z=\sqrt{.1622811}=.4028413=$ tangent 21° 56′¼, the sun's declination, which, from the nature of the question, must be north increasing, and therefore it is answerable to the 31st of May, the sun's right ascension being equal to the complement of his declination.

QUEST. XII. It is required to find a series of whole numbers, each term of which being divided by 14, shall leave a remainder of 4; divided by 50, shall leave a remainder of 30; divided by 85 shall leave a remainder of 45; and also each term divided by 95, shall leave a remainder of 85; by a general method which may be supplied to the solution of any other question of the like nature. This was the Prize Question in the *Gentleman's Diary* for the year 1789; to solve which, we shall first proceed to find the last term in the series.

Let $x=$ the quotient, when divided by 14. Then $14x+4=$ the required number. Also $\frac{14x+4-30}{50}=$ a whole number per question $=\frac{7x-13}{25}$; now the least value of y by the lemma delivered in Art. II. Sect. VII. is 9; which substituted in the above expression ($14x+4$) we have 130, which is the least number that will answer the first two conditions.

Now it is plain that the number which will answer three of the conditions must be such a one as will divide by 14 and 50, without a remainder, $+130$. The least number that will do this is 350, (see Section of Fractions in our new System of Arithmetic,) But as it may be some multiple thereof, let z be the multiple; so will $350z+130$ be the number; and $\frac{350z+130-45}{85}=$ a whole number per question $=\frac{70z+17}{17}=4z+1+\frac{2z}{17}$; and therefore $\frac{2z}{17}=$ a whole number; and because 2 and 17 are prime to each other, the least whole number for z is 17; this substituted in the foregoing expression ($350z+130$) it makes $5950+130=6080$, which is the least number that will answer three of the conditions. Now the number that will answer all the conditions must be the sum of this number, and some other that will divide both by 350 and 85, without a remainder. The least number that will do this $=350\times17=5950$; but as it may be some multiple thereof, let $5950y+6080=$ the required number; and then $\frac{5950y+6080-85}{95}=$ a whole number per question, $=\frac{1190y+1199}{19}=62y+63+\frac{12y+2}{19}$. Therefore $\frac{12y+2}{19}=$ a whole number; and the least value of y, by the said lemma, is 3, which substituted for y, we have the value of the least number in the required series $=17850+6080=23930$. Furthermore, the least number that will divide by 5950 and 95 without a remainder $=5950\times19=113050$; by the continual addition of which, an arithmetical series will be formed, exhibiting all the possible numbers that will satisfy the enquiry. Thus 23930, 136980, 250030, 363080, 476130, &c. *ad infinitum*, will, severally, if divided by the proposed numbers, 14, 50, 85, and 95, leave the given remainders 4, 30, 45, and 85, respectively. There are other ways of coming at the same thing; but I know of none so *clear*, so *general*, and withal so *easy*.

N. B. This question was proposed by Mr. Moss, an able Mathematician, and the above Solution to it was printed in this Work within four days after the publication of the Gentleman's Diary; and among all the Solutions that were published the following year, there was not one which had either the elegance or simplicity of this.

QUEST. XIII. To divide the Sum of Two given Cubes into Two other Cubes.

Let	1	x^3, y^3 be the cubes sought; b^3, c^3 the given cubes.
assume	2	$x=b+v$
	3	$y=c-\frac{bb}{cc}v$
2 & 3	4	$x^3=b^3+3bbv+3bv^2+v^3$
3 & 3	5	$y^3=c^3-3bbv+\frac{3b^4}{c^3}v^2-\frac{b^6}{c^6}v^3$
4+5	6	$x^3+y^3=b^3+c^3+3bv^2+\frac{3b^4}{c^3}v^2+v^3-\frac{b^6}{c^6}v^3=b^3+c^3$, per Quest.
6 tr.	7	$3bv^2+\frac{3b^4}{c^3}v^2=\frac{b^6}{c^6}v^3-v^3$.
7+$\frac{c^6}{vv}$	8	$3bc^6+3b^4c^3=b^6v-c^6v$.
8+	9	$v=\frac{b^3+c^3}{b^6-c^6}\times3bc^3=\frac{3bc^3}{b^3\times c^3}$.

QUEST. XIV. To find Three such Cube Numbers whose Sum may be both a Square and a Cube Number.

Let	1	a, e, y be their roots, x^3 the sum of their cubes.
per Quest.	2	$a^3+e^3+y^3=x^3$
2−y^3	3	$a^3+e^3=x^3-a^3$
assume	4	$\frac{x^4}{a^3}v-a=e$
	5	$xx-v=v$
	6	$x^3=$ a cube
4 & 3	7	$+\frac{x^{12}}{a^9}v^3-\frac{3x^8}{a^6}v^2+3x^4v-a^3$ } $=x^3$, per Quest.
5 & 3	8	$+x^6-3x^4v+3x^2v^2-v^3$ }
6, 7, 8,	9	$\frac{x^{12}}{a^9}v^3-\frac{3x^8}{a^6}vv+3x^4v^2-v^3=0$.
9+$\frac{a^6}{vv}$	10	$^{12}v=a^6v=x^6-a^6a^6\times3a^6x^2=\frac{3a^6xx}{x^6+a^6}$ where x and a may be taken at pleasure; then v being known, e and y are known by step 4 and 5. If
Suppose		$x=1$, $a=\frac{1}{2}$, then $v=\frac{1}{2}$, whence $e=\frac{1}{2}$, $y=\frac{1}{2}$, and the numbers are $\frac{1}{8}+\frac{1}{8}+\frac{1}{8}=\frac{3}{8}=1$. If
Or suppose		$x=2$, $a=1$, then $v=\frac{1}{2}$, and $e=\frac{7}{8}$, $y=\frac{7}{8}$, and the numbers are $1+\frac{2048383}{274625}+\frac{15252992}{274625}=64$.

What has been digested in this System is amply sufficient to initiate any persons of a mathematical Genius into the Method of Algebraical Operations, as well as to shew the extensiveness of the Art in cultivating and improving different Branches of Science. There is scarce a Subject within the reach of human Contemplation, but it may be applied to it with Success, provided the first Principles of the Subject are comprehended in the Mind.

ROBERT MOODY.

EXCISE OFFICE.

ALGEDO, the running of a gonorrhœa ſtopping ſuddenly after it appears. When it thus ſtops, a pain reaches to the anus, or to the teſticles, without their being ſwelled; and ſometimes this pain reaches to the bladder, in which caſe there is an urging to diſcharge the urine, which is with difficulty paſſed, and in very ſmall quantities at a time. The pain is continued to the bladder by the urethra; to the anus, by the acceleratory muſcles of the penis; and to the teſticles, by the *vaſa deferentia* and *veſiculæ ſeminales*. In this caſe, calomel, repeated ſo as to purge, brings back the running, and then all difficulty from this ſymptom ceaſes.

ALIEN, in law, implies a perſon born in a ſtrange country not within the king's allegiance; in contradiction to a denizen, or natural ſubject. The word is formed from the Latin *alius*, "another"; *q. d.* one born in another country. An alien is incapable of inheriting lands in Britain till naturalized by an act of parliament. No alien is intitled to vote at the election of members of parliament; nor can he enjoy any office, or be returned on any jury, unleſs where an alien is party in a cauſe, when the inqueſt is compoſed of an equal number of denizens and aliens. The reaſons for eſtabliſhing theſe laws were, that every man is preſumed to bear faith and love to that prince and country where he received protection during his infancy; and that one prince might not ſettle ſpies in another's country; but chiefly, that the rents and revenues of the country might not be drawn to the ſubjects of another. Some have thought that the laws againſt aliens were introduced in the time of Henry II. when a law was made at the parliament of Wallingford, for the expulſion of ſtrangers, in order to take away the Flemings and Picards introduced into the kingdom by the wars of King Stephen. Others have thought that the origin of this law was more ancient; and that it is an original branch of the feudal law; for by that law no man can purchaſe any lands, but he muſt be obliged to do fealty to the lords of whom the lands are holden; (ſee the article Fee;) ſo that an alien, who owed a previous faith to another prince, could not take an oath of fidelity in another ſovereign's dominions. Among the Romans, only the *Cives Romani* were eſteemed freemen; but when their territories increaſed, all the Italians were made free, under the name of *Latini*, though they had not the privilege of wearing gold rings all the time of Juſtinian. Afterwards all born within the pale of the empire were conſidered as citizens.

ALIENS *duty*, an impoſt laid on all goods imported into England, by *aliens* or denizens, and even on certain goods imported by natural ſubjects, if they be brought on foreign bottoms, over and above what is paid for the ſame goods imported by Britiſh, and in Britiſh ſhipping. 12 Stat. Car. II. *Aliens duty* is otherwiſe called *petty cuſtoms* and *navigation duty*. Fiſh, dried or ſalted, and codfiſh or herring, not caught in Britiſh veſſels, and cured by Britiſh, pay a double *aliens duty*. *Aliens duty* outwards, is taken off by an act of 11 Geo. I. cap. 59.

ALIENATION, in law, denotes the act of making over a man's property in land, tenements, &c. to another perſon. *Alienation in mortmain*, is making over lands, tenements, &c. to a body-politic, or to a religious houſe, for which the king's licence muſt firſt be obtained, otherwiſe the lands, &c. alienated will be forfeited. *Alienation in fee*, is the ſelling the fee-ſimple of any land, or other incorporeal right. All perſons who have a right to lands may generally alien them to others; but ſome alienations are prohibited; ſuch as alienations by tenants for life, &c. whereby they incur a forfeiture of their eſtate. By the ſtatute of Edward I. a bar was put to alienations by what we call *entails*, which is an expedient for procuring perpetuities in families; but counter expedients were deviſed to defeat this intent, and a practice was introduced of cutting off entails by fines, and of barring remainders and reverſions by recoveries. The ſtatute for alienations in Henry VII.'s time had a great effect on the conſtitution of this kingdom; as, among other regulations of that reign, it tended to throw the balance of power more into the hands of the people. By the ſtat. 12 Car. II. cap. 24 fines for alienations are taken away. Crown lands are only alienable under a faculty of perpetual redemption. The council of Lateran, held in 1123, forbids any clerk to alienate his benefice, prebend, or the like. By the laws of the ancient Jews, lands could only be alienated for the ſpace of 50 years. At each return of the jubilee all returned again to the primitive owners, or their deſcendants, to whom the lands were originally allotted at the firſt diſtribution of Canaan.

ALIMENT (from *ale*, to nouriſh) implies food both ſolid and liquid: from which by proceſs of digeſtion, is prepared a very mild, ſweet, and whitiſh liquor, reſembling milk, and diſtinguiſhed by the name of *chyle*; which being abſorbed by the lacteal veins, by them conveyed into the circulation, and there aſſimilated into the nature of blood, affords that ſupply of nutrition which the continual waſte of the body is found to require. Next to air, food is the moſt neceſſary thing for the preſervation of our bodies: and as on the choice thereof our health greatly depends, it is of great importance to underſtand, in general, what is the moſt proper for our nouriſhment; and, in particular deviations from health, what is the beſt adapted to reſtore us. Our blood and juices naturally incline to become putrid and acrimonious: freſh chyle, duly received, prevents this deſtructive tendency, and preſerves in them that mild ſtate which alone conſiſts with health. An animal diet affords the moſt of this bland nutritious mucilage; watry fluids dilute the too groſs parts, and carry off what is become unfit for uſe. It is only the ſmall portion of jelly which is ſeparated from the farinaceous parts of vegetables, that, after being much elaborated, is converted into the animal nature; yet the uſe of vegetables prevents both repletion, and a too great tendency to a putreſcent acrimony of the blood. In hot climates, as well as againſt the conſtitutional heat of particular perſons, vegetables are demanded in the largeſt portion: animal ſubſtances afford the higheſt reliſh while our appetite continues, but will ſate the appetite before the ſtomach is duly filled. Vegetables may be eaten after either fleſh or fiſh: few herbs or fruits ſatiate ſo much as that the ſtomach may not be filled with them, when it is already ſatisfied with fleſh or fiſh; whence it may be obſerved, that no diet, which is very nouriſhing, can be eat to fulneſs, becauſe its nutritious parts are oily and ſatiating. Health depends almoſt wholly on a proper craſis of the blood; and to preſerve this a mixture of vegetables in ſome degree is always required, for a loathing is ſoon the conſequence of animal food alone: hot acrid habits, too, receive from milk and vegetables the needful for correcting their exceſſes; but in cold, pituitous, and nervous habits, who want moſt nouriſhment from leaſt digeſtion, and from the ſmalleſt quantity of food, animal diet is to be uſed more freely.

Thus much being offered as general principles with reſpect to the matter and quality of our aliment, the valetudinarian may eaſily regulate his diet with ſome advantage to himſelf by an attention to the few enſuing particulars. In winter eat freely, but drink ſparingly: roaſt meat is to be preferred, and what is drank ſhould be ſtronger than at other ſeaſons. In ſummer, let thirſt determine the quantity to be drank; cold ſtomachs never require much: boiled meats and vegetables, if not otherwiſe contradicted, may now be more freely uſed. Lax habits require the winter's diet to be continued all the year, and rigid ones ſhould be confined to that of ſummer. Fat people ſhould faſt at times, but the lean ſhould never do ſo. Thoſe who are troubled with eructations occaſioned by their food, ſhould drink but little, and uſe ſome unaccuſtomed exerciſe. The thirſty ſhould drink freely, but eat ſparingly. In general, let moderation be obſerved; and though no dinner hath been had, a light ſupper is always to be preferred. After very high-ſeaſoned meats, a glaſs of water, acidulated with the acid elixir of vitriol, or, in very weak ſtomachs, the ſweet elixir of vitriol, is far more aſſiſtant to the work of digeſtion than the common method of taking brandy. See FOOD and DRINK.

ALIMENTARY *Duct* or *Canal*, is a name given by Dr. Tyſon, and ſome others, to that part of the body through which the food paſſes, from its reception into the mouth to its exit at the *anus*; including the *gula*, ſtomach, and inteſtines. See the Syſtem of ANATOMY. This duct has been ſaid to be the true characteriſtic of an animal, or (in the jargon of the ſchools) *in proprium quarto modo*; there being no animal without it, and whatever has it being properly enough ranged under the claſs of animals. Plants receive their nouriſhment by the numerous fibres of their roots, but have no common receptacle for digeſting the food received, or for carrying off the recrements. But in all, even the loweſt degree of animal life, we may obſerve a ſtomach and inteſtines, even where we cannot perceive the leaſt formation of any organ of the ſenſes, unleſs that common one of feeling, as in oyſters. Phil. Tranſ. No. 267, p. 776, ſeq. Dr. Wallis brings an argument, from the ſtructure of the alimentary tube in man, to prove that he is not naturally carnivorous; to which Dr. Tyſon makes ſome objections. V. Phil. Tranſ. No. 266, p. 777.

ALIQUANT PART, in arithmetic, is that number which cannot meaſure any other exactly without ſome remainder. Thus 7 is an aliquant part of 16; for twice ſeven wants two of 16, and three time 7 exceeds 16 by 5.

ALIQUOT PART, is that part of a number or quatity which will exactly meaſure it without any remainder. Thus 2 is an aliquot part of 4; 3 of 9; 4 of 16, &c.

We muſt not confound an *aliquot part* with that of a *commenſurable*; for every *aliquot part* is a *commenſurable*, but not *vice verſa*. Thus *four* is *commenſurable* with *ſix*, but is not an *aliquot part* of it. Phil. Tranſ. No. 41.

ALKAHEST, in chymiſtry, an univerſal menſtruum, capable of reſolving all bodies into their firſt principles. Van Helmont pretended he was poſſeſſed of ſuch a menſtruum; but, however credulous people might be impoſed on in his days, the notion is now become as ridiculous as the *philoſopher's ſtone*, the *perpetuum mobile*, &c. See ALCHYMY.—It is likewiſe uſed by ſome authors for all fixed ſalts volatilized.

ALKALI, in chymiſtry, one of the general diviſions of ſalts, comprehending that claſs of chymical elements, which, by their union with acids, form *perfect neutrals*, in oppoſition to the ſalts formed of acids with metals or earths, which are called *imperfect*. Alkaline ſalts are divided into two kinds, the *fixed* and *volatile*; and the former into two ſpecies, *vegetable* and *mineral*. All of theſe poſſeſs ſome properties in common, and ſome peculiar to each. Thoſe which they have in common, are. 1. An acrid and pungent taſte, which, when the ſalts are very pure and ſtrong, degenerates into abſolute cauſticity, and would entirely deſtroy the organ of ſenſation if long applied to it. 2. A tendency to diſſolve animal ſubſtances, and reduce them to a gelatinous ſubſtance, which all of them will do when very ſtrong. 3. An attraction

traction for acids, with a power of separating earths and metals from them, though previously combined with the same. 4. They change the blue vegetable juices to green; the green to yellow; the yellow to orange; the orange to red; and the red to purple. 5. They unite with oils, and destroy, or cause to fade, almost all kinds of colours that can be put upon cloth, whence their use in bleaching, &c. The properties common to both kinds of fixed alkalis are, 1. They resist the action of fire to a great degree, so that they can easily be reduced to a solid form by evaporating any liquid in which they happen to be dissolved. 2. By an intense fire, they flow into a liquid which concretes into an hard and solid mass in the cold. 3. When mixed in certain proportions with those earths or stones called *vitrifiable*, they melt, in a heat still more intense, into glass. 5. Mixed with ammoniacal salts, with animal substances, or with soot, they extricate a volatile alkali. For the properties of the several kinds of alkalis in their different states, together with their characters, combinations, and uses in medicine, see the System of CHYMISTRY, Part I. Chap. IV. throughout.

ALKALINE, in a general sense, something that has the properties of an ALKALI; in this sense we say, *alkaline salts*, *alkaline spirits*, *alkaline substances*, &c.

ALKALINE *Air*. For its nature and properties, see the System of AEROLOGY, Sect. VIII.

ALKEKENGI, a medicinal fruit or berry, also called the *winter-cherry*; of some use as an abstergent, dissolvent, and diuretic. The fruit is celebrated for its lithontriptic quality; and prescribed to cleanse the urinary passages of gravel, and other obstructions. Its detersive quality also recommends it against the jaundice, and other disorders of the *viscera*.

ALL *Saints*, in the calendar, denotes a festival celebrated on the first of November, in commemoration of all the saints in general: which is otherwise called *All-hallows*. The number of saints being so excessively multiplied, it was found too burthensome to dedicate a feast-day to each. In reality, there were not days enough, scarce hours enough, in the year for this purpose. Hence an expedient was had recourse to, by commemorating such in combination, who had no peculiar days of their own.

ALL *Souls*, in the calendar, denotes a feast-day held on the second of November, in commemoration of all the faithful deceased. The feast of *All Souls* was first introduced in the eleventh century, by Odilon, abbot of Cluny, who enjoined it on his own order: but it was not long before it became adopted by the neighbouring churches.

ALLANTOIS, otherwise called *farciminalis*, in anatomy, a thin, smooth, membranous substance, or vesicle, investing the *fœtus* of divers animals, and replete with urinous liquor conveyed to it from the *urachus*. The *allantois* makes a part of the *secundine*. It is conceived as an urinary tunic, placed between the *amnion* and *chorion*; which by the navel and *urachus* receives the urine that comes out of the bladder. The *allantois* appears differently in different animals. It is most conspicuous in the cow and sheep kind. Its length in the former extends to about twelve feet. It is very dilatable, and may be blown up to above a foot diameter. The inhabitants of Iceland make use of it, instead of glass, for windows. It is a point controverted among anatomists, whether the *allantois* be found in the human species. M. Drelincourt, professor of anatomy at Leyden, in an express dissertation on this membrane, maintains it peculiar to the ruminating kind. Several anatomists, who dispute the existence of the human *allantois*, allow of an intermediate membrane in the human species, between the *chorion* and *amnios*, but deny it the appellation of an *allantois*, as holding it to differ from the *allantoides* of brutes, in structure as well as office. Neither artery nor vein can be discovered in this membrane. See Mem. Acad. des Science, 1701. Dr. Hale, on the contrary, has given an accurate description of the human *allantois*: and assigned the reason why even those who believed its existence had not before fully found it out, and also an answer to those who yet deny its reality. See Phil. Trans. No. 271. For the arguments for and against the human *allantois*, see the System of COMPARATIVE ANATOMY, Chap. I. Sect. IV.

ALLEGIANCE, in law, is the tie which binds the subject to the king, in return for that protection which the king affords the subject. The thing itself, or substantial part of it, is founded in reason and the nature of government; the name and the form are derived to us from our Gothic ancestors. Under the feodal system, every owner of lands held them in subjection to some superior or lord, from whom, or from whose ancestors, the tenant or vassal had received them: and there was a mutual trust or confidence subsisting between the lord and vassal, that the lord should protect the vassal in the enjoyment of the territory he had granted him; and, on the other hand, that the vassal should be faithful to the lord, and defend him against all his enemies. This obligation on the part of the vassal was called his *fidelitas*, or fealty: and an oath of fealty was required by the feodal law to be taken by all tenants to their landlord, which is couched in almost the same terms as our ancient oath of allegiance; except that, in the usual oath of fealty, there was frequently a saving or exception of the faith due to a superior lord by name, under whom the landlord himself was perhaps only a tenant or vassal. But when the acknowledgment was made to the absolute superior himself, who was vassal to no man, it was no longer called the oath of fealty, but the oath of allegiance; and therein the tenant swore to bear faith to his sovereign lord, in opposition to all men, without any saving or exception. Land held by this exalted species of fealty, was called *feudum ligium*, a liege fee; the vassals *homines ligii*, or liege men; and the sovereign, their *dominus ligius*, or liege lord. And when sovereign princes did homage to each other for lands held under their respective sovereignties, a distinction was always made between *simple* homage, which was only an acknowledgement of tenure, and *liege* homage, which included the fealty beforementioned, and the services consequent upon it. In Britain, it becoming a settled principal of tenure, that all the lands in the kingdom are holden of the king as their sovereign and lord paramount, no oath but that of fealty could ever be taken to inferior lords; and the oath of allegiance was necessarily confined to the person of the king alone. By an easy analogy, the term of *allegiance* was then brought to signify all other engagements which are due from subjects to their prince, as well as those duties which were simply and merely territorial. And the oath of allegiance, as administered in England for upwards of 600 years, contained a promise "to be true and faithful to the king and his heirs, and truth and faith to bear of life and limb and terrene honour, and not to know or hear of any ill or damage intended him, without defending him therefrom." But, at the revolution, the terms of this oath being thought perhaps to favour too much the notion of non-resistance, the present form was introduced by the Convention Parliament, which is more general and indeterminate than the former; the subject only promising "that he will be faithful and bear *true* allegiance to the king," without mentioning "his heirs," or specifying in the least wherein that allegiance consists. The oath of supremacy is principally calculated as a renunciation of the pope's pretended authority: and the oath of abjuration, introduced in the reign of King William, very amply supplies the loose and general texture of the oath of allegiance; it recognizing the right of his majesty, derived under the act of settlement; engaging to support him to the utmost of the Juror's power; promising to disclose all traiterous conspiracies against him; and expressly renouncing any claim of the descendants of the late pretender, in as clear and explicit terms as the English language can furnish. This oath must be taken by all persons in any office, trust, or employment; and may be tendered by two justices of the peace to any person whom they shall suspect of disaffection. And the oath of allegiance may be tendered to all persons above the age of twelve years, whether natives, denizens, or aliens. See ABDICATION.

Besides these *express* engagements, the law also holds that there is an *implied*, *original*, and *virtual* allegiance, owing from every subject to his sovereign, antecedently to any express promise, and although the subject never swore any faith or allegiance in form. Thus Sir Edward Coke very justly observes, that "all subjects are equally bounden to their allegiance as if they had taken the oath; because it is written by the finger of the law in their hearts, and the taking of the corporal oath is but an outward declaration of the same."

Allegiance, both express and implied, is however distinguished by the law into two sorts or species, the one *natural*, the other *local*; the former being also perpetual, the latter temporary. *Natural* allegiance is such as is due from all men born within the king's dominions immediately upon their birth. For, immediately upon their birth, they are under the king's protection; at a time, too, when (during their infancy) they are incapable of protecting themselves. Natural allegiance is, therefore, a debt of gratitude; which cannot be forfeited, cancelled, or altered, by any change of time, place, or circumstance, nor by any thing but the united concurrence of the legislature. A Briton who removes to France, or to China, owes the same allegiance to the king of Britain there as at home, and twenty years hence as well as now. For it is a principle of universal law, That the natural-born subject of one prince cannot, by any act of his own, no, not by swearing allegiance to another, put off or discharge his natural allegiance to the former: for this natural allegiance was intrinsic, and primitive, and antecedent to the other; and cannot be divested without the concurrent act of that prince to whom it was first due. *Local* allegiance is such as is due from an alien, or stranger born, for so long time as he continues within the king's dominion and protection; and it ceases the instant such stranger transfers himself from this kingdom to another. Natural allegiance is therefore *perpetual*, and local *temporary* only; and that for this reason, evidently founded upon the nature of government, That allegiance is a debt due from the subject, upon an implied contract with the prince, that so long as the one affords protection, so long the other will demean himself faithfully.

The oath of *allegiance*, taken by the people to the king, is only the counter part to the coronation oath, taken by the king to the people, and, as such, partakes of the nature of a covenant; that is, is conditional, and ceases on a violation of the contract by the prince; at least this is the doctrine of some of the chief advocates for the Revolution. The anti-revolutioners, on the contrary, hold the oath of *allegiance* to be absolute and unconditional. The *oath* of allegiance, or rather the *allegiance* itself, is held to be applicable, not only to the political capacity of the king, or regal

office but to his natural perſon and blood royal: and for the miſapplication of their allegiance, viz. to the regal capacity or crown, excluſive of the perſon of the king, were the Spencer baniſhed in the reign of Edward II. And from thence aroſe that principle of perſonal attachment, and affectionate loyalty, which induced our forefathers (and, if occaſion required, would doubtleſs induce their ſons) to hazard all that was dear to them, life, fortune, and family, in defence and ſupport of their liege lord and ſovereign. It is to be obſerved, however, in explanation of this allegiance, that it does not preclude reſiſtance to the king, when his miſconduct or weakneſs is ſuch as to make reſiſtance beneficial to the community. It ſeems fairly preſumable, that the convention parliament, which introduced the oath of allegiance in its preſent form, did not intend to exclude all reſiſtance; ſince the very authority by which the members ſat together, was itſelf the effect of a ſucceſsful oppoſition to an acknowledged ſovereign. Again, the allegiance above deſcribed can only be underſtood to ſignify obedience to lawful commands. If, therefore, the king ſhould iſſue a proclamation levying money, or impoſing any ſervice or reſtraint, upon the ſubject, beyond what the law authoriſed, there would exiſt no part of obligation to obey ſuch a proclamation, in conſequence of having taken the oath of allegiance. Neither can allegiance be ſuppoſed to extend to the king after he is actually and abſolutely depoſed, driven into exile, or otherwiſe rendered incapable of exerciſing the regal office. The promiſe of allegiance implies, that the perſon to whom the promiſe is made continues king; that is, continues to exerciſe the power, and afford the protection, which belong to the office of king: for it is the poſſeſſion of theſe which makes ſuch a particular perſon the object of the oath.

ALLEGORY, in compoſition, conſiſts in chooſing a ſecondary ſubject, having all its properties and circumſtances reſembling thoſe of the principal ſubject, and deſcribing the former in ſuch a manner as to repreſent the latter. The principal ſubject is thus kept out of view, and we are left to diſcover it by reflection. In other words, an allegory is, in every reſpect, ſimilar to an hieroglyphical painting, excepting only that words are uſed inſtead of colours. Their effects are preciſely the ſame. An hieroglyphic raiſes two images in the mind; one ſeen, that repreſents one that is not ſeen; An allegory does the ſame; the repreſentative ſubject is deſcribed, and the reſemblance leads us to apply the deſcription to the ſubject repreſented.

There cannot be a finer or more correct allegory than the following, in which a vineyard is made by means of this figure to repreſent God's own people the Jews.

"Thou haſt brought a vine out of Egypt; thou haſt caſt out "the heathen, and planted it. Thou didſt cauſe it to take deep "root, and it filled the land. The hills were covered with its "ſhadow, and the boughs thereof were like the goodly cedars. "Why haſt thou then broken down her hedges ſo that all that "paſs do pluck her? The boar out of the wood doth waſte it, and "the wild beaſt doth devour it. Return, we beſeech thee, O "God of hoſts: look down from heaven, and behold, and viſit "this vine and the vineyard thy right hand hath planted, and the "branch thou madeſt ſtrong for thyſelf." Pſal. lxxx.

Nothing gives greater pleaſure than an allegory, when the repreſentative ſubject bears a ſtrong analogy, in all its circumſtances, to that which is repreſented. But moſt writers are unlucky in their choice, the analogy being generally ſo faint and obſcure, as rather to puzzle than to pleaſe. Allegories, as well as metaphors and ſimilies, are unnatural in expreſſing any ſevere paſſion which totally occupies the mind. For this reaſon the following ſpeech of Macbeth is juſtly commended by the learned author of Elements of Criticiſm:

> Methought I heard a voice cry, Sleep no more!
> Macbeth doth murder Sleep: the innocent Sleep:
> Sleep, that knits up the ravell'd ſleeve of Care,
> The birth of each day's life, ſore Labour's bath,
> Balm of hurt minds, great Nature's ſecond courſe,
> Chief nouriſher in life's feaſt. Act ii. Sc. 3.

For a further illuſtration of this ſubject, ſee the Treatiſe on ORATORY, Part. III. Sect. I. Article II. under the head *Metaphor*.

ALLEGRO, in muſic, a word uſed by the Italians to denote one of the ſix diſtinctions of *time*. *Allegro* expreſſes a ſprightly, quick motion, the quickeſt of all, excepting *preſto*. The uſual diſtinctions ſucceed each other in the following order: *grave*, *adagio*, *largo*, *vivace*, *allegro*, and *preſto*. It is to be obſerved, that the movements of the ſame name, as *adagio*, or *allegro*, are ſwifter in tripple than in common time. The triple $\frac{3}{4}$ is uſually *allegro*, or *vivace*; the triple $\frac{3}{2}$, $\frac{3}{8}$, $\frac{3}{16}$, $\frac{3}{32}$, are moſt commonly *allegro*.

ALLELUIAH, or HALLELUIAH, a word ſignifying, *praiſe the Lord*, to be met with either at the beginning or end of ſome pſalms: ſuch is pſalm cxlv. and thoſe that follow to the end. Alleluiah was ſung upon ſolemn days of rejoicing, Tobit xiii. 12. St. John in the Revelations, (xix. 1, 3, 4, 6,) ſays, that he "heard a great voice of much people in heaven, who ſaid, Alleluiah; and the four and twenty elders, and the four beaſts, fell down and worſhipped God that ſat on the throne, ſaying *Alleluiah*." This hymn of joy and praiſes was transferred from the ſynagogue to the church.

ALLEY, in gardening, a ſtrait parallel walk, bordered or bounded on each hand with trees, ſhrubs, or the like. For the diſpoſition of the ſeveral walks, as they reſpect ornamental gardening, ſee the TREATISE, Part I. Article II. Sect. II.

ALLIANCE, in the civil and canon law, the relation contracted between two perſons or two families by marriage. Alliance is alſo uſed for a treaty entered into by foreign princes and ſtates, for their mutual ſafety and defence. In this ſenſe alliances may be diſtinguiſhed into ſuch as are offenſive, whereby the contracting parties oblige themſelves jointly to attack ſome other power; and into defenſive ones, whereby they bind themſelves to ſtand by and defend each other in caſe they are attacked by others.

It has been diſputed, whether the ſtates of the empire have a right of making *alliances* without the emperor's participation; and whether the king of England be veſted with abſolute power of making *alliances* at diſcretion, without the conſent of parliament. Doctor Davenant aſſerts the negative. According to him, the contrary opinion owes its riſe to the mere flattery of modern courtiers, having no foundation in the ancient laws and conſtitution of the kingdom. King John and Richard II. were, according to this author, the firſt that attempted any thing like it. It is certain there occur numerous inſtances in hiſtory, where the king has aſked, or the parliament have offered, their advice concerning the *alliances* to be made; but there are many others, at leaſt of later times, wherein no footſteps of any ſuch conſultation appear. There are inſtances likewiſe where the parliament have declined giving any advice concerning ſuch arduous matters.

The forms or ceremonies of alliances have been various in different ages and countries. Among us, ſigning and ſwearing, ſometimes at the altar, are the chief; anciently, eating and drinking together, chiefly offering ſacrifices together, were the cuſtomary rite of ratifying an alliance. Among the Jews and Chaldeans, heifers or calves; among the Greeks, bulls or goats; and among the Romans, hogs were ſacrificed on this occaſion. Among the ancient Arabs, alliances were confirmed by drawing blood out of the palms of the hands of the two contracting princes with a ſharp ſtone, dipping therein a piece of their garments, and therewith ſmearing ſeven ſtones, at the ſame time invoking the gods Vrotalt and Alilat; *i. e.* according to Herodotus, Bacchus and Urania.

ALLIGATION, the name of a method of ſolving all queſtions that relate to the mixture of one ingredient with another. Though writers on arithmetic generally make alligation a branch of that ſcience, yet, as it is plainly nothing more than an application of the common properties of numbers, in order to ſolve a few queſtions that occur in particular branches of buſineſs, we chooſe rather to keep it diſtinct from the ſcience of arithmetic. Alligation is generally divided into *medial* or *alternate*. For the definition of theſe two kinds of Alligation, and the rules for their reſpective operations, with their uſes, &c. ſee the Syſtem of ARITHMETIC, Chap. XVII throughout.

ALLITERATION, an ornament of language chiefly uſed in poetry, and conſiſting in the repetition of the ſame letter at certain intervals. We do not remember to have ever ſeen any ſatisfactory account of alliteration in the writings of the critics; they ſeem to have paſſed it over in contemptuous ſilence; either as a falſe refinement, or as a mere trifle. It perhaps deſerves a better fate. Many chapters have been compoſed on quantity, on the expreſſion reſulting from different arrangements of long and ſhort ſyllables, and on the powers of pauſes as they are variouſly placed, without a word of Alliteration. This is the more extraordinary, as one ſhould think it impoſſible for any man to examine minutely, and, as it were, diſſect a number of verſes, without perceiving the vaſt abundance of this ornament. It is as if an anatomiſt ſhould publiſh a complete table of the arteries in the human body, and affect never to have ſeen a vein or a nerve: for it may be affirmed, with ſmall danger of miſtake, that if you examine any number of verſes, remarkable either for ſweetneſs or for energy, they will be found in ſome degree alliterative. We do not pretend to ſay, that the ſweetneſs and energy of verſification depends chiefly on this circumſtance, yet we cannot help believing that it may claim ſome ſhare: for it is a conſtant appearance, as far as we have ever obſerved, that the poets whoſe fame is higheſt for verſification are moſt extenſive dealers in this article.

The trifling poor appearance of the ornament itſelf, upon a ſuperficial view, and the frequent abuſe of it, are circumſtances indeed which give no encouragement to a ſerious inquiry into its nature and operation. How common is it for writers, who affect to be comic, when in want of other means for raiſing a ſmile, to uſe affected alliteration with ſucceſs! But, in the fine arts, no beauty nor grace beyond the power of ridicule. The nobleſt attitudes in painting have been rendered laughable by caricatura. St. Paul preaching at Athens, in the deſign of Raphael, appears elegant, noble, and in ſome degree awful. The ſame apoſtle, repreſented by Hogarth in nearly the ſame attitude, pleading before the governor Felix, ſeems altogether ridiculous. So the language and verſification of Milton in the Paradiſe Loſt appear only proper for the moſt elevated ſubjects. In the Splendid Shilling of Philips they appear equally proper for the loweſt. So fares it alſo with alliteration. Nor ought we to be mortified at the diſcovery, that much of the delight afforded by verſification ariſes

from a cauſe ſo pitiful as the repetition of the ſame letter twice, or oftener, on the accented parts of a verſe; for there are many other cauſes of pleaſure, which, when thus detected, and taken to pieces, ſeem equally contemptible.

We apprehend the principal operation of this ornament to be quite mechanical. It is eaſier for the organs of ſpeech to reſume, at ſhort intervals, one certain confirmation, than to throw themſelves into a number of different ones, unconnected and diſcordant. For example, a ſucceſſion of labials, interſperſed at regular diſtances, with dentals and gutturals, will be more eaſily pronounced than the ſucceſſion of all the three at random. Sounds of which the articulation is the eaſieſt are moſt completely in the power of the ſpeaker. He can pronounce them ſlowly or rapidly, ſoftly or with force, at pleaſure. In this we imagine the power and advantage of alliteration is founded: for we would not lay any ſtreſs on the pleaſure which can reſult to the ear from the repetition of the ſame letter. It has been compared to the frequent returns of the key-note in a muſical ſtrain; but that analogy is extremely faint. The ear, we preſume, can be pleaſed with alliteration only in ſo far as it contributes to the ſuperior eaſineſs of recitation; for what is recited with eaſe muſt be heard with pleaſure.

Theſe remarks might be confirmed and illuſtrated by numberleſs paſſages from the beſt poets. Some few lines will ſuffice, taken from Grey, who ſeems to have paid particular attention to this grace. He profeſſed to have learned this verſification from Dryden, as Dryden did from Spencer; and theſe three abound in alliteration above all the Engliſh poets. We chooſe Grey for another reaſon, in proof of what we mentioned before, that alliteration contributes not only to the *ſweetneſs*, but alſo to the *energy*, of verſification; for he uſes it chiefly when he aims at ſtrength and boldneſs. In the *Sifter Odes* (as Dr. Johnſon ſtyles them) almoſt every ſtrophe commences and concludes with an alliterative line. The poet, we ſuppoſe, wiſhed to begin with force, and end with dignity.

"*R*uin ſeize thee, ruthleſs king."
"To *h*igh-born *H*oel's *h*arp, or ſoft *L*lewellyn's *l*ay."
"*W*eave the warp, and weave the woof."
"Stamp we our vengeance *d*eep, and ratify his *d*oom."
"Regardleſs of the *ſ*weeping whirlwind's *ſ*way."
"That, hufh'd in grim r*e*poſe, expects his ev'ning *p*rey."

It muſt be obſerved here, that we hold a verſe alliterative which has a letter repeated on its accented parts, although thoſe parts do not begin words; the repeated letter bearing a ſtrong analogy to the bars in a muſical phraſe. Grey ſeems to have had a particular liking to theſe ſorts of balanced verſes, which divide equally, and of which the oppoſite ſide have an alliterative reſemblance.

"Eyes that *g*low, and fangs that *g*rin;
"Thoughts that *b*reathe, and words that *b*urn."
"*H*auberk craſh, and *h*elmet ring."

All theſe lines appear to us to have a force and energy, ariſing from alliteration, which renders them eaſy to be recited; or, if the reader pleaſes, *mouthed*. For the ſame reaſon the following paſſage appears ſad and ſolemn by the repetition of the labial liquid.

"*M*ountains, ye *m*ourn in vain."
"*M*odred, whoſe *m*agic ſong,"—&c.

If alliteration thus contributes to enforce the expreſſion of a poetical ſentiment, its advantages in poetry muſt be conſiderable. It is not, therefore, unworthy a poet's regard in the act of compoſition. If two words offer of equal propriety, the one alliterative, the other not, we think the firſt ought to be choſen. We would compare this to the practice of fuguing in muſic. A compoſer who aims at expreſſion will not hunt after fugues; but if they offer, if they ſeem to ariſe ſpontaneouſly from the ſubject, he will not reject them. So a good poet ought not to ſelect an epithet merely for beginning with a certain letter, unleſs it ſuit his purpoſe well in every other reſpect; for the beauty of alliteration, when happy, is not greater than its deformity when affected. A couplet from Pope will exemplify both; the firſt line being bad, and the ſecond good:

"*E*ternal beauties grace the *ſ*hining *ſ*cene;
"*F*ields ever *f*reſh, and *g*roves for ever *g*reen."

ALLIUM, (from 'αλεω, "to avoid or ſhun," becauſe many ſhun the ſmell of it,) GARLIC: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking in the ninth order, *Spathaceæ*. The characters are: the *calyx* is a common ſpatha, roundiſh, withering, and multiflorous. The *corolla* conſiſts of ſix oblong petals; The *ſtamina* have ſix ſubulated filaments, often the length of the corolla; the antheræ are oblong and erect: The *piſtillum* has a germen above, ſhorter, nearly three-cornered, with angles engraved with a line; the ſtyli are ſimple, the ſtigmata acute: The *pericarpium* is a very ſhort, broad, three-lobed capſul, with three cells and three valves: The *ſeeds* are many and roundiſh. Of this genus no fewer than 40 different ſpecies are enumerated by Linnæus, among which he includes the cepa and porrum, or onions and leeks. The following are the moſt remarkable. 1. The *ſativum*, or garlic, has a bulbous root, of an irregular roundiſh ſhape, with ſeveral fibres at the bottom; each root is compoſed of another of leſſer bulbs, called *cloves* of garlic, incloſed in one common membranous coat, and eaſily ſeparable from one another. All the parts of this plant, but more eſpecially the roots, have an acrimonious and almoſt cauſtic, taſte, with ſtrong offenſive ſmell, which laſt has induced thoſe who preſerved ſome of the ſpecies in gardens, on account of their yellow flowers, to eradicate them. This pungent root warms and ſtimulates the ſolids, and attenuates tenacious juices; for which it is well adapted, on account of its being very penetrating; inſomuch that, when applied to the feet, its ſcent is ſoon diſcovered in the breath; and, when taken internally, its ſmell is communicated to the urine, or the matter of an iſſue, and perſpires through the pores of the ſkin. Hence, in cold eucophlegmatic habits, it proves a powerful expectorant, diuretic, and emmenagogue; and, if the patient is kept warm, ſudorific. It is alſo of great ſervice in humoral aſthmas and catarrhous diſorders of the breaſt, and in other diſorders proceeding from a laxity of the ſolids, and cold ſluggiſh indiſpoſitions of the fluids. It is alſo frequently of ſervice in the dropſy; in the beginning of which it is particularly recommended by Sydenham, as a warm ſtrengthening medicine; we have even many examples where it acts ſo powerfully as a diuretic as to carry off all the water of dropſies. It may be taken the length of a dram or two in ſubſtance for a doſe. We have a ſyrup and oxymel made with it, which may be employed for the ſame purpoſes as the garlic in ſubſtance; but they are moſtly uſed in pulmonic diſorders. Externally applied, it inflames and ulcerates the ſkin, and is ſometimes employed for this uſe in ſinapiſms. It has alſo been recommended by Sydenham as a moſt powerful revellent; for which purpoſe he was led to make uſe of it in the confluent ſmall-pox. His method was to cut the root in pieces, and apply it, tied in a linen cloth, to the ſoles of the feet, about the eighth day of the diſeaſe, after the face began to ſwell; renewing it once a day till the danger was over. When made into an unguent with oils, and applied externally, garlic is ſaid to reſolve and diſcuſs cold tumours, and has been by ſome greatly celebrated in cutaneous diſorders. The acrimonious qualities of this root, however, render it manifeſtly improper on many occaſions. Its liberal uſe is apt to occaſion head-achs, flatulencies, thirſt, febrile heats, inflammatory diſtempers, and ſometimes diſcharges of blood from the hemorrhoidal veſſels. In hot bilious conſtitutions, where there is already a degree of irritation, where the juices are too thin and acrimonious, or the viſcera unſound, it never fails to aggravate the diſtemper.

In Kamtſchatka, the allium urſinum, or wild garlic, is very common and uſeful in medicine as well as food. Both Ruſſians and natives gather it in great quantities for winter ſervice. They ſteep it in water, then mix it with cabbages, onions, and other ingredients, and form out of them a ragout, which they eat cold. It is alſo the principal remedy for the ſcurvy. As ſoon as this plant appears above the ſnow, they ſeem to put this dreadful diſorder at defiance, and find a cure almoſt in its worſt ſtages.

2. The *aſcalonicum*, or eſchalot, was found wild in Paleſtine by Dr. Haſſelquiſt. The root of this ſpecies is very pungent, has a ſtrong, but not unpleaſant ſmell, and therefore is generally preferred to the onion for making high-flavoured ſoups and gravies. It is alſo put into pickles; and in the Eaſt Indies they uſe an abundance of it for this purpoſe.

3. The *cepa*, or common onion, differs from the garlic only in the ſwelling pipy ſtalk, which is much larger in the middle than at either end. From whence this was firſt brought into Europe is not known; but that it is not natural to Africa is beyond a doubt, it being evident that onions were eaten by the Egyptians above 2000 years before Chriſt; and they make a great part of their conſtant food to this day in Egypt. Dr. Haſſelquiſt ſays, it is not to be wondered at, that the Iſraelites ſhould long for them after they had left this place; for, whoever has taſted onions in Egypt, muſt allow, that none can be had better in any part of the univerſe. Here, he obſerves, they are ſweet; in other countries they are nauſeous and ſtrong. Here they are ſoft; whereas in the north and other parts they are hard, and their coats ſo compact that they are difficult to digeſt. They eat them roaſted, cut into four pieces, with ſome bits of roaſted meat, which the Turks call *kebab*; and with this diſh they are ſo delighted that they wiſh to enjoy it in paradiſe. They likewiſe make a ſoup of them in Egypt, which Haſſelquiſt ſays is one of the beſt diſhes he ever eat. The many ways of dreſſing onions in Britain are known to every family; but, in regard to wholeſomeneſs, there is certainly no method equal to boiling; as thus they are rendered mild, of eaſy digeſtion, and go off without leaving thoſe heats in the ſtomach and bowels which they are apt to do any other way. Their nature is to attenuate thick, viſcid juices; conſequently a plentiful uſe of them in cold, phlegmatic conſtitutions muſt prove beneficial. Many people ſhun them on account of the ſtrong diſagreeable ſmell they communicate to the breath. This may be remedied by eating a few raw parſley-leaves immediately after, which will effectually overcome the ſcent of the onions, and cauſe them to ſit more eaſy on the ſtomach. The varieties are, the Straſburgh, the Spaniſh, and the Egyptian onion.

Beſides the above-mentioned ſorts of onions, the ſcallions, or eſcallions, and Welſh onions were formerly in great repute. For the moſt approved method of cultivating onions, ſee the Treatiſe

on

on GARDENING, Part II. Article *Kitchen Garden*. Months *February*, *July*, and *Auguſt*.

4. The *porrum*, or leek, has been ſo long cultivated, that its native place of growth cannot be traced. It is undoubtedly the ſame as that mentioned in the eleventh chap. of Numbers, where it is ſaid, the Iſraelites longed for leeks in conjunction with onions. The leaves are much of the ſame nature as thoſe of the latter, and they are yet a conſtant diſh at the tables of the Egyptians, who chop them ſmall, and then eat them with their meat. They are in great eſteem too with the Welſh, and their general uſe as a pot-herb is well known. Their culture is the ſame with that of the onion.

ALLODIUM, land held of a man's own right, without acknowledgement of ſervice, or payment of any new rent, to another; and this is a property in the higheſt degree; but *feudum* is ſuch land as is held of another, for which ſervice is done, or rent is paid, as an acknowledgement thereof. See the article FEE. All the lands in England, except the crown-lands in the king's own hands, in right of his crown, are of the nature of FEUDUM, or FEE; for although many have lands by deſcent from their anceſtors, and others have bought land, it cannot come to any, either by deſcent or purchaſe, but with the burden that was laid upon him who had *novel-fee*, or firſt of all received it from his lord; ſo that there is no perſon hath *directum dominium*, i. e. the very property or demeſne in any land, but the king, in right of his crown.

The uſurpation of the feudal lords over the *allodial* lands went ſo far, that they were almoſt all either ſubjected to them, or converted into fees; whence the maxim *nulla terra ſine domino*; *no land without a lord*

ALLOY, or ALLAY, in matters of *coinage*, &c. a proportion of a baſer metal mingled with a finer or purer. Minters never ſtrike any gold or ſilver coin without *alloy*, always mixing ſome copper with thoſe two metals, according to a certain proportion, ſettled by the rules of the *Mint*. The jewellers, gold-wire drawers, gold-beaters, and gold and ſilverſmiths, are obliged to uſe *alloy* in the gold and ſilver they work; but it ought to be leſs than that of coin, to prevent their melting it in order to uſe it in their works. The braſs-founders alſo have their *alloy* of copper, pewter, and tin. This *alloy* differs according to what they deſign to caſt, whether ſtatues, guns, or bells. The pewterers, in making their ſeveral veſſels, diſhes, plates, &c. alſo make uſe of an *allay* of red copper, *regulus* of antimony, and ſome other minerals. There are ſeveral kinds of *alloy*; ſuch as *bronze*, *braſs*, *copper*, &c. See theſe articles in the ALPHABET.

Metallic ſubſtances cannot unite directly with earthy matters, not even with their own earths when deprived of their inflammable principle, and conſequently of their metallic properties. But in general it may be ſaid, that all metals may be *alloyed* with each other, although more or leſs eaſily, and although ſome of them have not yet been made to unite. As *metals* are bodies naturally ſolid, the firſt condition for their union is that they be fuſed; they then unite like all bodies that reciprocally diſſolve each other; and from theſe combinations new compounds reſult, which have the mixed properties of the component ſubſtances. In *metallic alloys*, as in almoſt all other *metallic* combinations, phenomena appear which depart from the general rules of combination; and ſome of the properties of metals forming an *alloy* are altered, increaſed, or diminiſhed by their union. The ductility, for inſtance, of a *metallic* compoſition is generally leſs than the ductility of the component metals alone and pure. The denſity, or ſpecific gravity, of metals and ſemi-metals, is alſo changed by *alloying* them with each other. Sometimes the ſpecific gravity of the compound is intermediate betwixt the ſpecific gravity of the component metals; ſometimes it is leſs, and frequently greater; this depends upon the nature of the metal.

There are two ſorts of *alloys* practiſed in the coinage of money: the one when gold and ſilver are uſed which have not yet been coined; the other when ſeveral ſpecies of coin, or ingots of different fineneſs, are melted together to coin new money. The proportion of the *alloy* with the finer metal is eaſy in the firſt caſe; ſince when once the fineneſs of the gold or ſilver is known by refining, it is only adding to it the *alloy* of copper required by law to bring it to the legal ſtandard. In England the ſtandard of gold coin is 22 *carats* of fine gold and 2 *carats* of *alloy* in the pound troy: the French, Spaniſh, and Flemiſh gold are nearly the ſame fineneſs. The pound weight is cut into 44 pieces and ½, each current for 21 ſhillings. The ſtandard of ſilver is 11 oz. 2 pennyweights troy of ſilver, and 18 pennyweights of *alloy* of copper. The *alloy* in gold coin is ſilver and copper, and in ſilver coin copper alone. Whether gold or ſilver be above or below ſtandard, is to be found by ASSAY. See ASSAY.

The chief reaſons alledged for the alloying of coin are, 1. The mixture of the metals, which when ſmelted from the mine are not perfectly pure. 2. The ſaving the expence it muſt otherwiſe coſt if they were to be refined. 3. The neceſſity of rendering them harder, by mixing ſome parts of other metal with them, to prevent the diminution of weight by wearing, in paſſing from hand to hand. 4. The melting of foreign gold or coin which is *alloyed*. 5. The charge of coinage, which muſt be made good by the profit ariſing from the money coined. 6. and laſtly, the duty belonging to the ſovereign, on acconnt of the power he has to cauſe money to be coined in his dominions. See GOLD, SILVER, REFINING, and ASSAY. See a particular account of the *alloy* of gold, its uſefulneſs, and its proportion in different coins, in Dr. Lewis's Commerc. P. Techt. p. 144, and ſeq. According to the different proportions of *alloy* money is of different degrees of fineneſs or baſeneſs, and is valued accordingly in foreign exchanges. For a further account of the different alloys, ſee the Syſtem of CHYMISTRY, Part III. Chap. I. and II. throughout.

ALMANACK, a book, or table, containing a calendar of days and months, the riſing and ſetting of the ſun, the age of the moon, the eclipſes of both luminaries, &c. Authors are divided with regard to the etymology of the word. All the claſſes of Arabs are commonly much given to the ſtudy of aſtronomy and aſtrology; to both which a paſtoral life, and a ſort of huſbandry, not only incline them, but give them time and leiſure to apply themſelves to them. They neither ſow, reap, plant, travel, buy or ſell, or undertake any expedition, without previouſly conſulting the ſtars, or, in other words, their almanacks, or ſome of the makers of them. From theſe people, by their vicinity to Europe, this art, no leſs uſeful in one ſenſe, than ſtupid and ridiculous in another, hath paſſed over hither: and thoſe aſtronomical compoſitions have ſtill everywhere not only retained their old Arabic name, but were, like theirs, for a long while, and ſtill are among many European nations, interſperſed with a great number of aſtrological rules for planting, ſowing, bleeding, purging, &c. down to the cutting of the hair, and paring of the nails. Regiomontanus appears to have been the firſt in Europe, however, who reduced almanacks into their preſent form and method, gave the characters of each year and month, foretold the eclipſes and other phaſes, calculated the motions of the planets, &c. His firſt almanack was firſt publiſhed in 1477. Almanacks differ from one another, chiefly, in containing ſome more, others fewer, particulars. The eſſential part is the calendar of months and days, with the riſings and ſettings of the ſun, age of the moon, &c. To theſe are added various parerga, aſtronomical, meteorological, chronological, political, rural, &c. as calculations and accounts of eclipſes, ſolar inveſtes, prognoſtics of weather, tables of the tides, terms, &c. liſts of poſts, offices, dignities, public inſtitutions, with many other articles, political as well as local, and differing in different countries. A great variety are annually publiſhed in Britain; ſome for binding, which may be denominated *book-almanacks*; others in looſe papers, called *ſheet-almanacks*.

Conſtruction of ALMANACKS. The firſt thing to be done is, to compute the ſun's and moon's place for each day of the year, or it may be taken from ſome ephemerides, and entered into the almanack; next, find the dominical letter, and, by means thereof, diſtribute the calendar into weeks; then, having computed the time of Eaſter, by it fix the other moveable feaſts; adding the immoveable ones, with the names of the martyrs, the riſing and ſetting of each luminary, the length of day and night, the aſpects of the planets, the phaſes of the moon, and the ſun's entrance into the cardinal points of the ecliptic, *i. e.* the two equinoxes and ſolſtices. (See ASTRONOMY, *paſſim.*) By the help of good aſtronomical tables or ephemerides, the conſtruction of almanacks is extremely eaſy.

ALME, or ALMA, ſinging and dancing girls in Egypt, who, like the Italian *Improviſatori*, can occaſionally pour forth "unpremeditated verſe." They are called *Almé*, from having received a better education than other women. They form a celebrated ſociety in this country. To be received into it, according to Mr. Savary, it is neceſſary to have a good voice, to underſtand the language well, to know the rules of poetry, and be able to compoſe and ſing couplets on the ſpot, adapted to the circumſtances. The Almé know by heart all the new ſongs. Their memory is furniſhed with the moſt beautiful tales. There is no feſtival without them; no entertainment of which they do not conſtitute the ornament. They are placed in a roſtrum, from whence they ſing during the repaſt. They then deſcend into the ſaloon, and form dances which have no reſemblance to ours. They are pantomime ballets, in which they repreſent the uſual occurrences of life. The myſteries of love too generally furniſh them with ſcenes. The ſuppleneſs of their bodies is inconceivable. One is aſtoniſhed at the mobility of their features, to which they give at pleaſure the impreſſion ſuited to the characters they play. The indecency of their attitudes is often carried to exceſs. Their looks, their geſtures, every thing ſpeaks, but in ſo expreſſive a manner, that it is impoſſible to miſtake them. At the beginning of the dance they lay aſide with their veils the modeſty of their ſex. A long robe of very thin ſilk goes down to their heels, which is ſlightly faſtened with a rich girdle. Long black hair, plaited and perfumed, is flowing on their ſhoulders. A ſhift, tranſparent as gauze, ſcarcely hides their boſom. As they put themſelves into motion, the ſhapes, the contours of their bodies ſeem to develope themſelves ſucceſſively. Their ſteps are regulated by the ſound of the flute, of caſtanets, the tambour de baſque, and cymbals, which accelerates or retards the meaſure. They are ſtill further animated by words adapted to ſuch ſcenes. They appear in a ſtate of intoxication. They are the Bacchants in a delirium. It is when they are at this point, that, throwing off all reſerve, they abandon themſelves totally to the diſorder of their ſenſes; it is then that a people, far from delicate, and who like nothing hidden, redouble their applauſes. Theſe Almé are ſent for into all the harams.

They teach the women the new airs; they amuſe them with amorous tales, and recite in their preſence poems, which are ſo much the more intereſting, as they furniſh a lively picture of their manners. They initiate them into the myſteries of their art, and teach them to contrive laſcivious dances. Theſe girls, who have a cultivated underſtanding, are very agreeable in converſation. They ſpeak their language with purity. The habit of dedicating themſelves to poetry renders the ſofteſt and moſt ſonorous expreſſions familiar to them. They repeat with a great deal of grace. In ſinging, nature is their only guide. Sometimes two of them ſing together, but always with the ſame voice. It is the ſame with an orcheſtra, where all the inſtruments playing in uniſon execute the ſame part.

The Almé aſſiſt at the marriage ceremonies, and march before the bride, playing on inſtruments. They make a figure likewiſe at funerals, and accompany the proceſſion, ſinging ſorrowful airs. They break forth into groans and lamentations, and give every ſign of grief and deſpair. Theſe women are paid very high, and ſeldom appear but amongſt the grandees and rich men. The common people have alſo their Almé. They are girls of the ſecond claſs, who try to imitate the former; but they have neither their elegance, their graces, nor their knowledge. They are every where to be met with. The public places and the walks about Grand Cairo are full of them. As the populace require alluſions ſtill more ſtrongly marked, decency will not permit the relation to what a pitch they carry the licentiouſneſs of their geſtures and attitudes.

ALMOND-TREE, in botany, the Engliſh name of the genus *Amygdalus*. For a deſcription of the genus, together with its produce and ſeveral uſes, ſee the article AMYGDALUS.

ALMONER, in its primitive ſenſe, denotes an officer in religious houſes, to whom belonged the management and diſtribution of the alms of the houſe. By the ancient canons, all monaſtries were to ſpend at leaſt a tenth part of their income in alms to the poor. The almoner of St. Pauls is to diſpoſe of the monies left for charity, according to the appointment of the donors, to bury the poor who die in the neighbourhood, and to breed up eight boys to ſinging for the uſe of the choir. By an ancient canon, all biſhops are required to keep almoners.

Lord Almoner, or Lord High Almoner, of England, is an eccleſiaſtical officer, generally a biſhop, who has the forfeiture of all deodands, and the goods of *felos de ſe*, which he is to diſtribute among the poor. He has alſo, by virtue of an ancient cuſtom, the power of giving the firſt diſh from the king's table to whatever poor perſon he pleaſes, or, inſtead of it, an alms in money.

ALMS, a general term for what is given out of charity to the poor. In the early ages of Chriſtianity, the alms of the charitable were divided into four parts; one of which was allotted to the biſhop, another to the prieſts, and a third to the deacons and ſubdeacons, which made their whole ſubſiſtence; the fourth part was employed in relieving the poor, and in repairing the churches. No religious ſyſtem is more frequent or warm in its exhortations to alms-giving than the Mahometan. The Alcoran repreſents alms as a neceſſary means to make prayer be heard. Hence that ſaying of one of their khaliſs: "Prayer carries us half way to God, faſting brings us to the door of his palace, and alms introduces us into the preſence chamber." Hence many illuſtrious examples of this virtue among the Mahometans. Haſan, the ſon of Ali, and grandſon of Mohammed, in particular, is related to have thrice in his life divided his ſubſtance equally between himſelf and the poor, and twice to have given away all he had. And the generality are ſo addicted to the doing of good, that they extend their charity even to brutes.

Alms alſo denotes lands or other effects left to churches or religious houſes, on condition of praying for the ſoul of the donor.

ALOE, in botany, a genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method, ranking under the 10th order, *Coronariæ*. The characters are: There is no *calyx*: The *corolla* is monopetalous, erect, ſix-cleft, and oblong; the tube gibbous; the border ſpreading, and ſmall; with a nectery-bearing bottom: The *ſtamina* conſiſt of ſix ſubulated filaments, rather ſurpaſſing the corolla in length, and inſerted into the receptacle; the anthere are oblong and incumbent: The *piſtillum* has an ovate germen; the ſtylus is ſimple, the length of the ſtamina; the ſtigma is obtuſe and trifid: The *pericarpium* is an oblong capſule, three-furrowed, three-celled, three-valved; The *ſeeds* are many and angular. Of this genus, botanical writers enumerate ten ſpecies.

The *aloe* is a kind of ſymbolic plant to the Mahometans, eſpecially in Egypt, and in ſome meaſure dedicated to the offices of religion; for whoever returns from a pilgramage to Mecca, hangs it over his ſtreet door as a token of his having performed that holy journey. The ſuperſtitious Egyptians believe that this plant hinders evil ſpirits and apparitions from entering the houſe; and on this account, whoever walks the ſtreets in Cairo, will find it over the doors both of Chriſtians and Jews. From the ſame plant the Egyptians diſtil a water, which is ſold in the apothecaries ſhops at Cairo, and recommended in coughs, hyſterics, and aſthmas. An experienced French ſurgeon, ſays Haſſelquiſt, gave a Coptite, 40 years old, afflicted with the jaundice, four tea-cups full of the diſtilled water of this ſpecies of aloe, and cured him in four days. This remedy, unknown to our apothecaries, is not difficult to be obtained, as the plant might eaſily be raiſed in the warm ſouthern parts of Europe. The Arabians call it *ſabbara*. Of the leaves of the Guinea aloe, mentioned by Mr. Adanſon in his voyage to Senegal, the negroes make very good ropes, not apt to rot in the water. Dr. Sloane mentions two ſorts of aloe; one of which is uſed for fiſhing-lines, bow-ſtrings, ſtockings, and hammocks: the other has leaves which, like thoſe of the wild-pine and banana, hold rain-water, and thereby afford a very neceſſary refreſhment to travellers in hot countries, where there is generally a ſcarcity of wells and water. In Mexico, the *maguei*, a ſpecies of aloe, yields almoſt every thing neceſſary to the life of the poor. Beſides making excellent hedges for their fields, its trunk ſerved in place of beams for the roofs of their houſes, and its leaves inſtead of tiles. From thoſe leaves they obtained paper, thread, needles, clothing, ſhoes and ſtockings, and cordage; and from its copious juice they made wine, honey, ſugar, and vinegar. Of the trunk, and thickeſt part of the leaves, when well baked, they made a very tolerable diſh of food. Laſtly, it was a powerful medicine in ſeveral diſorders, and particularly in thoſe of the urine. It is alſo at preſent one of the plants the moſt valued and moſt profitable to the Spaniards.

The medical ſubſtance known by the name of *aloes* is the inſpiſſated juice of ſome of the abovementioned ſpecies. The ancients diſtinguiſhed two ſorts of aloes: the one was pure, and of a yellowiſh colour, inclining to red, reſembling the colour of a liver, and thence named *hepatic*; the other was full of impurities, and hence ſuppoſed to be only the droſs of the better kind. At preſent, various ſorts are met with in the ſhops; which are diſtinguiſhed either from the places, from the ſpecies of the plants, or from ſome difference in the juices themſelves.

All the different kinds of aloes are gum-reſins, which contain more gummous than reſinous parts. Water, when of a boiling heat, diſſolves all the ſoluble parts of aloes: but if let ſtand till it grows cold, it lets drop moſt of its reſin. A ſtrong ſpirit diſſolves and keeps ſuſpended almoſt the whole of aloes, though it contains ſuch a large portion of gummous parts; hence it is evident, that aloes contains ſome principle, ſaline or other, which renders water capable of diſſolving reſin, and ſpirit capable of diſſolving gum.

Aloes is a ſtimulating ſtomachic purge, which, given in ſmall quantity, operates mildly by ſtool; but in large doſes acts roughly, and often occaſions an irritation about the anus, and ſometimes a diſcharge of blood. It is a good opening medicine to people of a lax habit, or who live a ſedentary life; and to thoſe whoſe ſtomach and bowels are loaded with phlegm or mucus, or who are troubled with worms, or are debilitated; becauſe at the ſame time that it carries off thoſe viſcid humours which pall the appetite, and overload the inteſtines, it ſerves as a ſtrengthener and bracer. In ſmall doſes, repeated from time to time, it not only cleanſes the primæ viæ, but likewiſe tends to promote the menſtrual diſcharge in women; and therefore it is frequently employed in chloroſis, or where the menſtrua are obſtructed. It is a good ſtomachic purge, and is given in all caſes where ſuch a one is wanted; but it is looked upon as a heating medicine, and not proper in bilious habits, or where there is much heat or fever; and its continued uſe is apt to bring on the piles. It is given in ſubſtance from five grains to a ſcruple, though formerly it uſed to be preſcribed in doſes of two or three times that quantity; but theſe large doſes ſometimes brought on troubleſome ſymptoms. As it is a ſlow working purge, it is generally taken at bed-time, and it operates next day. With regard to this, as well as all other reſinous purges, it ought to be obſerved, that when they are given in ſubſtance without any mixture, they are apt to adhere to the coats of the inteſtines, and to occaſion griping and uneaſineſs; for theſe reaſons aloes is generally mixed with ſome ſaponaceous or reſolvent body, to deſtroy its viſcid tenacity, before it is given in ſubſtance. The ſubſtances which are moſt uſed for this purpoſe are, a ſmall quantity of the fixt alkaline ſalts; ſoap; the yolk of an egg; and gummous vegetable extracts. Mr. Barton alledges, that by triturating aloes with a ſmall quantity of alkaline ſalts, its tenacity was more effectually deſtroyed than by any other thing he tried: that Caſtile ſoap and the yolk of an egg anſwered beſt, next to it; that manna, ſugar, and honey were far inferior to them; and that gummous or mucous vegetable extracts, ſuch as the extracts of gentian or of liquorice root, triturated with the aloes, in the proportion of one part of the extract to two of the aloes, and then made up into pills with a ſufficient quantity of ſyrup, deſtroyed the viſcidity of the aloes, and rendered its operation mild. Socotrine aloes contains more gummy matter than the hepatic; and hence it is likewiſe found to purge more, and with greater irritation. The firſt ſort therefore is moſt proper where a ſtimulus is required, as for promoting or exciting the menſtrual flux; whilſt the latter is better calculated to act as a common purge.

ALOPECURUS, or FOX-TAIL GRASS, in botany, a genus of the triandria digynia claſs. There are eight ſpecies, viz. the pratenſis, or meadow fox-tail graſs; the bulboſus, or bulbous fox-tail graſs; the geniculatus, or ſtote fox-tail graſs; and the myoſuroides, or field fox-tail graſs: theſe four grow wild in Britain: The agreſtis, the monſpelienſis, the paniceus, and the hordeiformis, are all natives of France, and the ſouthern parts of Europe, except the

the laſt, which is a native of India. For a more particular account of this kind of graſs, ſee the Syſtem of AGRICULTURE, Sect. X.

ALPHABET, the natural or cuſtomary ſeries of the ſeveral letters of a language. See LANGUAGE and WRITING. The word is formed from *alpha* and *beta*, the firſt and ſecond letters of the Greek alphabet. The number of letters is different in the alphabets of different languages. The Engliſh alphabet contains 24 letters; to which if we add *j* and *v* conſonant, the ſum will be 26: the French contains 23; the Hebrew, Chaldee, Syriac, and Samaritan, 22 each; the Arabic 28; the Perſian 31; the Turkiſh 33; the Georgian 36; the Coptic 32; the Muſcovite 43; the Greek 24; the Latin 22; the Sclavonic 27; the Dutch 26; the Spaniſh 27; the Italian 20; the Ethiopic and Tartarian, each 202; the Indians of Bengal 21; the Barameſe 19. The Chineſe have, properly ſpeaking, no alphabet, except we call their whole language by that name; their letters are words, or rather hieroglyphics, amounting to about 80,000. In effect, *alphabets* were not contrived with deſign, according to the juſt rules of reaſon and analogy; but have been ſucceſſively framed, altered, &c. as occaſion offered. And hence many grievous complaints as to their deficiencies; and divers attempts to eſtabliſh new and more adequate ones in their places. Biſhop Wilkins charges all the *alphabets* extant with great irregularities, with reſpect to both the order, number, power, figure, &c. As to the order, it appears inartificial, precarious, and confuſed; in that the vowels and conſonants are not reduced into claſſes, with ſuch order of precedence and ſubſequence as their natures will bear. Even the Hebrew order is not free from this imperfection. It has been a matter of conſiderable diſpute, whether the method of expreſſing our ideas by viſible ſymbols, called *letters*, be really a human invention; or whether we ought to attribute an art ſo exceedingly uſeful to an immediate revelation from the Deity.

The late Mr. Sheridan obſerves, that our alphabet is ill calculated for the notation of the Engliſh tongue, as there are many ſounds for which we have no letters or marks: and there ought to be nine more characters or letters to make a complete alphabet, in which every ſimple ſound ought to have a mark peculiar to itſelf. The reaſon of the deficiency is, that the Roman alphabet was formerly adopted for the notation of the Engliſh language, though by no means ſuited to the purpoſe.

ALPS, in geography, beſide its proper ſignification, by which it denotes a certain chain of mountains, which ſeparate Italy from France and Germany, is ſometimes uſed as an appellative to denote any mountains of extraordinary height. [See the SYSTEM, Article ITALY.] In this ſenſe, Auſonius, and others, call the Pyrenean mountains, *Alps*; and Gellius, the Spaniſh Alps, *Alpini Hiſpani*.

ALTAR, a place upon which ſacrifices were anciently offered to ſome deity. The heathens at firſt made their altars only of turf; afterwards they were made of ſtone, of marble, of wood, and even of horn, as that of Apollo in Delos. Altars differed in figure as well as in materials. Some were round, others ſquare, and others triangular. All of them were turned towards the eaſt, and ſtood lower than the ſtatues of the gods; and were generally adorned with ſculpture, repreſenting either the gods to whom they were erected, or their ſymbols.

Before temples were in uſe, altars were erected ſometimes in groves, ſometimes in the highways, and ſometimes on the tops of mountains; and it was a cuſtom to engrave upon them the name, enſign, or character, of the deity to whom they were conſecrated. In the great temples of ancient Rome there were ordinarily three altars: the firſt was placed in the ſanctuary, at the foot of the ſtatue of the divinity, upon which incenſe was burnt and libations offered; the ſecond was before the gate of the temple, and upon it they ſacrificed the victims; and the third was a portable altar, upon which were placed the offering and the ſacred veſſels. Beſides theſe uſes of altars, the ancients ſwore upon them, and ſwore by them, in making alliances, confirming treaties of peace, and other ſolemn occaſions. Altars alſo ſerved as places of refuge to all thoſe who fled to them, whatever crime they had committed. Altars are doubtleſs as ancient as ſacrifices themſelves; conſequently their origen is not much later than that of the world. Gen. ch. iv. Some attribute their origin to the Ægyptians; others to the Jews; others to the patriarchs before the flood. Some carry them as far back as Adam, whoſe altar is much ſpoken of by Jewiſh and even Chriſtian writers. Others are contented to make the patriarch Enoch the firſt who conſecrated a public altar. Be this as it will, the earlieſt altars we find any expreſs teſtimony of are thoſe erected by Abraham. Altars, in the patriarchal times, were very rude. The altar which Jacob ſet up at Beth-el was nothing but a ſtone, which ſerved him inſtead of a bolſter; that of Gideon, a ſtone before his houſe; and the firſt which God commanded Moſes to erect was probably of earth, or unpoliſhed ſtones, without any iron; for if any uſe was made of that metal, the altar was declared impure. The principal altars of the Jews were, The altar of *incenſe*; that of *burnt offering*; and the *altar* or *table for the ſhew-bread*.

Altar is ſometimes alſo uſed, among Chriſtians, for a ſquare table, placed on the eaſtern ſide of the church, raiſed a little above the floor, and ſet a part for the celebration of the euchariſt. Its form is not borrowed either from that of the heathen *altars*, or even from that of the Jews in the temple; but, as the euchariſt was inſtituted by Jeſus Chriſt, at ſupper, and upon a table, the modern *altar* is made in the form of a table; whence it is more uſually, and even more ſignificantly, denominated *Communion Table*.

ALTERATIVE, in medicine, a property, or power, in certain medicines, whereby they induce an alteration in the body, and diſpoſe it for health and recovery, by correcting ſome indiſpoſition, without occaſioning any ſenſible evacuation. *Alteratives*, therefore, muſt generally be either ſuch remedies as deſtroy ſome prevailing acrimony in the *primæ viæ*, or in the juices; or elſe ſuch as reſolve concretions in the blood-veſſels, and diſpoſe them, when thus reſolved, to paſs out of the body by perſpiration, or ſome of the leaſt remarkable evacuations. *Alteratives* are generally divided into four kinds, which are, *abſorbents* for imbibing and blunting the acid juices; *temperating medicines* for checking and mitigating the rage of the bilious intemperies: *penetrating medicines* for diſſolving and attenuating the thick and viſcid juices; and, in fine, *demulcents* for ſheathing and mitigating their burning and corroſive acrimony.

ALTERNATION is uſed to expreſs the different changes or alterations of orders in any number of things propoſed. This is alſo called *permutation*, &c. and is eaſily found by a continual multiplication of all the numbers, beginning at unity. Thus, if it be required to know how many changes or alternations can be rung on ſix bells, multiply the numbers 1, 2, 3, 4, 5, 6, continually into one another; and the laſt product gives the number of changes, See the Syſtem of ARITMETIC, Chap. XXI.

ALTHÆA, MARSHMALLOW: A genus of the polyandria order, belonging to the monodelphia claſs of plants. The *vulgaris*, or common marſhmallow, is the only ſpecies uſed in medicine. The whole plant, eſpecially the root, abounds with a mild mucilage. It has the general virtues of an emollient medicine; and proves ſerviceable in a thin acrimonious ſtate of the juices, and where the natural mucus of the inteſtines is abraded. It is chiefly recommended in ſharp defluxions upon the lungs, hoarſeneſs, dyſenteries; and likewiſe in nephritic and calculous complaints: not, as ſome have ſuppoſed, that this medicine has any peculiar power of diſſolving or expelling the calculus, but as, by lubricating and relaxing the veſſels, it procures a more free and eaſy paſſage. The root is ſometimes employed externally for ſoftening and maturing hard tumours; chewed, it is ſaid to give eaſe in difficult dentition of children. This root gave name to an officinal ſyrup, decoction, and ointment; and was likewiſe an ingredient in the compound powder of gum tragacanth and the oil and plaſter of mucilages. But of all theſe formulæ the ſyrup alone is now retained.

ALTITUDE, in geometry, the third dimenſion or body, conſidered with regard to its elevation above the ground, called alſo *height* or *depth*.

ALTITUDE *of a figure*, in geometry, is the diſtance of its vertex from its baſe, or the length of a perpendicular let fall from the vertex to the baſe. See the SYSTEM, Part I. Sect. II. Plate I. Fig. 5.

ALTITUDE, acceſſible, and inacceſſible. The method of taking conſiderable terreſtrial altitudes, of which thoſe of mountains are the greateſt, by means of the barometer, is very eaſy and expeditious. It is done by obſerving, on the top of the mountain, how much the mercury has fallen below what it was at the foot of the mountain. See BAROMETER.

ALTITUDE *of the eye*, in perſpective, is a right line let fall from the eye perpendicular to the geometrical plane. See the SYSTEM, Section III.

ALTITUDE, in aſtronomy, is the diſtance of a ſtar, or other point, in the mundane ſphere, from the horizon. This altitude may be either *true* or *apparent*. If it be taken from the rational or real horizon, the altitude is ſaid to be true or real; if from the apparent or ſenſible horizon, the altitude is apparent. Or rather, the apparent altitude is ſuch as it appears to our obſervation; and the *true* is that from which the refraction has been ſubtracted. The true altitudes of the ſun, fixed ſtars, and planets, differ but very little from their apparent altitudes; becauſe of their great diſtance from the centre of the earth, and the ſmallneſs of the earth's ſemidiameter, when compared thereto. But the difference between the true and apparent altitude of the moon is about 32. This ſubject is further explained in the Syſtem of ASTRONOMY, under the ſeveral particulars relative to the *Solar Syſtem*, *Planets*, &c.

There are three ways of meaſuring *altitudes*, viz. *geometrically*, *trigonometrically*, and *optically*. The firſt is ſomewhat indirect and unartful; the ſecond is performed by means of inſtruments for the purpoſe; and the third by ſhadows. See the Syſtems of GEOMETRY and OPTICS, and the Treatiſe on TRIGONOMETRY.

The inſtruments chiefly uſed in meaſuring *altitudes*, are the quadrant and theodolite; for the deſcriptions, applications, &c. whereof, ſee under the articles QUADRANT and THEODOLITE. For a repreſentation of the quadrant of altitude, ſee the Plate annexed to the Treatiſe on the GLOBES, Fig. 3. Let. Z. A. For a repreſentation of the Theodolite, ſee the Plate annexed to the Syſtem of SURVEYING, Fig. 7.

ALTITUDE *of the pyramids in Egypt* was measured so long ago as the time of Thales, by means of their shadow, which makes one of the first geometrical observations we have an exact account of. Plutarch has given an account of the manner of this operation, which, according to this author, was done by erecting a staff perpendicular upon the end of the shadow of the pyramid; and by two triangles made by the beams of the sun, he demonstrated, that there was the same proportion between the shadows as between the pyramid and the staff. Stanl. Hist. Phil. P. i. p. 9.

ALVEOLI, in anatomy, those little sockets in the jaws wherein the teeth are set. The *alveoli* are lined with a membrane of exquisite sense, which seems to be nervous, and is wrapt about the roots of each tooth; from whence, and from the nerve, proceeds that pain called *odontalgy*, or tooth-ach. Of these *alveoli* there are usually sixteen in each jaw.

ALVUS, among anatomists, is sometimes used to express the lower belly, or *venter*; called by anatomists *abdomen*; for the several parts of which see the System of ANATOMY, Part. III.

ALUM, in chymistry, a clear and transparent saline matter, usually sold in large masses, of a very austere and astringent taste, useful in medicine and in various arts. Native alum is mixed with heterogeneous matters, or efflorescles in various forms upon the ores during calcination. It rarely occurs in a crystallized state, though thus it is said to be met with in Egypt, Sardinia, Spain, Bohemia, and other places. It is also found in the waters, impregnated with fixed air, but very seldom in fountains or hot medicated waters. There are several kinds of alum to be met with; but these differ from one another in being mixed with some salts which are not of the aluminous kind. See the System of CHYMISTRY, Part II. Chap. IV. That called the Roman alum has been considered as preferable to any other. This is usually met with in small crystals, and has a reddish colour, most probably owing to a small quantity of calx of iron, which, however, does not in the least impair its qualities. The other kinds of alum contain a proportion of vitriolated tartar, or sal ammoniac, according to the nature of the alkali used in its preparation. Mr. Bergman informs us, that the vegetable alkali, if pure, does not hurt the alum, though it be added in the preparation; but that the volatile alkali, by adulterating it with a portion of vitriolic sal ammoniac, renders it unfit for some purposes. The alum, made by adding a portion of clay to the liquor, at the beginning of the boiling, he considers as equal, if not superior, to Roman alum. He informs us also, that a kind of alum some time ago began to be manufactured at Brunswick, which was equal in quality to the Roman alum. On a chymical analysis of this alum, he found it mixed with cobalt.

This salt is extremely useful in the art of dyeing; as by means of it a great number of colours are fixed and rendered permanent upon cloth, which otherwise would either not adhere in any degree, or only for a short time. In what manner this is accomplished we are very ignorant. It constitutes the basis of crayons, which generally consist of the earth of alum finely powdered and tinged for the purpose. In the preparation of Prussian blue, it prevents the basis of martial vitriol, which is soluble in acids, from being precipitated by the superfluous alkali employed in the preparation of that pigment; that is, the alkali which is not saturated by the colouring matter. As this basis adheres more strongly than the clay to the vitriolic acid, and would form a green by the mixture of its yellowness; the white earth of alum likewise, according to its quantity, dilutes the darker colours, even black itself, and produces an infinite number of shades. It is also of use in the making of candles; for being mixed with the tallow, it gives it a hardness and consistency which it has not naturally. Wood sufficiently soaked in a solution of alum does not easily take fire, and the same is true of paper impregnated with it; which for that reason is very properly employed in preserving gun-powder, as it also excludes the moisture of the air. Paper impregnated with alum is useful in whitening silver, and silvering brass without heat. Alum is also of use in tanning, where it assists in restoring the cohesion of the skins almost entirely destroyed by the lime. Vintners fine down their wines, &c. with alum; fishers use it to dry codfish with; and bakers have mixed it with the flour to make their bread compact and white: to this last use of it great objections have been made, but unjustly, for it is entirely innocent, and now seldom used.

In medicine it is of considerable use as an astringent and tonic. It is reckoned particularly serviceable for restraining hemorrhages, and immoderate secretions from the blood; but less proper in intestinal fluxes. In violent hemorrhages, it may be given in doses of 15 or 20 grains, and repeated every hour or half hour till the bleeding abates; in other cases, smaller doses are more adviseable; large ones being apt to nauseate the stomach, and occasion violent constipations of the bowels. It is used also externally, in astringent and repellent lotions and collyria. Burnt allum, taken internally, has been highly extolled in cases of colic. In such instances, when taken to the extent of a scruple for a dose, it has been said gently to move the belly, and give very great relief from the severe pain. Its officinal preparations are, for external use, *pulvis styptieus* and *aqua styptica*; for external applications, the *aqua aluminis* and *coagulum aluminis* and *alumen ustum*; which last is no other than the alum dried by fire, or freed from the watery moisture, which, like other salts, it always retains in its crystalline form. By this loss of its water it becomes sharper, so as to act as a slight escharotic; and it is chiefly with this intention that it is employed in medicine, being very rarely taken internally.

ALUM *mines* are said to have been first found in Italy in the year 1460; and in 1506 king Henry VII. made a monopolizing grant of this commodity to Augustine Chigi, a merchant of Sienna. In the year 1608 the manufacture of alum was first invented and successively practised in England, meeting with great encouragement in Yorkshire, where it was first made, from Lord Sheffield, and other gentlemen of that county. King James I. by advice of his ministry, assumed the monopoly of it to himself, and therefore prohibited the importation of foreign alum; and in 1625 the importation of it was further prohibited by the proclamation of Charles I.

ALUM-*works*, places where alum is prepared and manufactured in quantities for sale. They differ from alum-mines, as in the former an artificial alum, and in the latter natural alum, is produced.

AMALGAMA, or AMALGAM, in chymistry, a mass of *mercury*, united and incorporated with a *metal*. For the metals with which mercury is amalgamated, see the SYSTEM, Part. III. Chap. II. Sect. V.

The word *amalgama* is applied to the *alloys* of metallic metals with *mercury*, which is capable of being *alloyed* more or less easily with almost all metallic substances. The *amalgama* of *mercury* with lead is a soft, friable substance, of a silver colour.

AMALGAMATION, the operation of making an amalgam, or mixing mercury with any metal. For the combination of one metal with another, it is generally sufficient that one of them be in a state of fluidity. Mercury being always fluid, is therefore capable of amalgamation with other metals without heat; nevertheless, heat considerably facilitates the operation. See the System of CHYMISTRY, Part III. Chap. II. Sect. V.

To amalgamate without heat requires nothing more than rubbing the two metals together in a mortar; but the metals to be united with the mercury should be previously divided into very thin plates or grains. When heat is used (which is always most effectual, and with some metals indispensably necessary) the mercury should be heated till it begins to smoke, and the grains of metal made red-hot before they are thrown into it. If it be gold or silver, it is sufficient to stir the fluid with an iron rod for a little while, and then throw it into a vessel filled with water. This amalgam is used for gilding or silvering on copper, which is afterwards exposed to a degree of heat sufficient to evaporate the mercury. Amalgamation with lead or tin is effected by pouring an equal weight of mercury into either of these metals in a state of fusion, and stirring with an iron rod. Copper amalgamates with great difficulty, and iron not at all.

AMAUROSIS, a deprivation of sight; the eye remaining fair, and seemingly unaffected. *Amaurosis* is the same with what the Latins more usually call *gutta serena*. For a description of its several degrees, and the most approved methods of treatment, see the System of MEDICINE, Genus LXIII.

AMAZONS, in antiquity, a nation of female warriors, who founded an empire in Asia Minor, upon the River Thermodoon, along the coasts of the Black Sea. They are said to have formed a state out of which men were excluded. What commerce they had with that sex was only with strangers; they killed all their male children; and they cut off the right breasts of their females, to make them more fit for the combat. From which last circumstance it is, that they are supposed to take their name, viz. from the privative *α*, and *μαζος*, *mamma*, "breast."

The Amazons are represented as being armed with bows and arrows, with javelins, and also with an axe of a particular construction, which was denominated the axe of the Amazons. According to the elder Pliny, this axe was invented by Penthisilea, one of their queens. On many ancient medals are representations of the Amazons, armed with these axes. They are also said to have had bucklers in the shape of a half-moon.

That at any period there should have been women, who, without the assistance of men, built cities and governed them, raised armies and commanded them, administered public affairs, and extended their dominion by arms, is undoubtedly so contrary to all that we have seen and known of human affairs, as to appear in a very great degree incredible; but that women may have existed sufficiently robust and sufficiently courageous to have engaged in warlike enterprizes, and even to have been successful in them, is certainly not impossible, however contrary to the usual course of things. In support of this side of the question, it may be urged, that women who have been early trained to warlike exercises, to hunting, and to an hard and laborious mode of living, may be rendered more strong, and capable of more vigorous exertions, than men who have led indolent, delicate, and luxurious lives, and who have seldom been exposed even to the inclemencies of the weather. The limbs of women, as well as of men are strengthened and rendered more robust by frequent and laborious exercise. A nation of women, therefore, brought up and disciplined as the ancient Amazons are represented to have been, would be superior to an equal number of effeminate men; though they might be much inferior to an equal number of hardy men trained up and disciplined in the same manner.

That much of what is ſaid of the Amazons is fabulous, there can be no reaſonable doubt; but it does not therefore follow, that the whole is without foundation. The ancient medals and monuments on which they are repreſented are very numerous, as are alſo the teſtimonies of ancient writers. It ſeems not rational to ſuppoſe that all this originated in fiction, though it may be much blended with it. The Abbé Guyon ſpeaks of the hiſtory of the Amazons as having been regarded by many perſons as fabulous, "rather from prejudice than from any real and ſolid examination;" and it muſt be acknowledged, that the arguments in favour of their exiſtence, from ancient hiſtory, and from ancient monuments, are extremely powerful. The fact ſeems to be, that truth and fiction have been blended in the narrations concerning theſe ancient heroines. Inſtances of heroiſm in women have occaſionally occurred in modern times, ſomewhat reſembling that of the ancient Amazons. The times and the manners of chivalry in particular, by bringing great enterprizes, bold adventures, and extravagant heroiſm, into faſhion, inſpired the women with the ſame taſte. The women, in conſequence of the prevailing paſſion, were now ſeen in the middle of camps and of armies. They quitted the ſoft and tender inclinations, and the delicate offices of their own ſex, for the toils and the toilſome occupations of ours. During the cruſades, animated by the double enthuſiaſm of religion and of valour, they often performed the moſt romantic exploits; obtained indulgencies on the field of battle, and died with arms in their hands, by the ſide of their lovers or of their huſbands.

In Europe, the women attacked and defended fortifications; princeſſes commanded their armies, and obtained victories. Such was the celebrated Joan de Montfort, diſputing for her duchy of Bretagne, and fighting herſelf. Such was that ſtill more celebrated Margaret of Anjou, an active and intrepid general and ſoldier, whoſe genius ſupported a long time a feeble huſband; which taught him to conquer; which replaced him upon the throne; which twice relieved him from priſon; and, oppreſſed by fortune and by rebels, which did not bend till after ſhe had decided in perſon twelve battles.

The warlike ſpirit among the women, conſiſtent with ages of barbariſm, when every thing is impetuous becauſe nothing is fixed, and when all exceſs is the exceſs of force, continued in Europe upwards of 400 years, ſhowing itſelf from time to time, and always in the middle of convulſions, or on the eve of great revolutions. But there were æras and countries in which that ſpirit appeared with particular luſtre. Such were the diſplays it made in the 15th and 16th centuries in Hungary, and in the iſlands of the Archipelago and the Mediterranean, when they were invaded by the Turks.

Among the ſtriking inſtances of Amazonian conduct in modern ladies, may be mentioned that of Jane of Belville, widow of Monſ. de Cliſſon, who was beheaded at Paris in the year 1343, on ſuſpicion of carrying on a correſpondence with England and the Count de Montfort. This lady, filled with grief for the death of her late huſband, and exaſperated at the ill treatment which ſhe conſidered him as having received, ſent off "her ſon ſecretly to London; and when her apprehenſions were removed with reſpect to him, ſhe ſold her jewels, fitted out three ſhips, and put to ſea to revenge the death of her huſband upon all the French with whom ſhe ſhould meet. This new corſair made ſeveral deſcents upon Normandy, where ſhe ſtormed caſtles; and the inhabitants of that province were ſpectators more than once, whilſt their villages were all on a blaze, of one of the fineſt women in Europe, with a ſword in one hand and a torch in the other, urging the carnage, and eyeing with pleaſure all the horrors of war."

In the year 1590, the League party obtained ſome troops from the king of Spain. Upon the news of their being diſembarked, Barri de St. Aunez, Henry IV's governor of Lucate, ſet out to communicate a ſcheme to the Duke de Montmorenci, commander in that province. He was taken in his way by ſome of the troops of the League, who were upon their march with the Spaniards towards Leucate. They were perſuaded, that by thus having the governor in their hands the gates of that place would be immediately opened to them, or at leaſt would not hold out long. But Conſtantia de Cecilli, his wife, after having aſſembled the garriſon, put herſelf ſo reſolutely at their head, pike in hand, that ſhe inſpired the weakeſt with courage; and the beſiegers were repulſed wherever they preſented themſelves. Shame and their great loſs having rendered them deſperate, they ſent a meſſage to this courageous woman, acquainting her, that if ſhe continued to defend herſelf they would hang her huſband. She replied, with tears in her eyes, "I have riches in abundance; I have offered them, and I do ſtill offer them, for his ranſom; but I would not ignominiouſly purchaſe a life which he would reproach me with, and which he would be aſhamed to enjoy. I will not diſhonour him by treaſon againſt my king and country." The beſiegers having made a freſh attack without ſucceſs, put her huſband to death, and raiſed the ſiege. Henry IV. afterwards ſent to this lady the brevet of governeſs of Leucate, with the reverſion for her ſon.

The famous Maid of Orleans, alſo, is an example known to every reader.

The Abbé Arnaud, in his memoirs, ſpeaks of a Counteſs of St. Balmont, who uſed to take the field with her huſband, and fight by his ſide. She ſent ſeveral Spaniſh priſoners of her taking to Marſhal Feuquiers; and what is not a little extraordinary, this Amazon at home was all affability and ſweetneſs, and gave herſelf up to reading and acts of piety.

Dr. Johnſon ſeems to have given ſome credit to the accounts which have been tranſmitted down to us concerning the ancient Amazons: and he has endeavoured to ſhow, that we ought not haſtily to reject ancient hiſtorical narrations becauſe they contain facts repugnant to modern manners, and exhibit ſcenes to which nothing now occurring bears a reſemblance. "Of what we know not (ſays he) we can only judge by what we know. Every novelty appears more wonderful as it is more remote from any thing with which experience or teſtimony have hitherto acquainted us; and if it paſſes farther, beyond the notions that we have been accuſtomed to form, it becomes at laſt incredible. We ſeldom conſider, that human knowledge is very narrow; that national manners are formed by chance; that uncommon conjunctures of cauſes produce rare effects; or that what is impoſſible at one time or place may yet happen in another. It is always eaſier to deny than to enquire. To refuſe credit confers for a moment an appearance of ſuperiority which every little mind is tempted to aſſume, when it may be gained ſo cheaply as by withdrawing attention from evidence, and declining the fatigue of comparing probabilities. Many relations of travellers have been ſlighted as fabulous, till more frequent voyages have confirmed their veracity; and it may reaſonably be imagined, that many ancient hiſtorians are unjuſtly ſuſpected of falſhood, becauſe our own times afford nothing that reſembles what they tell. Few narratives will either to men or women appear more incredible than the hiſtories of the Amazons; of female nations, of whoſe conſtitution it was the eſſential and fundamental law, to exclude men from all participation either of public affairs or domeſtic buſineſs; where female armies marched under female captains, female farmers gathered the harveſt, female partners danced together, and female wits diverted one another. Yet ſeveral ſages of antiquity have tranſmitted accounts of the Amazons of Cauſaeus; and of the Amazons of America, who have given their name to the greateſt river in the world, Condamine lately found ſuch memorials as can be expected among erratic and unlettered nations, where events are recorded only by tradition, and new ſwarms ſettling in the country from time to time, confuſe and efface all traces of former times."

No author has taken ſo much pains upon this ſubject as Dr. Petit. But, in the courſe of his work, he has given it as his opinion, that there is great difficulty in governing the women even at preſent, though they are unarmed and unpractiſed in the art of war. After all his elaborate enquiries and diſcuſſions, therefore, this learned writer might probably think, that it is not an evil of the firſt magnitude that the race of Amazons now ceaſes to exiſt.

Rouſſeau ſays, "The empire of the woman is an empire of ſoftneſs, of addreſs, of complacency. Her commands are careſſes, her menaces are tears." But the empire of the Amazons was certainly an empire of a very different kind. Upon the whole, we may conclude with Dr. Johnſon: "The character of the ancient Amazons was rather terrible than lovely. The hand could not be very delicate that was only employed in drawing the bow, and brandiſhing the battle-axe. Their power was maintained by cruelty, their courage was deformed by ferocity; and their example only ſhows, that men and women live beſt together."

AMBASSADOR, or EMBASSADOR, a public miniſter ſent from one ſovereign prince, as a repreſentative of his perſon, to another. Ambaſſadors are either ordinary or extraordinary. Ambaſſador *in ordinary*, is he who conſtantly reſides in the court of another prince, to maintain a good underſtanding, and look to the intereſt of his maſter. Till about two hundred years ago, ambaſſadors in ordinary were not heard of: all, till then, were ambaſſadors *extraordinary*; that is, ſuch as are ſent on ſome particular occaſion, and who retire as ſoon as the affair is diſpatched. By the law of nations, none under the quality of a ſovereign prince can ſend or receive an ambaſſador. By the civil law, the moveable goods of an ambaſſador, which are accounted an acceſſion to his perſon, cannot be ſeized on, neither as a pledge, nor for payment of a debt, nor by order or execution of judgment, nor by the king's or ſtate's leave where he reſides, as ſome conceive; for all actions ought to be far from an ambaſſador, as well that which toucheth his neceſſaries as his perſon. Nor can any of the ambaſſador's domeſtic ſervants that are regiſtered in the ſecretaries of ſtate's office be arreſted in perſons or goods; if they are, the proceſs ſhall be void; and the parties ſueing out and executing it ſhall ſuffer and be liable to ſuch penalties and corporal puniſhment as the lord chancellor or either of the chief juſtices ſhall think fit to inflict. Yet ambaſſadors cannot be defended when they commit any thing againſt that ſtate, or the perſon of the prince, with whom they reſide; and if they are guilty of treaſon, felony, &c. or any other crime againſt the law of nations, they loſe the privilege of an ambaſſador, and may be ſubject to puniſhment as private aliens.

AMBER, in natural hiſtory, a ſolid, hard, ſemipellucid, bituminous ſubſtance of a particular nature, of uſe in medicine and in ſeveral of the arts. Amber has been of great repute in the world from the earlieſt times. Many years before Chriſt it was in eſteem as a medicine; and Plato, Ariſtotle, Herodotus, Æſchylus, and others, have commended its virtues. In the times of the

Romans

Romans it became in high eſtimation as a gem; and in the luxurious reign of Nero, immenſe quantities of it were brought to Rome, and uſed for ornamenting works of various kinds. The moſt remarkable property of this ſubſtance is, that, when rubbed, it draws or attracts other bodies to it; and this it is obſerved, it does, even to thoſe ſubſtances which the ancients thought it had an antipathy to; as oily bodies, drops of water, human ſweat, &c. Add, that by friction it is brought to yield light pretty copiouſly in the dark; whence it is reckoned among the native phoſphori.

From ἤλεκτρον, the Greek name for amber, is derived the term *Electricity*, which is now very extenſively applied not only to the power of attracting light bodies inherent in amber, but to other ſimilar powers, and their various effects, in whatever bodies they reſide, or to whatever bodies they may be communicated. See the SYSTEM, Part. I. Sect. II.

Amber aſſumes all figures in the ground; that of a pear, an almond, a pea, &c. Within ſome pieces, leaves, inſects, &c. have likewiſe been found included; which ſeems to indicate, either that the amber was originally in a fluid ſtate, or that having been expoſed to the ſun, it was once ſoftened, and rendered ſuſceptible of the leaves, inſects, &c. which came in its way. The latter of theſe ſuppoſitions ſeems the more agreeable to the phenomenon, becauſe thoſe inſects, &c. are never found in the centre of the pieces of amber, but always near the ſurface. It is obſerved by the inhabitants of thoſe places where amber is produced, that all animals, whether terreſtrial, aerial, or aquatic, are extremely fond of it, and that pieces of it are frequently found in their excrements. The bodies of inſects, found buried in amber, are viewed with admiration by all the world; but of the moſt remarkable of theſe, many are to be ſuſpected as counterfeits, the great price at which beautiful ſpecimens of this kind ſell, having tempted ingenious cheats to introduce animal bodies in ſuch artful manners into ſeemingly whole pieces of amber, that it is not eaſy to detect the fraud. Of thoſe inſects which have been originally incloſed in amber, ſome are plainly ſeen to have ſtruggled hard for their liberty, and even to have left their limbs behind them in the attempt; it being no unuſual thing to ſee, in a maſs of amber that contains a ſtout beetle, the animal wanting one or perhaps two of its legs; and thoſe legs left in different places, nearer that part of the maſs from which it has travelled. This alſo may account for the common accident of finding legs or wings of flies, without the reſt of their bodies, in pieces of amber; the inſects having, when entangled in the yet ſoft and viſcid matter, eſcaped, at the expence of leaving thoſe limbs behind them. Beautiful leaves, of a pinnated ſtructure, reſembling ſome of the ferns, or maidenhairs, have been found in ſome pieces, but theſe are rare, and the ſpecimens of great value.

Naturaliſts have been greatly divided as to the origin of this ſubſtance, and what claſs of bodies it belongs to; ſome referring it to the vegetable, others to the mineral, and ſome even to the animal kingdom. Pliny deſcribes it as "a reſinous juice, oozing from "aged pines and firs, (others ſay from poplars, whereof there are "whole foreſts on the coaſts of Sweden,) and diſcharged thence "into the ſea; where, undergoing ſome alteration, it is thrown, "in this form, upon the ſhores of Pruſſia, which lie very low." He adds, "that it was hence the ancients gave it the denomination "*ſuccinum*; from *ſuccus*, juice." Some ſuppoſe amber a compound ſubſtance. Pruſſia, ſay they, and the other countries which produce amber, are moiſtened with a bituminous juice, which, mixing with vitriolic ſalts abounding in thoſe places, the point of thoſe ſalts fix its fluidity, whence it congeals; and the reſult of that congelation makes what we call amber; which is more or leſs pure, tranſparent, and firm, as thoſe parts of ſalt and bitumen are more or leſs pure, and are mixed in this or that proportion. Upon the whole, it ſeems generally agreed upon, that amber is a true bitumen of a foſſile origin. In a late volume of the *Journal de Phyſique*, however, we find it aſſerted by Dr. Girtanner to be an animal product, a ſort of honey or wax formed by a ſpecies of large ant, called by Linnæus, *formica rufa*. Theſe ants, our author informs us, inhabit the old pine foreſts, where they ſometimes form hills about ſix feet in diameter; and it is generally in theſe ancient foreſts, or in places where they have been, that foſſile amber is found. This ſubſtance is not ſo hard as that which is taken up in the ſea at Pruſſia, and which is well known to naturaliſts. It has the conſiſtence of honey, or of half-melted wax; but it is of a yellow colour, like common amber; it gives the ſame product by chymical analyſis, and it hardens like the other when it is ſuffered to remain ſome time in a ſolution of common ſalt. This accounts for the inſects that are ſo often found incloſed in it. Among theſe inſects ants are always the moſt prevailing; which tends farther, M. Girtanner thinks, to the confirmation of this hypotheſis. Amber then, in his opinion, is nothing but a vegetable oil rendered concrete by the acid of ants, juſt as wax is nothing but an oil hardened by the acid of bees; a fact inconteſtibly proved, we are told, ſince M. Metherie has been able to make artificial wax by mixing oil of olives with the nitrous acid, and which wax is not to be diſtinguiſhed from the natural. See Syſtem of CHYMISTRY, Part. IV. Chap. I. Sect. 3.

There are ſeveral indications which diſcover where amber is to be found. The ſurface of the earth is there covered with a ſoft ſcaly ſtone; and vitriol in particular always abounds there, which is ſometimes found white, ſometimes reduced into a matter, like melted glaſs, and ſometimes figured like petrified wood. Amber of the fineſt kind has been found in England. It is frequently thrown on the ſhores of Yorkſhire, and many other places, and found even in our clay-pits: the pits dug for tile clay, between Tyburn and Kenſington gravel-pits, and that behind St. George's Hoſpital, at Hyde-park corner, have afforded fine ſpecimens.

Poland, Sileſia, and Bohemia, are famous for the amber dug up there at this time. Germany affords great quantities of amber, as well dug up from the bowels of the earth, as toſſed about on the ſhores of the ſeas and rivers there. Saxony, Miſnia, and Sweden, and many other places in this tract of Europe, abound with it. Denmark has afforded, at different times, ſeveral quantities of foſſile amber; and the ſhores of the Baltic abound with it. But the countries lying on the Baltic afford it in the greateſt abundance of all; and of theſe the moſt plentiful country is Pruſſia, and the next is Pomerania. Pruſſia was, as early as the times of Theodoric the Goth, famous for amber; for this ſubſtance coming into great repute with this prince, ſome natives of Pruſſia, who were about his court, offered their ſervice to go to their own country, where that ſubſtance, they ſaid, was produced, and bring back great ſtores of it. They accordingly did ſo; and from this time Pruſſia had the honour to be called the country of amber, inſtead of Italy, which had before undeſervedly that title. This article alone brings his Pruſſian Majeſty a revenue of 26,000 dollars annually. The amber of Pruſſia is not only found on the ſea coaſts, but in digging; and though that of Pomerania is generally brought from the ſhores, yet the people who dig, on different occaſions, in the very heart of the country, at times find amber. Amber has a ſubacrid, reſinous taſte, and fragrant aromatic ſmell, eſpecially when diſſolved. It differs from the other bituminous ſubſtances in this, that it yields by diſtillation a volatile acid ſalt, which none of the others do; otherwiſe it affords the ſame ſort of principles as them, viz. an acid phlegm, an oil which gradually becomes thicker as the diſtillation is continued; and when the operation is finiſhed, there remains a black *caput mortuum* in the retort. When boiled in water, it neither ſoftens, nor undergoes any ſenſible alteration. Expoſed to the fire in an open veſſel, it melts into a black maſs very like a bitumen. It is partly ſoluble in ſpirit of wine, and likewiſe in ſome eſſential oils; but it is with difficulty that the expreſſed ones are brought to act upon it; the ſtronger ſorts of fixed alkaline lixivia almoſt totally diſſolve it; this ſubſtance is principally of two colours, white and yellow. The white is the moſt eſteemed for medicinal purpoſes, as being the moſt odoriferous, and containing the greateſt quantity of volatile ſalt; though the yellow is moſt valued by thoſe who manufacture heads and other toys with it, by reaſon of its tranſparency. Amber, when it has once been melted, irrecoverably loſes its beauty and hardneſs. There have been ſome, however, who pretended they had an art of melting ſome ſmall pieces of amber into a maſs, and conſtituting large ones of them; but this ſeems ſuch another undertaking as the making of gold; all the trials that have yet been made by the moſt curious experimenters, proving, that the heat which is neceſſary to melt amber is ſufficient to deſtroy it. Phil. Tranſ. No. 248. p. 25.

Amber in ſubſtance has been much recommended as a nervous and cordial medicine; and alledged to be very efficacious in promoting the menſtrual diſcharge, and the exclution of the fœtus and ſecundines in labour: but as in its crude ſtate it is quite inſoluble by our juices, it certainly can have very little effect on the animal ſyſtem, and therefore it is now ſeldom given in ſubſtance. The forms in which amber is prepared are, a tincture, a ſalt, and an oil.

AMBERGREASE, AMBERGRIS, or GREY AMBER, in natural hiſtory, is a ſolid, opake, aſh-coloured, fatty, inflammable ſubſtance, variegated like marble, remarkably light, rugged and uneven in its ſurface, and has a fragrant odour when heated. It does not effervesce with acids; it melts freely over the fire, into a kind of yellow roſin; and is hardly ſoluble in ſpirit of wine. It is found ſwimming upon the ſea, or the ſea coaſt, or in the ſand near the ſea-coaſt; eſpecially in the Atlantic ocean, on the ſea-coaſt of Braſil, and that of Madagaſcar; on the coaſt of Africa, of the Eaſt Indies, China, Japan, and the Molucca Iſlands; but moſt of the ambergriſe which is brought to England comes from the Bahama Iſlands, from Providence, &c. where it is found on the coaſt. It is alſo ſometimes found in the abdomen of whales by the whale fiſhermen, always in lumps of various ſhapes and ſizes, weighing from half an ounce to an hundred and more pounds. The piece which the Dutch Eaſt India Company bought from the king of Tydor weighed 182 pounds. An American Fiſherman from Antigua found ſome years ago, about 52 leagues ſouth-eaſt from the Windward iſlands, a piece of ambergriſe in a whale, which weighed about 130 pounds, and ſold for 500l. ſterling. There have been many different opinions concerning the origin of this ſubſtance. It has been ſuppoſed to be a foſſile bitumen or naphtha, exuding out of the bowels of the earth in a fluid form, and diſtilling into the ſea, where it hardens and floats on the ſurface. But having been frequently found in the belly of whales, it has by others been conſidered as entirely an animal ſubſtance.

Cluſius aſſerted it to be a phlegmatic recrement, or indurated indigeſtible part of the food, collected and found in the ſtomach of the whale, in the ſame manner as the *bezoars* are found in the ſtomach of other animals.

But

But the moſt ſatisfactory account of the real origin of ambergriſe, is that given by Dr. Swediar, in the 73d volume of the Philoſophical Tranſactions, Art. 15.

We are told by all writers on ambergriſe, that ſometimes claws and beaks of birds, feathers of birds, parts of vegetables, ſhells, fiſh, and bones of fiſh, are found in the middle of it, or variouſly mixed with it. Of a very large quantity of pieces, however, which the Doctor examined, he found none that contained any ſuch thing; though he allows, that ſuch ſubſtances may ſometimes be found in it; but in all the pieces of any conſiderable ſize, whether found on the ſea or in the whale, he conſtantly found a conſiderable quantity of black ſpots, which, after the moſt careful examination, appeared to be the beaks of the *Sepia Octopodia*; and theſe beaks, he thinks, might be the ſubſtances which have hitherto been always miſtaken for claws or beaks of birds, or for ſhells. The preſence of theſe beaks in ambergriſe proves evidently, that all ambergriſe containing them is, in its origin, or muſt have been once, of a very ſoft or liquid nature, as otherwiſe thoſe beaks could not ſo conſtantly be intermixed with it throughout its whole ſubſtance.

That ambergriſe is found either upon the ſea and ſea coaſt, or in the bowels of whales, is a matter of fact univerſally credited. But it has never been examined into and determined, whether the ambergriſe found upon the ſea and ſea-coaſt is the ſame as that found in the whale, or whether they are different from one another? Whether that found on the ſea or ſea-coaſt has ſome properties, or conſtituent parts, which that found in the whale has not? And laſtly, Whether that found in the whale is ſuperior or inferior in its qualities and value to the former? It is likewiſe a matter of conſequence to know, whether ambergriſe is found in all kinds of Whales, or only in a particular ſpecies of them? Whether it is conſtantly and always to be met with in thoſe animals? And, if ſo, in what part of their body it is to be found?

All theſe queſtions we find very ſatisfactorily diſcuſſed by Dr. Swediar. According to the beſt information that he could obtain from ſeveral of the moſt intelligent perſons employed in the ſpermaceti whale-fiſhery, and in procuring and ſelling ambergriſe, it appears, that this ſubſtance is ſometimes found in the belly of the whale, but in that particular ſpecies only which is called the *ſpermaceti whale*, and which from its deſcription and delineation appears to be the *Phyſeter Macrocephalus* Linnæi.

The New England fiſhermen, according to their account, have long known that ambergriſe is to be found in the ſpermaceti whale; and they are ſo convinced of this fact, that whenever they hear of a place where ambergriſe is found, they always conclude that the ſeas in that part are frequented by this ſpecies of whale, as the other ſpecies of the whale do not contain it.

The perſons who are employed in the ſpermaceti whale-fiſhery, confine their views to the Phyſeter macrocephalus. They look for ambergriſe in all the ſpermaceti whales they catch, but it ſeldom happens that they find any. Whenever they hook a ſpermaceti whale, they obſerve, that it conſtantly not only vomits up whatever it has in its ſtomach, but alſo generally diſcharges its fæces at the ſame time; and if this latter circumſtance takes place, they are generally diſappointed in finding ambergriſe in its belly. But whenever they diſcover a ſpermaceti whale, male or female, which ſeems torpid and ſickly, they are always pretty ſure to find ambergriſe, as the whale in this ſtate ſeldom voids its fæces upon being hooked. They likewiſe generally meet with it in the dead ſpermaceti whales, which they ſometimes find floating on the ſea. It is obſerved alſo, that the whale, in which they find ambergriſe, often has a morbid protuberance; or, as they expreſs it, a kind of gathering in the lower parts of its belly, in which, if cut open, ambergriſe is found. It is obſerved, that all thoſe whales, in whoſe bowels ambergriſe is found, ſeem not only torpid and ſick, but are alſo conſtantly leaner than others; ſo that, if we may judge from the conſtant union of theſe two circumſtances, it would ſeem that a larger collection of ambergriſe in the belly of the whale is a ſource of diſeaſe, and probably ſometimes the cauſe of its death. As ſoon as they hook a whale of this deſcription, torpid, ſickly, emaciated, or one that does not dung on being hooked, they immediately either cut up the above-mentioned protuberance, if there be any, or they rip open its bowels from the orifice of the anus, and find the ambergriſe, ſometimes in one, ſometimes in different lumps, of generally from three to twelve or more inches in diameter, and from one pound to twenty or thirty pounds in weight, at the diſtance of two, but moſt frequently of about ſix or ſeven feet from the anus, and never higher up in the inteſtinal canal; which, according to their deſcription, is, in all probability, the inteſtinum cæcum, hitherto miſtaken for a peculiar bag made by nature for the ſecretion and collection of this ſingular ſubſtance. That the part they cut open to come at the ambergriſe is no other than the inteſtinal canal is certain, becauſe they conſtantly begin their inciſion at the anus, and find the cavity every where filled with the fæces of the whale, which from their colour and ſmell it is impoſſible for them to miſtake. The ambergriſe found in the inteſtinal canal is not ſo hard as that which is found on the ſea or ſea-coaſt, but ſoon grows hard in the air; when firſt taken out it has nearly the ſame colour, and the ſame diſagreeable ſmell, though not ſo ſtrong, as the more liquid dung of the whale has; but on expoſing it to the air, it by degrees not only grows greyiſh, and its ſurface is covered with a greyiſh duſt like old chocolate, but it alſo loſes its diſagreeable ſmell, and, when kept for a certain length of time, acquires the peculiar odour which is ſo agreeable to moſt people.

The gentlemen the Doctor converſed with confeſſed, that if they knew not from experience that ambergriſe thus found will in time acquire the above-mentioned qualities, they would by no means be able to diſtinguiſh ambergriſe from hard indurated fæces. This is ſo true, that whenever a whale voids its fæces upon being hooked, they look carefully to ſee if they cannot diſcover among the more liquid excrements (of which the whale diſcharges ſeveral barrels) ſome pieces floating on the ſea, of a more compact ſubſtance than the reſt; theſe they take up and waſh, knowing them to be ambergriſe.

It is known, that the Sepia octopodia, or cuttle-fiſh, is the conſtant and natural food of the ſpermaceti whale, or Phyſeter macrocephalus. Of this the fiſhers are ſo well perſuaded, that whenever they diſcover any recent relics of it ſwimming on the ſea, they conclude that a whale of this kind is, or has been, in that part. Another circumſtance which corroborates the fact is, that the ſpermaceti whale, on being hooked, generally vomits up ſome remains of the Sepia. Hence it is eaſy to account for the many beaks, or pieces of beaks, of the Sepia found in all ambergriſe. The beak of the Sepia is a black horny ſubſtance, and therefore paſſes undigeſted through the ſtomach into the inteſtinal canal, where it is mixed with the fæces: after which it is either evacuated with them, or if theſe latter be preternaturally retained, forms concretions with them, which render the animal ſick and torpid, and produce an obſtipation, which ends either in an abſcels of the abdomen, as has been frequently obſerved, or becomes fatal to the animal; whence, in both the caſes, or the burſting of its belly, that hardened ſubſtance, known under the name of *ambergriſe*, is found ſwimming on the ſea, or thrown upon the coaſt.

The uſe of ambergriſe in Europe is now nearly confined to perfumery, though it has formerly been recommended in medicine by ſeveral eminent phyſicians. Hence the Eſſentia Ambræ Hoffmanni, Tinctura Regia Cod. Pariſini, Troſchiſci de Ambra Ph. Wurtemberg, &c.

The Turks make uſe of it as an aphrodiſiac. Our perfumers add it to ſcented pillars, candles, balls or bottles, gloves and hair-powder; and its eſſence is mixed with pomatums for the face and hands, either alone or mixed with muſk, &c. though its ſmell is to ſome perſons extremely offenſive.

Ambergriſe may be known to be genuine by its fragrant ſcent when a hot needle or pin is thruſt into it, and its melting like fat of an uniform conſiſtence; whereas the counterfeit will not yield ſuch a ſmell, nor prove of ſuch a fat texture. One thing, however, is very remarkable, that this drug, which is the moſt ſweet of all the perfumes, ſhould be capable of being reſembled in ſmell by a preparation of one of the moſt odious of all things. Mr. Homberg found, that a veſſel in which he had made a long digeſtion of the human fæces, acquired a very ſtrong and perfect ſmell of ambergriſe, inſomuch that any one would have thought a great quantity of eſſence of ambergriſe had been made in it. The perfume was ſo ſtrong and offenſive, that the veſſel was forced to be removed out of the elaboratory.

AMBITION, *ambitio*, is generally uſed in a bad ſenſe, for an immoderate or illegal purſuit of power. In ſtrict meaning, however, of the word, it ſignifies the ſame with the *ambitus* of the Romans. Ambition in the former and more uſual ſenſe, is one of thoſe paſſions that is never to be ſatisfied. It ſwells gradually with ſucceſs, and every acquiſition ſerves but as a ſpur to further attempts. "If a man (it has been well obſerved) could at once accompliſh all his deſires, he would be a miſerable creature; for the chief pleaſure of this life is to wiſh and deſire. Upon this account, every prince who aſpires to be deſpotic, aſpires to die of wearineſs. Searching every kingdom for the man who has the leaſt comfort in life, Where is he to be found? In the royal palace. What! his majeſty? Yes; eſpecially if he be deſpotic."

AMEN, נכן ſignifies *true*, *faithful*, *certain*. It is made uſe of likewiſe to affirm any thing, and was a ſort of affirmation uſed often by our Saviour: Αμην, Αμην λεγω υμιν i. e. *Verily, verily, I ſay unto you*. Laſtly, it is underſtood as expreſſing a wiſh; as *Amen, So be it*, Numb. v. 22. or an affirmation, *Amen, yet I believe it*, 1 Cor. xiv. 16. The Hebrews and the five books of Pſalms conclude, according to their way of diſtributing them, with the words *amen, amen*; which the Septuagint have tranſlated γενοιτο, γενοιτο; and the Latins *fiat, fiat, that is, Let it be done*.

AMENDMENT *of Bills in Parliament*, means ſome alteration made in the original draught, and we read of *amendment*, of *amendments*, *amendments* or returns of repreſentatives, &c. See PARLIAMENT. In caſes of wrong returns, ſo reported by the committee of privileges and elections, and voted by the Houſe of Commons, it is uſually ordered that the returns be amended by the returning officer, according to the directions of the houſe, without iſſuing a new writ. Amendments ought always to be in that houſe from whence the thing to be amended originally proceeded, though the directions for the amendments came from the other houſe. Hakew. Mann. of Paſſing Bills, p. 167.

AMERCEMENT, or AMERCIAMENT, in law, a pecuniary punishment imposed upon offenders, at the discretion of the court; frequently also called *misericordia*. There is this stated difference between fines and amercements; that fines are punishments certain and determined by some statutes; but amercements are arbitrary impositions, proportioned to the fault and wholly at the mercy of the court.

AMETHYST, a transparent gem of a purple colour, which seems composed of a strong blue and a deep red; and, according as either of those prevails, affording different tinges of purple, sometimes approaching to violet, and sometimes even fading to a pale rose colour. Though the amethyst is generally of a purple colour, it is nevertheless sometimes found naturally colourless, and may at any time be easily made so by putting it into the fire; in which pellucid or colourless state, it so resembles the diamond, that its want of hardness seems the only way of distinguishing it. The amethyst is scarce inferior to any of the gems in the beauty of its colour; and in its purest state is of the same hardness, and at least of an equal value, with the ruby and sapphire. It is found of various sizes, from the bigness of a small vetch, to an inch and an half in diameter, and often to much more than that in length. Its shape is extremely various, and sometimes roundish, sometimes oblong, and at others flatted, at least on one side; but its most common appearance is in a crystalliform figure, consisting of a thick column, composed of four planes, and terminated by a flat and short pyramid, of the same number of sides; or else, of a thinner and longer hexangular column; and sometimes of a long pyramid, without any column. It makes the gayest figure in the last of these states, but is hardest and most valuable in the roundish and pebble-like form. The amethyst is found in the East and West Indies, and in several parts of Europe; the oriental ones, at least some of the finer specimens, being so hard and bright as to equal any of the coloured gems in value. However, by far the greater number of amethysts fall infinitely short of these; as all the European ones, and not a few of those brought from the East and West Indies, are very little harder than common crystal.

AMIANTHUS, or EARTH-FLAX, a fibrous, flexile, elastic, mineral substance, consisting of short, abrupt, and interwoven filaments. It is found in Germany, in the strata of iron ore, sometimes forming veins of an inch diameter. Its fibres are so flexible that cloth has been made of them, and the shorter filaments that separate in the washing of the stone may be made into paper in the common manner. For the method of its preparation for manufacture into cloth, see ASBESTOS. See further the System of CHYMISTRY, Part II. Chap. III.

AMMONIAC, a concrete, gummy, resinous juice, brought from the East Indies, usually in large masses, composed of little lumps or tears, of a milky colour, but soon changing, upon being exposed to the air, of a yellowish hue. We have no certain account of the plant which affords this juice; the seeds usually found among the tears resemble those of the umbelliferous class. It has been, however, alledged, and not without some degree of probability, that it is an exudation from a species of the *ferula*, another species of which produces the asafœtida. The plant producing it is said to grow in Nubia, Abyssinia, and the interior parts of Egypt. It is brought to the western part of Europe from Egypt, and to England from the Red Sea, by some of the ships belonging to the East India Company trading to those parts. Such tears as are large, dry, free from little stones, seeds, or other impurities, should be picked out, and preferred for internal use: the coarser kind is purified by solution and colature, and then carefully inspissating it; unless this be artfully managed, the gum will lose a considerable deal of its more volatile parts. There is often vended in the shops, under the name of strained gum ammoniacum, a composition of ingredients much inferior in virtue.

Ammoniac has a nauseous sweet taste, followed by a bitter one; and a peculiar smell, somewhat like that of galbanum, but more grateful; it softens in the mouth, and grows of a whiter colour upon being chewed. Thrown upon live coals, it burns away in flame; it is in some measure soluble in water and in vinegar, with which it assumes the appearance of milk; but the resinous part, amounting to about one half, subsides on standing. Ammoniac is an useful deobstruent, and frequently prescribed for opening obstructions of the abdominal viscera, and in hysterical disorders occasioned by a deficiency of the menstrual evacuations. It is likewise supposed to deterge the pulmonary vessels; and proves of considerable service in some kinds of asthmas, where the lungs are oppressed by viscid phlegm: in this intention a solution of gum ammoniac in vinegar of squills proves a medicine of great efficacy, though not a little unpleasant. In long and obstinate cholics proceeding from viscid matter lodged in the intestines, this gummy resin has produced happy effects, after the purges and the common carminatives had been used in vain. Ammoniac is most commodiously taken in the form of pills; about a scruple may be given every night, or oftener. Externally it softens and ripens hard tumours; a solution of it in vinegar stands recommended by some for resolving even schirrhous swellings. A plaster made of it and squill-vinegar is recommended by some in white swellings. A dilute mixture of the same is likewise rubbed on the parts, which are also fumigated with the smoke of juniper berries. In the shops is prepared a solution of it in pennyroyal water, called from its milky colour *lac ammoniaci*. It is an ingredient also in the squill pills. For the method of producing the Ammoniac or volatile Alkali, see the System of CHYMISTRY, Part I. Chap. IV. Sect. II.

Sal AMMONIAC, a volatile salt, of which there are two kinds, ancient and modern. The ancient sort, described by Pliny and Dioscorides, was a native salt, generated in those large inns or caravanseras where the crowd of pilgrims, coming from the temple of Jupiter Ammon, used to lodge; who, in those parts, travelling upon camels, and those creatures when in Cyrene, a province of Egypt, where that celebrated temple stood, urining in the stables, or (say some) in the parched sands, out of this urine, which is remarkably strong, arose a kind of salt, denominated sometimes (from the temple) *Ammoniac*, and sometimes (from the country) *Cyreniac*. Since the cessation of these pilgrimages, no more of this salt is produced there; and, from this deficiency, some suspect there never was any such thing. But this suspicion is removed, by the large quantities of a salt, nearly of the same nature, thrown out by Mount Ætna. The characters of the ancient sal ammoniac are, that it cools water, turns aqua fortis into aqua regia, and consequently dissolves gold. For the various methods by which the *Sal Ammoniac* is produced, see the System of CHYMISTRY, Part I. Chap. V. Sect. IV. Art. II.

AMNIOS, or AMNION, in anatomy, the innermost membrane wherewith the fœtus in the womb is immediately invested. The *amnios* is a white, soft, thin, transparent membrane; making part of the secundine, and lying under the *chorion*. See the System of MIDWIFERY, Part I. Sect. VI.

The existence of the *allantois* in human subjects is questioned; but the *amnios* is found in all animals, both viviparous and oviparous. Dr. Hunter says, that the *amnios*, viewed in the microscope, appears to have blood vessels, but that they are really lymphatics. It contains a limpid liquor, like a thin jelly-broth; which, because the stomach of the fœtus is always found full of it, is supposed to be the matter of its nourishment. But authors differ widely as to the quantity and quality of the liquor of the *amnios*.

AMOMUM, *Ginger*: a genus of the Monogynia order, belonging to the Monandria class of plants.

The dried roots of ginger are of great use in the kitchen, as well as in medicine. They furnish a considerable export from some of the American islands. The green roots, preserved as a sweet meat, are preferable to every other kind. The Indians mix them with their rice, which is their common food, to correct its natural insipidity. This spice, mixed with others, gives the dishes seasoned with it a strong taste, which is extremely disagreeable to strangers. Ginger is a very useful spice, in cold flatulent colics, and in laxity and debility of the intestines; it does not heat so much as those of the pepper kind, but its effects are much more durable. The cardamoms and grains of paradise have the same medicinal qualities with ginger. In Jamaica, the common people employ it in baths and fomentations with good success, in complaints of the viscera, in pleurisies, and in obstinate and continued fevers.

AMOS, or the Prophecy of Amos, a canonical book of the Old Testament. This prophet boldly remonstrates against the crying sins that prevailed among the Israelites; and reproves the people of Judah for their sensuality and injustice. He terrifies them both with frequent threatnings, and pronounces that their sins will at last end in the ruin of Judah and Israel. He begins with denunciations of judgment and destruction against the enemies of the Jews, and concludes with promises of restoring the tabernacle of David, and of erecting the kingdom of Christ.

AMPELIS, the Chatterer, in ornithology, according to Linnæus, is the 68th Genus, and of the order of *Passeres*, but Latham, in his improved arrangement, makes it the 32 Genus, and of the same order: the distinguishing characters are, that the tongue is furnished with a rim or margin all round, and the bill is conical and strait. There are seven species, all natives of foreign countries, except the garrulus, which is a native both of Europe and the West Indies. In the former, the native country of these birds is Bohemia: from whence they wander over the rest of Europe, and were once superstitiously considered as presages of a pestilence. They appear annually about Edinburgh in February; and feed on the berries of the mountain-ash. They also appear as far south as Northumberland; and, like the fieldfare, make the berries of the white thorn their food. It is but by accident that they ever appear farther south. They are gregarious; feed on grapes, where vineyards are cultivated; are easily tamed; and are esteemed delicious food. This species is about the size of a black bird: the bill is short, thick, and black; on the head is a sharp pointed crest, reclining backwards: the lower part of the tail is black; the end of a rich yellow: the quill feathers are black, the three first tipt with white; the six next have half an inch of their exterior margin edged with fine yellow, the interior with white. But what distinguishes this from all other birds, are the horny appendages from the tips of seven of the secondary feathers, of the colour and gloss of the best red wax. For representation, see the SYSTEM, Plate II. Genus 32.

SYSTEM OF AMPHIBIOLOGY.

THIS part of Natural Hiſtory comprehends all thoſe animals called amphibia, from their living partly in water and partly on land, and forms the third claſs of Zoology, or the animal kingdom, according to the arrangement of Linnæus, in that valuable work the Syſtema Naturæ.

This great author obſerves, that there have been fewer writers on this branch of natural hiſtory than any other; and that thoſe who have written on the ſubject, are not to be relied on. He mentions four; *Seba*, *Cateſbæus*, *Gronovius and Garden*; and remarks that they are all deficient both in point of enumeration and deſcription. We ſhall not enter into a detail of all the animals which compoſe this claſs; as it would lead us far beyond the limits of our plan, but confine ourſelves to ſuch obſervations on thoſe of a peculiar nature, which we preſume will be found intereſting, curious and entertaining.

It has been a queſtion whether the animals commonly called *amphibious*, live moſt in the water or on land. If we conſider the words ἀμφὶ (*utrinque*, both ways), and βίος (*vita*, life), from which the term *amphibious* is derived; we ſhould underſtand, that animals having this title, ſhould be capable of living as well by land, or in the air, as by water; or of dwelling in either conſtantly at will: but it will be difficult to find any animal that can fulfil this definition, as being equally qualified for either. An ingenious naturaliſt, therefore, from conſidering their œconomy reſpectively, treats them under two diſtinct heads, viz. 1. Such as enjoy their chief functions by land, but occaſionally go into the water. 2. Such as chiefly inhabit the water, but occaſionally go aſhore. What he advances on this ſubject is curious, and will illuſtrate the nature of this claſs.

1. Of the firſt order, he particularly conſiders the phocæ; and endeavours to ſhew, that none of them can live chiefly in the water, but that their chief enjoyment of the functions of life is on ſhore. Theſe animals, he obſerves, are really quadrupeds; (ſee the article PHOCA and the Syſtem of MAMMALIA, Plate II. Genus 11.) but as their chief food is fiſh, they are under a neceſſity of going out to ſea to hunt their prey, and to great diſtances from ſhore; taking care that, however great the diſtance, rocks or ſmall iſlands are at hand, as reſting places when they are tired, or when their bodies become too much macerated in the water; and they return to the places of their uſual reſort to ſleep, copulate, and bring forth their young, for the following reaſons viz. It is well known, that the only eſſential difference (as to the general ſtructure of the heart) between amphibious and mere land animals, or ſuch as never go into the water, is, that in the former the oval hole remains always open. Now, in ſuch as are without this hole, if they were to be immerſed in water for but a little time, reſpiration would ceaſe, and the animal muſt die; becauſe a great part of the maſs of blood paſſes from the heart by the pulmonary artery through the lungs, and by the pulmonary veins returns to the heart, while the aorta is carrying the greater part of the maſs to the head and extremities, &c.

Now, the blood paſſes through the lungs in a continual uninterrupted ſtream, while reſpiration is gentle and moderate; but when it is violent, then the circulation is interrupted, for inſpiration and exſpiration are now carried to their extent; and in this ſtate the blood cannot paſs through the lungs either during the total inſpiration or total exſpiration of the air in breathing: for, in the former caſe, the inflation compreſſes the returning veins; and, in the latter, by the collapſion of the lungs, theſe veins are interrupted alſo; ſo that it is only between theſe two violent actions that the blood can paſs: and hence it is, that the lives of animals are ſhortened, and their health impaired, when they are ſubjected to frequent violent reſpiration; and thus it is, that when animals have once breathed, they muſt continue to reſpire ever after, for life is at an end when that ceaſes.

There are three neceſſary and principal uſes of reſpiration in all land-animals, and in thoſe kinds that are counted amphibious. The firſt is that of promoting the circulation of the blood through the whole body and extremities. In real fiſhes, the force of the heart is alone capable of ſending the blood to every part, as they are not furniſhed with limbs or extremities; but in the others mentioned, being all furniſhed with extremities, reſpiration is an aſſiſtant force to the arteries, in ſending blood to the extremities; which, being ſo remote from the heart, have need of ſuch aſſiſtance, otherwiſe the circulation would be very languid in theſe parts: thus we ſee, that in perſons ſubject to aſthmatic complaints, the circulation grows languid, the legs grow cold and oedematous, and other parts ſuffer by the defect in reſpiration. A ſecond uſe of breathing is, that, in inſpiration, the variety of particles, of different qualities, which float always in the air, might be drawn into the lungs, to be inſinuated into the maſs of blood, being highly neceſſary to contemperate and cool the agitated maſs, and to contribute refined pabulum to the finer parts of it, which, meeting with the daily ſupply of chyle, ſerves to aſſimilate and more intimately mix the maſs, and render its conſtitution the fitter for ſupporting the life of the animal. Therefore it is, that valetudinarians, by changing foul or unwholeſome air for a free, good, open air, often recover from lingering diſeaſes. A third principal uſe of reſpiration is, to promote the exhibition of voice in animals; which all thoſe that live on the land do according to their ſpecific natures.

From theſe conſiderations it appears, that the phocæ of every kind are under an abſolute neceſſity of making the land their principal reſidence. But there is another very convincing argument why they reſide on ſhore the greateſt part of their time; namely, that the fleſh of theſe creatures is analogous to that of other land animals; and therefore, by over long maceration added to the fatigue of their chacing their prey, they would ſuffer ſuch a relaxation as would deſtroy them. It is well known, that animals which have lain long under water, are reduced to a very lax and even putrid ſtate; and the phoca muſt baſk in the air on ſhore: for while the ſolids are at reſt, they acquire their former degree of tenſion, and the vigour of the animal is reſtored; and while he has an uninterrupted placid reſpiration, his blood is refreſhed by the new ſupply of air, as explained above, and he is rendered fit for his next cruiſe: for action waſtes the moſt exalted fluids of the body, more or leſs, according to its duration and violence; and the reſtorative reſt muſt continue a longer or ſhorter time, according to the quantity of the previous fatigue.

Let us now examine by what power theſe animals are capable of remaining longer under water than land-animals.

All theſe have the oval hole open between the right and left auricles of the heart; and, in many, the canalis arterioſus alſo: and while the phoca remains under water, which he may continue an hour or two, more or leſs, his reſpiration is ſtopped; and the blood, not finding the paſſage through the pulmonary artery free, ruſhes through the hole from the right to the left auricle, and partly through the arterial canal, being a ſhort paſſage to the aorta, and thence to every part of the body, maintaining the circulation: but, upon riſing to come aſhore, the blood finds its paſſage again through the lungs the moment he reſpires.

Thus the fœtus in utero, during its confinement, having the lungs compreſſed, and conſequently the pulmonary arteries and veins impervious, has the circulation of the blood carried on through the oval hole and the arterial canal. Now, ſo far the phoca in the water, and the fœtus in utero, are analogous; but they differ in other material circumſtances. One is, that the fœtus having never reſpired, remains ſufficiently nouriſhed by the maternal blood circulating through him, and continues to grow till the time of his birth, without any want of reſpiration during nine months confinement: the phoca, having reſpired the moment of his birth, cannot live very long without it, for the reaſons given before; and this hole and canal would be cloſed in them, as it is in land-animals, if the dam did not, ſoon after the birth of the cub, carry him ſo very frequently into the water to teach him; by which practice theſe paſſages are kept open during life, otherwiſe they would not be capable of attaining the food deſigned for them by Providence.

Another difference is, that the phoca, as was ſaid before, would be relaxed by maceration in remaining too long in the water; whereas the fœtus in utero ſuffers no injury from continuing its full number of months in the fluid it ſwims in: the reaſon is, that water is a powerful ſolvent, and penetrates the pores of the ſkins of land animals, and in time can diſſolve them; whereas the *liquor amnii* is an inſipid ſoft fluid, impregnated with particles more or leſs mucilaginous, and utterly incapable of making the leaſt alteration in the cutis of the fœtus.

Otters, beavers, and ſome kinds of rats, go occaſionally into the water for their prey, but cannot remain very long under water. "I have often gone to ſhoot otters (ſays our author), and watched all their motions: I have ſeen one of them go ſoftly from a bank into the river, and dive down; and in about two minutes riſe, at 10 or 15 yards from the place he went in, with a middling ſalmon in his mouth, which he brought on ſhore; I ſhot him, and ſaved the fiſh whole." Now as all fœtuſes have theſe paſſages open, if a whelp of a true water-ſpaniel was immediately after its birth, ſerved as the phoca does her cubs, and immerſed in water, to ſtop reſpiration for a little time every day, it is probable that the hole and canal would be kept open, and the dog be made capable of remaining as long under water as the phoca. In the caſtor, or beaver, diſſected by the academiſts of Paris, though the foramen was not actually open, yet the marks of it appeared; and the cauſe of its cloſure might well enough be accounted for, from the animal's having been detained a good while from the water, by which the part having been in diſuſe cloſed up. In the otter the caſe is different; there is no appearance of any thing like a foramen, and hence the neceſſity the creature is under of riſing, from time to time, above water, to take in air. Phil. Tranſ. No. 124. This ſtructure of the feet of the caſtor pronounces it amphibious at firſt ſight, the fore-feet being formed like thoſe of terreſtrial animals, who hold their food in their feet e. gr. ſquirrels, while the hind-feet are faſhioned after the manner of river fowl, with webs or membranes between the toes, as the gooſe, duck, &c.

Frogs, how capable ſoever of remaining in the water, yet cannot avoid living on land, for they reſpire; and if a frog be thrown into a river, he makes to the ſhore as faſt as he can. See the Article *Rana*.

The lizard kind, ſuch as may be called water-lizards (ſee LACERTA in the Alphabet,) are all obliged to come to land, in order to depoſit their eggs, to reſt, and to ſleep. Even the croco-

diles,

diles, who dwell much in rivers, ſleep and lay their eggs on ſhore; and, while in the water, are compelled to riſe to the ſurface to breathe; yet, from the texture of his ſcaly covering, he is capable of remaining in the water longer by far than any ſpecies, of the phoca, whoſe ſkin is analogous to that of a horſe or cow. For the anatomical formation of this animal, ſee the Syſtem of COMPARATIVE ANATOMY, Plate IV.

The hippopotamus, who wades into the lakes or rivers, is a quadruped, and remains under water a conſiderable time; yet his chief reſidence is upon land, and he muſt come on ſhore for reſpiration. See HIPPOPOTAMUS, and the Syſtem of MAMMALIA, Plate X. Genus 34.

The teſtudo, or ſea tortoiſe (ſee TESTUDO), though he goes out to ſea and is often found far from land; yet, being a reſpiring animal, cannot remain long under water. He has indeed a power of rendering himſelf ſpecifically heavier or lighter than the water, and therefore can let himſelf down to avoid an enemy or a ſtorm: yet he is under a neceſſity of riſing frequently to breathe, for reaſons given before; and his moſt uſual ſituation, while at ſea, is upon the ſurface of the water, feeding upon the various ſubſtances that float in great abundance every where about him. Theſe animals ſleep ſecurely upon the ſurface, but not under water, and can remain longer at ſea than any other of this claſs, except the crocodile, becauſe, as it is with the latter, his covering is not in danger of being too much macerated; yet they muſt go on ſhore to copulate and lay their eggs. For repreſentation of the ſkeleton of a tortoiſe, ſee the Syſtem of COMPARATIVE ANATOMY. Plate V.

2. The conſideration of theſe is ſufficient to inform us of the nature of the firſt order of the claſs of amphibious animals; let us now ſee what is to be ſaid of the ſecond order in our diviſion of them, which are ſuch as chiefly inhabit the waters, but occaſionally go on ſhore.

Theſe are but of two kinds: the eels, and water ſerpents or ſnakes of every kind. It is their form that qualifies them for loco-motion on land, and they know their way back to the water at will; for by their ſtructure they have a ſtrong periſtaltic motion, by which they can go forward at a pretty good rate (ſee the Articles *Serpent* and *Muræna*), whereas all other kinds of fiſh, whether vertical or horizontal, are incapable of a voluntary loco-motion on ſhore; and therefore, as ſoon as ſuch fiſh are brought out of the water, after having flounced a while, they lie motionleſs, and ſoon die.

Let us now examine into the reaſon why theſe vermicular fiſh, the eel and ſerpent kinds, can live a conſiderable time on land, and the vertical and horizontal kinds die almoſt immediately when taken out of the water: and, in this reſearch, we ſhall come to know what analogy there is between land animals and thoſe of the waters. All land-animals have lungs, and can live no longer than while theſe are inflated by the ambient air, and alternately compreſſed for its expulſion; that is, while reſpiration is duly carried on, by a regular inſpiration and exſpiration of air.

In like manner, the fiſh in general have, inſtead of lungs, gills or bronchiæ; and as in land-animals the lungs have a large portion of the maſs of blood circulating through them, which muſt be ſtopped if the air has not a free ingreſs and egreſs into and from them; ſo, in fiſh, there is a great number of blood-veſſels that paſs through the bronchiæ, and a great portion of their blood circulates through them, which muſt in like manner be totally ſtopped, if the bronchiæ are not perpetually wet with water. So that, as the air is to the lungs in land-animals a conſtant aſſiſtant to the circulation; ſo is the water to the bronchiæ of thoſe of the rivers and ſeas: for when theſe are out of the water the bronchiæ very ſoon grow criſp and dry, the blood-veſſels are ſhrunk, and the blood is obſtructed in its paſſage; ſo, when the former are immerſed in water, or otherwiſe prevented from having reſpiration, the circulation ceaſes, and the animal dies. See the Syſtem of ICHTHYOLOGY, Sect. III. and COMPARATIVE ANATOMY, Chap. III.

Again, as land-animals would be deſtroyed by too much maceration in water; ſo fiſhes would, on the other hand, be ruined by too much exſiccation; the latter being, from their general ſtructure and conſtitution, made fit to bear, and live in, the water; the former, by their conſtitution and form, to breathe and dwell in the air.

But it may be aſked, why eels and water-ſnakes are capable of living longer in the air than the other kinds of fiſh? This is anſwered by conſidering the providential care of the great Creator for theſe and every one of his creatures: for ſince they were capable of loco-motion by their form, which they need not be if they were never to go on ſhore; it ſeemed neceſſary that they ſhould be rendered capable of living a conſiderable time on ſhore, otherwiſe their loco-motion would be in vain. How is this provided for? Why, in a moſt convenient manner: for this order of fiſhes have their bronchiæ well covered from the external drying air; they are alſo furniſhed with a ſlimy mucus, which hinders their becoming criſp and dry for many hours: and their very ſkins always emit a mucous liquor, which keeps them ſupple and moiſt for a long time: whereas the bronchiæ of other kinds of fiſh are much expoſed to the air, and want the ſlimy matter to keep them moiſt. Now, if any of theſe, when brought out of the water, were laid in a veſſel without water, they might be preſerved alive a conſiderable time, by only keeping the gills and ſurface of the ſkin conſtantly wet, even without any water to ſwim in.

A great part of the fly-kind may be ſaid, in one ſenſe, to be amphibious. Gnats drop their eggs in water, where hatching, the young live and breathe after the manner of fiſhes, till at length undergoing a metamorphoſis, they take wing, quit their native element, and become inhabitants of the air.

In theſe, as in many other inſtances, we ſee how wonderfully is the ſtructure of every part of the creation to ſubſerve the grand deſigns of the Creator, and to diſplay his omnipotence and benevolence throughout all his works.

It has been advanced that *man* may, by art, be rendered amphibious, and able to live under water as well as frogs. As the fœtus lives *in utero* without air, and the circulation is there continued by means of the foramen ovale; by preſerving the paſſage open, and the other parts *in ſtatu quo*, after the birth, the ſame faculty would ſtill continue. Now, the foramen, it is alledged, would be preſerved in its open ſtate, were people accuſtomed, from their infancy, to hold their breath a conſiderable time once a-day, that the blood might be forced to reſume its priſtine paſſage, and prevent its drying up as it uſually does. This conjecture ſeems, in ſome meaſure, ſupported by the practice of divers who are taught from their childhood to hold their breath, and keep long under water, by which means the ancient channel is kept open. A Calabrian monk at Madrid laid claim to this amphibious capacity, making an offer to the king of Spain, to continue twice twenty-four hours under water, without ever coming up to take breath. Kircher gives an account of a Sicilian named the *fiſh Colas*, who by a long habitude from his youth, had ſo accuſtomed himſelf to live in water, that his nature ſeemed to be quite altered; ſo that he lived rather after the manner of a fiſh than a man.

Claſſification according to Linnæus.

The claſſical characters of the Amphibia or Amphibious animals, are the following. They have the heart furniſhed with one ventricle and one auricle, their blood is cold and red, and they reſpire voluntarily.

This claſs is divided into three Orders, viz. Reptiles, Serpentes, and Nantes.

ORDER I. *Reptiles.* The reptiles have legs, and breathe by the mouth. This order contains four genera, viz. Teſtudo, Draco, Lacerta and Rana. See theſe Articles.

ORDER II. *Serpentes.* The ſerpentes have no legs, and breathe by the mouth. This order contains ſix genera, viz. Crotalus, Boa, Coluber, Anguis, Amphiſbæna and Cæcilia. See theſe Articles.

ORDER III. *Nantes.* The Nantes are furniſhed with lungs, and at the ſame time breathe by lateral gills, and the rays of their fins are cartilaginous. This order contains fourteen genera, viz. Petromyzon, Raja, Squalus, Chimæra, Lophius, Acipenſer, Cyclopterus, Balliſtes, Oſtracion, Tetrodon, Diodon, Centriſcus, Syngnaſus, and Pegaſus. See theſe Articles.

Here it is neceſſary to obſerve, that the order Nantes was introduced in the Syſtem of Ichthyology, firſt compiled by Artedi, a Swediſh Naturaliſt of great eminence, and fellow ſtudent with Linnæus, who on the diſeaſe of his friend, reviſed and publiſhed his Syſtem in Latin. But Linnæus, though in all his former editions of the Syſtema Naturæ, he adopted the method of Artedi, with little variation; in the latter edition has removed the Cetaceous order into the claſs Mammalia, and the order Nantes into the claſs Amphibia.

To theſe three Orders ſome naturaliſts add a fourth, which they call Meantes. The Meantes have both lungs and gills, and the feet are furniſhed with toes and claws. This order has but one genus, viz. the Siren.

The generic characters of this claſs are taken from the general figure of the body; from their having tails or no tails; being covered with a ſhell; having teeth or no teeth in the mouth; being furniſhed with wings; having covered or naked bodies; from the number, ſituation and figure of the ſcuta and ſcales; from the number and ſituation of the ſpiracula, from the ſituation of the mouth, &c.

The deſcriptions of the ſeveral genera are given in the order of the alphabet. The ſpecific characters are ſo very various, that it would be ſuperfluous to enumerate them.

From this ſummary view of this claſs of the animal kingdom, called Amphibia, for the cauſes heretofore aſſigned, we ſee, as in numberleſs other inſtances in the boundleſs extent of Natural Hiſtory, how wonderfully the ſtructure and œconomy of every part of the creation is adapted to ſubſerve the deſigns of the Almighty Creator, and to diſplay his omnipotence and benevolence throughout all his works; ſo that nothing can afford more ſublime enjoyment to a contemplative mind, than, according to the language of the author of the Eſſay of Man,

"To look thro' Nature up to Nature's God."

AMPHISBÆNA, in amphibiology, a genus of ſerpents, belonging to the order of ſerpentes, ſo called from the falſe notion of its having two heads, becauſe it moves with either end foremoſt. The head of the amphiſbæna is ſmall, ſmooth, and blunt; the noſtrils are very ſmall; the eyes are minute and blackiſh; and the mouth is furniſhed with a great number of ſmall teeth. The body is cylindrical, about a foot long, and divided into about 200 annular convex ſegments like thoſe of a worm; and it has about 40 longitudinal ſtreaks, of which 12 on each ſide are in the form of ſmall croſſes, like the Roman X; the anus is a tranſverſe ſlit; and the laſt ring or ſegment of the belly has eight ſmall papillæ, forming a tranſverſe line before the anus; the tail, i. e. all the ſpace below the anus, is ſhort, conſiſting of 30 annular ſegments, without being marked with the croſs lines, and is thick and blunt at the point. The colour of the whole animal is black, variegated with white; but the black prevails moſt on the back, and the white on the belly. It has a great reſemblance to a worm, living in the earth, and moving equally well with either end foremoſt. There are but two ſpecies, viz. 1. The fuliginoſa, which anſwers exactly to the above deſcription, and is found in Libya, and in different parts of America. 2. The alba, which is totally white, is a native of both the Indies, and is generally found in ant-hillock. The bite of the amphiſbæna is reckoned to be mortal by many authors; but as it is not furniſhed with dog-fangs, the uſual inſtruments of conveying the poiſon of ſerpents, later writers eſteem it not to be poiſonous. They feed upon ants and earth-worms, but particularly the latter.

AMPHISCII, in geography and aſtronomy, the people who inhabit the torrid zone. The word comes from ἀμφὶ, *about*, and σκιὰ, *ſhadow*. They are thus denominated, as having their ſhadow turned ſometimes one way and ſometimes another, i. e. at one time of the year to the north, and at another to the ſouth. The amphiſcii are called alſo *aſcii*.

AMPHITHEATRE, in antiquity, a ſpacious edifice, built either round or oval, with a number of riſing ſeats, upon which the people uſed to behold the combats of gladiators, of wild beaſts, and other ſports.

There are amphitheatres ſtill ſtanding at Rome, at Pola, at Niſmes, &c. The amphitheatre of Veſpaſian, called the *Coliſeum*, and that at Verona in Italy, are the moſt celebrated now remaining of all antiquity. Remains of amphitheatres are ſhown alſo at Arles, Bourdeaux, &c. The amphitheatre at Pola, an ancient republic of Iſtria, is very entire; it conſiſts of two orders of Tuſcan pillars, one over the other. The lower have pedeſtals, which is extraordinary; this order having ſcarce ever more than baſes to ſupport them. The amphitheatre of Veſpaſian is computed to have been capable of holding 87,000 ſpectators. That of Verona is the beſt preſerved: for though moſt of the great and beſt ſtones of the outſide are picked out, yet the great vault, on which the rows of the ſeats are laid, is entire; the rows alſo (which are 44 in number) are entire. Every row is a foot and a half high, and as much in breadth; ſo that a man ſits conveniently in them; and allowing for a ſeat a foot and a half, the whole will hold 23,000 perſons.

AMPLIFICATION, in rhetoric, part of a diſcourſe or ſpeech, wherein a crime is aggravated, a praiſe or commendation heightened, or a narration enlarged, by an enumeration of circumſtances; ſo as to excite the proper emotions in the minds of the auditors. Such is the paſſage in Virgil, where, inſtead of ſaying merely that Turnus died, he amplifies the circumſtances of his death.

——Aſt illi ſolvuntur frigore membra,
Vitaque cum gemitu fugit indignata ſub umbras.

AMPLITUDE, in aſtronomy, an arch of the horizon intercepted between the eaſt or weſt point and the centre of the ſun, or a planet, at its riſing or ſetting; and ſo is either north and ſouth, or ortive and occaſive. See the SYSTEM, Sect. IX. and problems annexed.

Magnetical AMPLITUDE. The different riſing or ſetting of the ſun from the eaſt or weſt points of the compaſs, is found by obſerving the ſun, at his riſing and ſetting, by an amplitude-compaſs. For rules reſpecting this branch of navigation, ſee the SYSTEM, Part I. Sect. IV.

AMULET, a charm, or preſervative againſt miſchief, witchcraft, or diſeaſes. Amulets were made of ſtone, metal, ſimples, animals, and in a word of every thing that imagination ſuggeſted. Sometimes they conſiſted of words, characters, and ſentences, ranged in a particular order, and engraved upon wood, &c. and worn about the neck, or ſome other part of the body. At other times they were neither written nor engraved; but prepared with many ſuperſtitious ceremonies, great regard being uſually paid to the influence of the ſtars. The Arabians have given to this ſpecies of amulet the name of *Taliſman*. All nations have been fond of amulets; the Jews were extremely ſuperſtitious in the uſe of them, to drive away diſeaſes; and the Miſna forbids them, unleſs received from an approved man, who had cured at leaſt three perſons before by the ſame means.

Among the Romans, amulets were made of the wood of the croſs, or ribbands with a text of ſcripture written in them, as preſervatives againſt diſeaſes. Notwithſtanding the progreſs of learning and refinement, there is not any country in Europe, even at this day, who do not believe in ſome charm or other. The pope is ſuppoſed to have the virtue of making amulets which he exerciſes in conſecrating of *Agnus Dei's*, &c. The ſponge which has wiped his table, was formerly in great veneration as a preſervative from wounds, and from death itſelf: on this account it was ſent with great ſolemnity by Gregory II. to the duke of Aquitain.

AMYGDALUS, the ALMOND and PEACH: a genus of the Monogynia order, belonging to the Icoſandria claſs of plants; and, in the natural method, ranking under the 30th order, *Pomaceæ*. The characters are: The *calyx* is a ſingle-leaved perianthium beneath, tubular and quinquefid: the *corolla* conſiſts of five oblong petals, which are inſerted into the calyx: the *ſtamina* conſiſt of 30 ſlender erect filaments, half the length of the corolla, and inſerted into the calyx; the antheræ are ſimple: *piſtillum* has a round villous germen above; a ſimple ſtylus, the length of the ſtamina; and the ſtigma headed: the *pericarpium* is a large roundiſh villous drupa, with a longitudinal furrow: the *ſeed* is an ovate compreſſed nut, perforated in the pores.

Species. 1. The Communis, or Common Almond, a native of Africa, will grow to near 20 feet high; and whether planted ſingly in an open place, or mixed with others in clumps, ſhrubbery-quarters, &c. ſhows itſelf one of the fineſt flowering trees in nature. Thoſe who never yet ſaw it, may eaſily conceive what a noble appearance this tree muſt make, when covered all over with a bloom of a delicate red, which will be in March; a time when very few trees are ornamented either with leaves or flowers. No ornamental plantation, therefore, of what ſort or kind ſoever, ſhould be without almond-trees. Neither are the beauties of the flowers the only thing deſirable in this tree: the fruit would render it worthy of planting, were there no other motive. It ripens well, and its goodneſs is not unknown to us. The white-flowering almond, well known in our nurſeries, is a variety of this ſpecies, and is cultivated for the ſake of the flowers and the fruit, though the flowers are inferior to the others; and unleſs it be ſet againſt a ſouth wall, in a well ſheltered place, there will be little hopes of bearing fruit.

2. The Nana, Dwarf almond, is a native of Aſia Minor. Of this ſhrub there are two ſorts, the ſingle and the double. Both grow to about four or five feet high, and are in the firſt eſteem as flowering ſhrubs. The ſingle ſort has its beauties; but the double kind is matchleſs. In both the flowers are arranged the whole length of the laſt year's ſhoots; their colour is a delicate red; and they ſhow themſelves early in the ſpring, which ſtill enhances their value.

3 The Perſica, or Peach, is ſaid to be a native of Europe; but of what place is not known. Cultivation has produced many varieties of this fruit; of which the following are the moſt eſteemed.

1. The White Nutmeg.
2. The red Nutmeg
3. The Early Purple.
4. The ſmall Mignon.
5. The White Magdalen.
6. The Yellow Alberge.
7. The Large French Mignon.
8. The Beautiful Chevreuſe.
9. The Red Magdalen.
10. The Chancellor.
11. Smith's Newington.
12. The Montauban.
13. The Malta.
14. The Vineuſe.
15. The Bellegarde.
16. The Bourdine.
17. The Roſanna.
18. The Admirable.
19. The Old Newington.
20. The Royal.
21. The Ramboullilet.
22. The Portugal.
23. The Late Admirable
24. The Nivette.
25. Venus's Nipple
26. The Late Purple.
27. The Perſique.
28. The Catharine.
29. The Monſtrous Pavy.
30. The Bloody Peach.

For the moſt approved method of pruning, nailing, and the ſubſequent management of peaches, &c. ſee the Treatiſe on GARDENING, Article Fruit Garden, Months *January* and *May*.

Uſes. Sweet almonds are reckoned to afford little nouriſhment; and, when eaten in ſubſtance, are not eaſy of digeſtion, unleſs throughly comminuted: Peeled, and eaten ſix or eight at a time, they ſometimes give preſent relief in the heart-burn. But in medicine they are moſtly uſed for making emulſions; and they abound not only with an oil, but likewiſe with a mucilage fit for incorporating oil and water together.

Emulſions are commonly prepared from almonds, by beating an ounce of them, after being blanched, into a fine pulp, in a marble or ſtone mortar; and triturating them well with half an ounce (more or leſs) of fine ſugar; and then adding, by little at a time, a quart of water; taking care to continue grinding them while the water is poured on; after which the white milky liquor is ſtrained through a cloth, and put into a quart bottle. Some people add a dram of blanched bitter almonds to an ounce of the ſweet, which they think makes the emulſions more agreeable. Such emulſions have been much uſed as drink in acute diſeaſes, for diluting and blunting acrimonious juices in the firſt paſſages, and acrid ſaline particles in the blood; and for ſoftening and lubricating the fibres and membranes.

It has been a common practice to diſſolve from half an ounce to an ounce, or more, of gum arabic in the water uſed for making

the emulſions; and to make patients drink freely of them, while bliſters are applied to the body, in order to prevent ſtranguary; and to order them to be uſed in caſes of gravel, and of inflammation of the bladder or urethra; and in heat of urine from virulent gonorrhœas or other cauſes.

Camphor, reſin of jalap, and other reſinous ſubſtances, by being triturated with almonds, become miſcible with water, and more mild and pleaſant than they were before; and therefore they are frequently ordered to be rubbed with them, and made up into pills or boluſes with the addition of ſome conſerve or gum arabic mucilage: or they are incorporated with watery liquors into the form of an emulſion.

Formerly the ſeeds of the lettuce, of the cucumber, of the white poppy, and of a number of other plants, were employed for making emulſions; but now in this country the ſweet almonds ſupply the place of all the reſt.

The bitter almonds are not ſo much uſed as they were formerly; becauſe they have been found to deſtroy ſome ſorts of animals: this effect was related by the ancients, but believed to be fictitious; becauſe when eaten by men they appear to be innocent and produce no deleterious effects. However, the facts related by Wepfer in his Treatiſe *de Cicuta Aquatica*, having been confirmed by later experiments; and it having been diſcovered that a water drawn from them had deleterious effects, and that the diſtilled water from the lauro-ceraſus leaves, which have a bitter taſte reſembling that of bitter almonds, was ſtill more poiſonous; it raiſed a ſuſpicion of the wholeſomeneſs of thoſe bitter ſubſtances, and has made phyſicians more cautious of uſing them, though they have been employed for making orgeate and other liquors, without producing any bad effects.

As to the peach and nectarine, they are ſufficiently known as delicious fruits. Peach flowers have an agreeable ſmell, and a bitteriſh taſte; diſtilled, without any addition, by the heat of a water-bath, they yield one-ſixth their weight, or more, of a whitiſh liquor, which, as Mr. Bolduc obſerves, communicates to a large quantity of other liquids a flavour like that of the kernels of fruits. An infuſion in water of half an ounce of the freſh gathered flowers, or a dram of them when dried, ſweetened with ſugar, proves for children an uſeful laxative and anthelmintic: the leaves of the tree are, with this intention, ſomewhat more efficacious, though leſs agreeable. The fruit has the ſame quality with the other ſweet fruits, that of abating heat, quenching thirſt, and gently looſening the belly.

ANABAPTISTS, a name given to Chriſtians who maintain that baptiſm ought always to be performed by immerſion; that it ought not to be adminiſtered to children before the age of diſcretion, or that at this age it ought to be re-adminiſtered to thoſe who have been baptized in their infancy, becauſe, they ſay, the adminiſtration of this ſacrament is neither valid nor uſeful, if it be done by ſprinkling only, and not by immerſion; or if the perſons who receive it, be not in a condition to give the reaſons of their belief. The word *Anabaptiſt* is compounded of ἀνὰ *new*, and βαπτιστὴς, a *baptiſt*; and this general denomination has been indiſcriminately applied to people of very different principles and practices; though many of them object to the name, and hold nothing in common, excepting ſome one or other of the above-mentioned opinions concerning baptiſm.

The Novatians, the Cataphrygians, and the Donatiſts, may be conſidered as a kind of Anabaptiſts in the earlier ages, though not then denoted by this name; for they contended, that thoſe Chriſtians of the catholic church who joined themſelves to their reſpective parties ſhould be rebaptized. But we muſt not claſs under the ſame denomination thoſe biſhops of Aſia and Africa, who, in the third century, maintained, that baptiſm adminiſtered by thoſe whom they called heretics was not valid, and therefore that ſuch of them as returned into their churches ought to be rebaptized. Nor do the Engliſh and Dutch Baptiſts conſider the denomination as at all applicable to their ſect: by whom the baptiſm appointed by Chriſt is held to be "nothing ſhort of *immerſion, upon a perſonal profeſſion of faith*," of which profeſſion infants being incapable, and ſprinkling being no adequate ſymbol of the thing intended, the baptizing of proſelytes to their communion, who in their infancy had undergone the ceremony of ſprinkling, cannot, it is urged, be interpreted a repetition of the baptiſmal ordinance.

Anabaptiſts, in a ſtrict and proper ſenſe, appear to be thoſe who not only rebaptize, when they arrive at an adult age, perſons that were baptized in their infancy, but alſo, as often as any perſon comes from one of their ſects to another, or as often as any one is excluded from their communion and again received into the boſom of their church, they baptize him. And ſuch were many of the German Baptiſts. But the ſingle opinion common to all the ſects to which the name of *Anabaptiſts* has been indiſcriminately applied, is that of the invalidity of *infant baptiſm*, in whatever way adminiſtered: and hence the general denomination of *Antipædobaptiſts*; which includes Anabaptiſts, Baptiſts, Mennonites, Waterlandians, &c. as diſtinguiſhed by their reſpective peculiarities; though *Anabaptiſts* ſeem to have been adopted by moſt writers as the general term.

To the above peculiar notion concerning the baptiſmal ſacrament, the Anabaptiſts added principles of a different nature, depending upon certain ideas which they entertained concerning a perfect church-eſtabliſhment, pure in its members, and free from the inſtitutions of human policy. The Anabaptiſts appear to have made little noiſe, or to have been little noticed, before the time of the reformation in Germany. The moſt prudent and rational part of them conſidered it poſſible, by human wiſdom, induſtry, and vigilance, to purify the church from the contagion of the wicked, provided the manners and ſpirit of the primitive Chriſtians could but recover their loſt dignity and luſtre; and ſeeing the attempts of Luther, ſeconded by ſeveral perſons of eminent piety, prove ſo ſucceſsful, they hoped that the happy period was arrived in which the reſtoration of the church to purity was to be accompliſhed, under the divine protection, by the labours and counſels of pious and eminent men. Others, far from being ſatisfied with the plan of reformation propoſed by Luther, looked upon it as much beneath the ſublimity of their views; and conſequently undertook a more perfect reformation, or, to expreſs more properly their viſionary enterpriſe, they propoſed to found a new church, entirely ſpiritual, and truly divine.

This ſect was ſoon joined by great numbers, and (as uſually happens in ſudden revolutions of this nature) by many perſons, whoſe characters and capacities were very different, though their views ſeemed to turn upon the ſame object. Their progreſs was rapid; for, in a very ſhort ſpace of time, their diſcourſes, viſions, and predictions, excited commotions in a great part of Europe, and drew into their communion a prodigious multitude, whoſe ignorance rendered them eaſy victims to the illuſions of enthuſiaſm. The moſt pernicious faction of all thoſe which compoſed this motly multitude, was that which pretended that the founders of the new and perfect church, were under the direction of a divine impulſe, and were armed againſt all oppoſition by the power of working miracles. It was this faction that, in the year 1521, began their fanatical work, under the guidance of Munzer, Stubner, Storck, &c.

Theſe perſons were diſciples of Luther; but well knowing that their opinions were ſuch as would receive no ſanction from him, they availed themſelves of his abſence to diſſeminate them in Wittemburgh, and had the addreſs to over-reach the piety of Melancthon. Their principal purpoſe was to gain over the populace, and to form a conſiderable party. To effect this, ſays Bayle, they were induſtrious and active, each in his own way. Storck, wanting knowledge, boaſted of inſpiration; and Stubner, who had both genius and erudition, laboured at commodious explications of Scripture. Not content with diſcrediting the court of Rome, and decrying the authority of conſiſtories, they taught, that among Chriſtians, who had the precepts of the goſpel to direct, and the ſpirit of God to guide them, the office of magiſtracy was not only unneceſſary, but an unlawful encroachment on their ſpiritual liberty; that the diſtinctions occaſioned by birth, or rank, or wealth, being contrary to the ſpirit of the goſpel, which conſiders all men as equal, ſhould be entirely abolished; that all Chriſtians, throwing their poſſeſſions into the common ſtock, ſhould live together in that ſtate of equality which becomes members of the ſame family; that as neither the laws of nature nor the precepts of the New Teſtament had placed any reſtraint upon men with regard to the number of wives which they might marry, they ſhould uſe that liberty which God himſelf had granted to the patriarchs. They employed at firſt the various arts of perſuaſion in order to propagate their doctrine. They preached, exhorted, admoniſhed, and reaſoned, in a manner that ſeemed proper to impreſs the multitude; and related a great number of viſions and revelations with which they pretended to have been favoured from above. But when they ſaw that theſe methods of making proſelytes were not attended with ſuch a rapid ſucceſs as they fondly expected, and that the miniſtry of Luther and other eminent reformers were detrimental to their cauſe, they then had recourſe to more expeditious meaſures, and madly attempted to propagate their fanatical doctrine by force of arms. Munzer and his aſſociates, in the year 1525, put themſelves at the head of a numerous army, compoſed for the moſt part of the peaſants of Suabia, Thuringia, Franconia, and Saxony, and declared war againſt all laws, government, and magiſtrates of every kind, under the chimerical pretext that Chriſt was now to take the reins of civil and eccleſiaſtical government into his own hands, and to rule alone over the nations. But this ſeditious crowd was routed and diſperſed, without much difficulty, by the Elector of Saxony and other princes; and Munzer their ring-leader ignominiouſly put to death, and his factious counſellors ſcattered abroad in different places.

Many of his followers, however, ſurvived, and propagated their opinions through Germany, Switzerland, and Holland. In the year 1533, a party of them ſettled at Munſter, under the direction of two Anabaptiſt prophets, John Matthias, a baker of Haerlem, and John Bockholt, a journeyman taylor of Leyden. Having made themſelves maſters of the city, they depoſed the magiſtrates, confiſcated the eſtates of ſuch as had eſcaped, and depoſited the wealth they amaſſed together in a public treaſury for common uſe. They made preparations of every kind for the defence of the city; and ſent out emiſſaries to the Anabaptiſts in the Low Countries, inviting them to aſſemble at Munſter, which was now dignified with the name of Mount Sion, that from hence they might be deputed

puted to reduce all the nations of the earth under their dominion. Matthias, who was the firſt in command, was ſoon cut off in an act of phrenſy by the biſhop of Munſter's army; and was ſucceeded by Bockholdt, who was proclaimed by a ſpecial deſignation of Heaven, as he pretended, king of Sion, and inveſted with legiſlative powers like thoſe of Moſes. The extravagances of Bockholdt were too numerous to be recited: it will be ſufficient to add, that the city of Munſter was taken after a long ſiege and an obſtinate reſiſtance; and Bockholdt the mock monarch was puniſhed with a moſt painful and ignominious death.

It muſt, however, be acknowledged, that the true riſe of the numerous inſurrections of this period ought not to be attributed to religious opinions. The firſt inſurgents groaned under the moſt grevious oppreſſions; they took up arms principally in defence of their civil liberties; and of the commotions that took place. The Anabaptiſt leaders above-mentioned ſeem rather to have availed themſelves, than to have been the prime movers. That a great part of the main body, indeed, conſiſted of Anabaptiſts ſeems indiſputable: and whatever fanaticiſm exiſted among them would naturally be called forth or be inflamed by the ſituations that occurred, and rioted, then in its wildeſt ſhapes. At the ſame time it appears from hiſtory, that a great part alſo conſiſted of Roman Catholics, and a ſtill greater of perſons who had ſcarcely any religious principles at all. Indeed, when we read of the vaſt numbers that were concerned in thoſe inſurrections, of whom it is reported that 100,000 fell by the ſword, it appears reaſonable to conclude that a great majority of them were not Anabaptiſts.

Before concluding this article, it muſt be remarked, that the Baptiſts or Mennonites in England and Holland are to be conſidered in a very different light from the enthuſiaſts we have been deſcribing: and it appears equally uncandid and invidious, to trace up their diſtinguiſhing ſentiment, as ſome of their adverſaries have done, to thoſe obnoxious characters, and there to ſtop, in order as it were to aſſociate with it the ideas of turbulence and fanaticiſm, with which it certainly has no natural connection. Their coincidence with ſome of thoſe oppreſſed and infatuated people in denying baptiſm to infants, is acknowledged by the Babtiſts: but they diſavow the practice which the appellation of *Anabaptiſts* implies; and their doctrines ſeem referable to a more ancient and reſpectable origin. They appear ſupported by hiſtory in conſidering themſelves as the deſcendents of the Waldenſes, who were ſo grievouſly oppreſſed and perſecuted by the deſpotic heads of the Romiſh hierarchy; and they profeſs an equal averſion to all principles of rebellion on one hand, and to all ſuggeſtions of fanaticiſm on the other. See BAPTISTS.

ANACREONTIC, in the Greek and Latin poetry, ſomething invented by Anacreon, or in the manner and taſte of Anacreon, a poet of Teios, who lived upwards of 400 years before Chriſt, famous for the delicacy of his wit, and the exquiſite, yet eaſy and natural, turn of his poeſy. We have ſeveral of his odes ſtill extant; and there are few of the modern poets who have not written Anacreontics in imitation of them. They are moſtly compoſed in verſes of ſeven ſyllables; or rather of three feet and a half, ſpondees and iambics, though ſometimes anapæſts. Hence verſes in that meaſure are ſometimes called *Anacreontics*, or *Anacreontic verſes*.

The verſes of Anacreon are ſweeter, ſays Scaliger, than Indian ſugar. His beauty and chief excellence, ſays Madam Dacier, lay in imitating nature, and in following reaſon; ſo that he preſented to the mind no images but what were noble and natural. The odes of Anacreon, ſays Rapin, are flowers, beauties, and perpetual graces; it is familiar to him to write what is natural and to the life, he having an air ſo delicate, ſo eaſy, and graceful, that among all the ancients there is nothing comparable to the method he took, nor to that kind of writing he followed. He flows ſoft and eaſy, every where diffuſing the joy and indolence of his mind through his verſe, and tuning his harp to the ſmooth and pleaſant temper of his ſoul. But none has given a juſter character of his writings than the God of Love, as taught to ſpeak by Mr. Cowley:

> All thy verſe is ſofter far
> Than the downy feathers are
> Of my wings, or of my arrows,
> Of my mother's doves and ſparrows:
> Graceful, cleanly, ſmooth, or round,
> All with Venus' girdle bound.

ANALOGY, in philoſophy, a certain relation and agreement between two or more things, which in other reſpects are entirely different. There is likewiſe an analogy between beings that have ſome conformity or reſemblance to one another; for example, between animals and plants; but the analogy is ſtill ſtronger between two different ſpecies of certain animals.

Analogy enters much into all our reaſoning, and ſerves to explain and illuſtrate. A great part of our philoſophy, indeed, has no other foundation than analogy.

It is natural to mankind to judge of things leſs known, by ſome ſimilitude, real or imaginary, between them and things more familiar or better known. And where the things compared have really a great ſimilitude in their nature, when there is reaſon to think that they are ſubject to the ſame laws, there may be a conſiderable degree of probability in concluſions drawn from analogy. Thus we may obſerve a very great ſimilitude between this earth which we inhabit, and the other planets, Saturn, Jupiter, Mars, Venus and Mercury. They all revolve round the ſun, as the earth does, although at different diſtances, and in different periods. They borrow all their light from the ſun, as the earth does. Several of them are known to revolve round their axis like the earth, and, by that means, muſt have a like ſucceſſion of day and night. Some of them have moons, that ſerve to give them light in the abſence of the ſun, as our moon does to us. They are all, in their motions, ſubject to the ſame law of gravitation as the earth is. From all this ſimilitude, it is not unreaſonable to think, that thoſe planets may, like our earth, be the habitation of various orders of living creatures. There is ſome probability in this concluſion from analogy.

But it ought to be obſerved, that, as this kind of reaſoning can afford only probable evidence at beſt; ſo, unleſs great caution be uſed, we are apt to be led into error by it. To give an inſtance of this: Anatomiſts, in ancient ages, ſeldom diſſected human bodies, but very often the bodies of thoſe quadrupeds whoſe internal ſtructure was thought to approach neareſt to that of the human body. Modern anatomiſts have diſcovered many miſtakes the ancients were led into, by their conceiving a greater ſimilitude between the ſtructure of men and of ſome beaſts than there is in reality. Perhaps no author has made a more juſt and a more happy uſe of this mode of reaſoning, than biſhop Butler in his analogy of Religion, Natural and Revealed, to the Conſtitution and Courſe of Nature. In that excellent work, the author does not ground any of the truths of religion upon analogy, as their proper evidence. He only makes uſe of analogy to anſwer objections againſt them. When objections are made againſt the truths of religion, which may be made with equal ſtrength againſt what we know to be true in the courſe of nature, ſuch objections can have no weight. Analogical reaſoning, therefore, may be of excellent uſe in anſwering objections againſt truths which have other evidence. It may likewiſe give a greater or a leſs degree of probability in caſes where we can find no other evidence. But all arguments drawn from analogy are ſtill the weaker, the greater diſparity there is between the things compared; and therefore muſt be weakeſt of all when we compare body with mind, becauſe there are no two things in nature more unlike.

There is no ſubject in which men have always been ſo prone to form their notions by analogies of this kind, as in what relates to the mind. We form an early acquaintance with material things by means of our ſenſes, and are bred up in a conſtant familiarity with them. Hence we are apt to meaſure all things by them; and to aſcribe to things moſt remote from matter the qualities that belong to material things. It is for this reaſon that mankind have, in all ages, been ſo prone to conceive the mind itſelf to be ſome ſubtile kind of matter: That they have been diſpoſed to aſcribe human figure, and human organs, not only to angels, but even to the Deity.

The derivation of the word Analogy indicates, as profeſſor Caſtillon of Berlin obſerves, a reſemblance diſcernible by reaſon. This is confirmed by the ſenſe in which the term is uſed in geometry, where it ſignifies an equality o ratios. In explaining this ſubject, it is obſerved, there may be a reſemblance between ſenſations and a reſemblance between perceptions: the former is called *phyſical reſemblance*, becauſe it acts upon the phyſical or ſenſitive faculty; the latter *moral reſemblance*, becauſe it affects the moral or rational faculty of man.

Every phyſical reſemblance may be reduced to one or more equalities; and every moral reſemblance to one or more identities. Wherever there is moral reſemblance there is analogy. Analogy may therefore be reduced to identity and always ſuppoſes compariſon. Two objects are ſaid to have an analogy to each other or are called *analogous*, when ſome identity is diſcovered upon comparing them. An *analogical concluſion*, is a concluſion deduced from ſome identity.

The principles of analogy are a compariſon of two objects; and one or more identities reſulting from their being thus compared. The characters of analogy are—that two objects be compared—that there be one or more identities between theſe objects; and that this is diſcernible only by reaſon or intellect.

Phyſical reſemblance is to the ſenſes what *analogy* is to the underſtanding. The former, when perfect, becomes equality; but the latter, identity.

Reſemblance and analogy are the foundations both of probability and of certainty. When we are not ſatisfied that the reſemblance or the analogy is complete, we ſtop at probability; which becomes certainty when we are, or think we are, aſſured that the reſemblance or the analogy is perfect. In reaſoning by analogy, we ſhould be careful not to confound it with reſemblance; and alſo not to deduce from the identity or identities, on which the analogy is founded, a concluſion, which has either no relation, or only a partial relation, to theſe identities.

The principal uſe of analogy in the inveſtigation of phyſical and moral truth, according to our author, may be reduced to the four following: 1. By means of our ſenſes to improve, firſt our own judgment, and afterwards that of others, with reſpect to intellectual ſubjects. 2. To deduce a general from a particular truth.

Having

Having diſcovered and proved the truth of a propoſition with reſpect to any particular object, examine whether this truth flows from a quality peculiar to this ſingle object, or common to ſeveral objects. In the latter caſe all theſe objects may be comprehended under one general idea, founded on their common quality. Subſtitute this general idea inſtead of the particular object, and the propoſition will become general, without ceaſing to be true; becauſe whatever evidently and ſolely reſults from the identity, on which an analogy is founded, muſt neceſſarily be true with reſpect to all thoſe objects in which the analogy is the ſame. 3. To prove the truth or falſehood of propoſitions which cannot be otherwiſe demonſtrated. 4. To diſcover new truths in both natural and moral philoſophy,

The analogy between the three kingdoms, of plants, animals, and minerals, has been the ſource of a variety of diſcoveries, either real or imaginary: hence it is we have learnt, that plants breathe: that the ſap circulates in them; that generation is performed by eggs in the human kind; that the planets have their atmoſpheres, their inhabitants, their trees, their ſeas, &c. Indeed, if we will follow whither analogy, real or imaginary, will lead us, there is no end of ſcience.

As to divine and ſupernatural matters, it is aſſerted we know nothing of them, but by analogy; that is, by the mediation and ſubſtitution of thoſe ideas we have of ourſelves and other natural beings. Our ideas of God himſelf ariſe from this ſpring; we have no direct and immediate perception of him. The knowledge we have of the Supreme Being, is only an obſervation of his works, and a reflection of the mind, which ſhews what power, wiſdom, &c. appear neceſſary to enable him to produce them. Having no proper ideas of his perfections, we give them the names of thoſe faculties of men, which we judge neceſſary. See an excellent treatiſe on the Analogy of Religion, natural and revealed, to the Conſtitution and Courſe of Nature, by biſhop Butler (as before-mentioned) in which, by evincing the analogy or likeneſs that ſubſiſts between the ſyſtem of things and diſpenſation of providence, which revelation informs us of, and that ſyſtem of things and diſpenſation of providence which experience and reaſon inform us of, i. e. the known courſe of nature, he is led to aſcribe both to the ſame author and cauſe.

ANALYSIS, in a general ſenſe, implies the reſolution of ſomething compounded into its original and conſtitutent parts. The word is Greek, and derived from ἀναλύω, to reſolve.

ANALYSIS, in mathematics, is properly the method of reſolving problems by means of algebraical equations; whence we often find that theſe two words, *analyſis* and *algebra* are uſed as ſynonymous.

Analyſis under its preſent improvements, muſt be allowed the apex or height of all human learning: it is this method which furniſhes us with the moſt perfect examples of the art of reaſoning; gives the mind an uncommon readineſs at deducing and diſcovering, from a few data, things unknown; and, by uſing ſigns for ideas, preſents things to the imagination, which otherwiſe ſeemed out of its ſphere: by this, geometrical demonſtrations may be greatly abridged, and a long ſeries of argumentations, wherein the mind cannot without the utmoſt effort and attention diſcover the connection of ideas, are hereby converted into ſenſible ſigns, and the ſeveral operations required therein effected by the combination of thoſe ſigns. But, what is more extraordinary, by means of this art, a number of truths are frequently expreſſed by a ſingle line, which in the common way of explaining and demonſtrating things would fill whole volumes. Thus, by mere contemplation of one ſingle line, whole ſciences may be ſometimes learnt in a few minutes time, which otherwiſe could ſcarce be attained in many years.

ANALYSIS, is divided, with regard to its object, into that of *finites* and *infinites*. *Analyſis of Finite Quantities*, is what we otherwiſe call ſpecious arithmetic or algebra. See the Syſtem of ALGEBRA, Introduction. *Analyſis of Infinites*, called alſo the *New Analyſis*, is particularly uſed for the method of fluxions, or the different calculus. See FLUXIONS.

ANALYSIS, in logic, ſignifies the method of tracing things backward to their ſource, and of reſolving knowledge into its original principles. This is alſo called the method of *reſolution*; and ſtands oppoſed to the ſynthetic method, or that of *compoſition*. The art of logical analyſis conſiſts principally in combining our perceptions, claſſing them together with addreſs, and contriving proper expreſſions for conveying our thoughts, and repreſenting their ſeveral diviſions, claſſes, and relations. See the Syſtem, Part IV. throughout.

ANALYSIS, in rhetoric and oratory, is that which examines the connections, tropes, figures, and the like, inquiring into the propoſition, diviſion, paſſions, arguments, and other branches of oratory. See the Treatiſe on Oratory, Part III. Sect. I. Art 2.

Several authors, as Freigius and others, have given analyſes of Cicero's Orations, wherein they reduce them to their grammatical and logical principles; ſtrip them of all the ornaments and additions of rhetoric which otherwiſe diſguiſe their true form, and conceal the connection between one part and another. The deſign of theſe authors is to have thoſe admired harangues juſt ſuch as the judgment diſpoſed them, without the help of imagination; ſo that here we may coolly view the force of each proof, and admire the uſe Cicero made of rhetorical figures to conceal the weak part of a cauſe. A collection has been made of the analyſes formed by the moſt celebrated authors of the 16th century, in 3 vols. folio.

ANALYSIS is alſo uſed in chymiſtry, for the decompounding of a mixed body, or the ſeparation of the principles and conſtituent parts of a compounded ſubſtance. To analyze bodies, or reſolve them into their component parts, is indeed the chief object of the art of chymiſtry. Chymiſtry furniſhes, ſeveral means for the decompoſition of bodies, which are all founded on the differences of the properties belonging to the different principles of which the body to be analyſed is compoſed. If, for example, a body be compoſed of ſeveral principles, ſome of which have a great, and others a moderate degree of volatility, and, laſtly, others are fixed, its moſt volatile parts may be firſt ſeparated by a gradual heat in diſtilling veſſels; and then the parts which are next in volatility will paſs over in diſtillation; and laſtly, thoſe parts which are fixed, and capable of reſiſting the action of fire, will remain at the bottom of the veſſel. For the modes of practice with reſpect to analyſing the ſeveral bodies, ſee the Syſtem, throughout.

ANALYSIS is alſo uſed for a kind of ſyllabus, or table of the principle heads or articles of a continued diſcourſe, diſpoſed in their natural order and dependency. Analyſes are more ſcientifical than alphabetical indexes; but they are leſs uſed, as being more intricate. Analyſis is likewiſe uſed for a brief, but methodical illuſtration of the principles of a ſcience: in which ſenſe it is nearly ſynonymous with what we otherwiſe call a *Syntaxis*.

ANALYTIC, or ANALYTICAL, ſomething that belongs to or partakes of, the nature of analyſis. Thus we ſay, an analytical demonſtration, analytical proceſs, analytical table or ſcheme, analytical method of inveſtigation, &c.

The analytic method ſtands oppoſed to the ſynthetic. In natural philoſophy, as in mathematics, the inveſtigation of difficult things by the analytic method ought to precede the method of compoſition. This analyſis conſiſts in making experiments and obſervations, and in drawing general concluſions therefrom by induction; and admitting of no objections againſt the concluſions, but ſuch as are drawn from experiments, and other certain truths: and though the reaſoning from experiments and obſervations by induction be no demonſtration of general concluſions, yet it is the beſt method of reaſoning which the nature of things admits of; and may be eſteemed ſo much the ſtronger, as the induction is more general; and, if no exception occur from phenomena, the concluſion may be pronounced general. By this way of analyſis, we may proceed from compounds to their ingredients; from motions to the forces producing them; and in general from effects to their cauſes, and from particular cauſes to more general ones, until we arrive at thoſe which are the moſt general. This is the analytic method according to the illuſtrious Newton. The ſynthetic method conſiſts in aſſuming the cauſes diſcovered and received as principles: and by them explaining the phenomena proceeding from them, and proving the explanations. See SYNTHESIS, and the Syſtem of LOGIC, Part IV.

ANALYTICS, *Analytica*, the ſcience and uſe of analyſis. The great advantage of the modern mathematics above the ancient is in point of analytics. To the modern analytics principally belong algebra: for an hiſtorical account of which, with the ſeveral authors thereon, ſee the Introduction to the Syſtem of ALGEBRA.

ANARCHY, the want of government in a nation, where no ſupreme authority is lodged, either in the prince, or other rulers: but the people live at large, and all things are in confuſion. All kinds of ſtates are ſubject to anarchies. We read of civil anarchies, eccleſiaſtical or ſpiritual anarchies, and even anarchies in the republic of letters.

Anarchy is ſuppoſed to have reigned after the deluge, before the foundation of monarchies. We ſtill find it obtain in divers parts, eſpecially of Africa and America; e. gr. among the Iroquois, who are obſerved by travellers to live in a perfect independency of any ſuperior; among the Californians, where every family makes its own laws, as well as religion; in Chili, where every maſter of a family is a king; in the Marian iſlands, where neither prince nor law is known, but every perſon governs himſelf according to his own will; and to mention no more, among the Hottentots, where the only reſemblance of government is, that in each neighbourhood, the eldeſt is the firſt in honour, and his advice chiefly followed, not from any civil authority he is veſted with, but on account of his ſuperior experience.

Some extend the idea of anarchy farther, ſo as to make it comprehend all the more popular governments. In this ſenſe, anarchy amounts to much the ſame with Democracy. Hobbs, in this ſenſe, call the Roman commonwealth an anarchy. It has been ſometimes controverted which of the two is beſt, a ſtate of anarchy, or of tyranny and arbitrary power. This controverſy, however, does not appear to be of any great uſe; it is of little purpoſe to determine which is beſt, ſince a ſtate of anarchy, naturally, nay neceſſarily, paves the way for deſpotiſm; and confuſion is always the parent of oppreſſion.

ANARCHY is alſo applied to certain troubleſome and diſorderly

periods, even in governments otherwiſe regular. In Germany, the ſpace from the election of Richard duke of Cornwall, to that of duke Rud, of Hapſburg, is commonly called the *anarchy* or *interregnum*. In England, the period between the death of Cromwell and king Charles's Reſtoration, is commonly repreſented as an anarchy. Every month produced a new ſcheme, or form of government. Enthuſiaſts talked of nothing but annulling all the laws, aboliſhing all writings, records, and regiſters, and bringing all men to the primitive level. No modern nation is more ſubject to *anarchies* than Poland: where every interval between the death of one king and the election of another, is a perfect picture of confuſion, inſomuch that it is a proverb among thoſe people, that Poland is governed by confuſion.

The Jewiſh hiſtory preſents numerous inſtances of *anarchies* in that ſtate, uſually denoted by this phraſe, *that in thoſe days there was no king in Iſrael, but every man did that which was right in his own eyes*; which is a juſt picture of an *anarchy*. The firſt *anarchy* we read of in that commonwealth, is that which enſued on the death of Joſhua, who leaving no ſucceſſor, the government devolved to the elders of the tribes, who ruled each according to his own will. After the death of theſe elders, the *anarchy* became complete.

ANAS, in ornithology, a genus of birds belonging to the order of anſeres. The beak of this genus is a little obtuſe, covered with an epidermis or ſkin, gibbous at the baſe, and broad at the apex: the tongue is obtuſe and fleſhy; the feet are webbed and fitted for ſwimming. The moſt remarkable ſpecies are as follow:

1. The cygnus; of which there are two varieties, viz. the ferus and manſuetus.

a, The ferus, with a ſemicylindrical black bill, yellow wax, and a white body, is the whiſtling or wild ſwan of Engliſh authors, and is leſs than the tame or mute ſpecies, being about five feet in length. Theſe birds inhabit the northern world as high as Iceland, and as low as the ſoft climate of Greece or of Lydia, the modern Anatolia, in Aſia Minor: it even deſcends as low as Egypt. They ſwarm, during ſummer, in the great lakes and marſhes of the Tartarian and Siberian deſerts; and reſort in great numbers to winter about the Caſpian and Euxine ſeas. Thoſe of the eaſtern parts of Siberia retire beyond Kamtſchatka, either to the coaſts of America, or to the iſles north of Japan. In Siberia they ſpread far north, but not to the Arctic circle. They arrive in Hudſon's Bay about the end of May, where they breed in great numbers on the ſhores, in the iſlands, and in the inland lakes; but all retire to the ſouthern parts of North America in autumn, even as low as Carolina and Louiſiana. In Carolina they are ſaid to be of two ſorts; the larger, called from its note the Trumpeter, arrive in great flocks to the freſh rivers in winter, and in February retire to the great lakes to breed: the leſſer are called Hoopers, and frequent moſtly the ſalt water. The Indians of Louiſiana wear the ſkins, with the down attached to them, ſewed together by way of covering; and of the larger feathers they make diadems for their chiefs, as well as weave the ſmaller on threads, as barbers do for their wigs, with which they cover garments, that are worn only by women of the higheſt rank. In Auguſt theſe birds loſe their feathers, and are not able to fly: when the natives of Iceland and Kamtſchatka hunt them with dogs, which catch them by the neck, and eaſily ſecure their prey. In the laſt place they are alſo killed with ſticks. The eggs are accounted good food; and the fleſh, eſpecially that of the young, is much eſteemed by the inhabitants. The uſes of the feathers are manifeſt to every one; and the ſkins of the body are worn by the inhabitants; beſides which, that of the legs, taken off whole, is uſed for purſes, and appears not unlike ſhagreen. Wild ſwans, Linnæus ſays, frequently viſit Sweden after a thaw, and are caught with apples in which a hook is concealed. The wild ſwan frequents our coaſts in hard winters in large flocks, but does not breed in Great Britain. Martain acquaints us, that ſwans come in October in great numbers to Lingey, one of the Weſtern Iſles; and continue there till March, when they return northward to breed. A few continue in Mainland, one of the Orkneys, and breed in the little iſles of the freſh-water lochs; but the multitude retire at the approach of ſpring. On that account, ſwans are there the poor man's almanack: on their quitting the iſle, they preſage good weather; on their arrival, they announce bad. Theſe, as well as moſt other water-fowl, prefer, for the purpoſe of incubation, thoſe places that are leaſt frequented by mankind: accordingly we find that the lakes and foreſts of the diſtant Lapland are filled during ſummer with myriads of water-fowl; and there ſwans, geeſe, the duck-tribe, gooſanders, divers, &c. paſs that ſeaſon; but in autumn return to us, and to other more hoſpitable ſhores.

This ſpecies has ſeveral diſtinctions from the ſpecies which we in Britain call the *tame ſwan*. In Ruſſia this ſpecies more fitly claims the name, it being the kind moſt commonly tamed in that empire. The whiſtling ſwan carries its neck quite erect, the other ſwims with it arched. This is far inferior in ſize. This has twelve ribs on a ſide, the mute only eleven. But the moſt remarkable is the ſtrange figure of the windpipe; which falls into the cheſt, then turns back like a trumpet, and afterwards makes a ſecond bend to join the lungs. Thus it is enable to utter a loud and ſhrill note. The other ſwan, on the contrary is the moſt ſilent of birds: it can do nothing more than hiſs, which it does on receiving any provocation. The vocal kind emits its loud notes only when flying or calling. Its ſound is, *wheugh, wheugh*, very loud and ſhrill, but not diſagreeable, when heard far above one's head and modulated by the winds. The natives of Iceland compare it to the notes of a violin. In fact, they hear it (ſays Mr. Pennant) at the end of their long and gloomy winter, when the return of the ſwans announces the return of ſummer; every note muſt be therefore melodious which preſages the ſpeedy thaw, and the releaſe from their tedious confinement.

It is from this ſpecies alone that the ancients have given the fable of the ſwan being endued with the powers of melody. Embracing the Pythagorean doctrine, they made the body of this bird the manſion of the ſouls of departed poets; and after that, attributed to the birds the ſame faculty of harmony which their inmates poſſeſſed in a pre-exiſtent ſtate. The vulgar, not diſtinguiſhing between ſweetneſs of numbers and melody of voice, thought that real which was only intended figuratively. The mute ſwan, Mr. Pennant obſerves, never frequents the Padus, nor is ever ſeen on the Cayſter in Lydia; each of them ſtreams celebrated by the poets for the great reſort of ſwans.

In time a ſwan became a common topic for a *bard*. Horace calls Pindar *Dircæum Cygnum*; and in one ode even ſuppoſes himſelf changed into a ſwan. Virgil ſpeaks of his poetical brethren in the ſame manner:

Vare, tuum nomen
Cantantes ſublime ferent ad ſidera cygni. *Eclog.* ix.

When he ſpeaks of them figuratively, he aſcribes to them melody, or the power of muſic; but when he talks of them as birds, he lays aſide fiction, and, like a true naturaliſt, gives them their real note:

Dant ſonitum *rauci* per ſtagna loquacia cygni,
Æneid Lib. x. 50.

It was alſo a popular opinion among the ancients, that the ſwan foretold its own end. To explain this, we muſt conſider the twofold character of the poet, *vates* and *poeta*, which the fable of the tranſmigration continues to the bird; or they might be ſuppoſed to derive that faculty from Apollo, their patron deity, the god of prophecy and divination. As to their being ſuppoſed to ſing more ſweetly at the approach of death, the cauſe is beautifully explained by Plato, who attributes that unuſual melody to the ſame ſort of ecſtaſy that good men are ſometimes ſaid to enjoy at that awful hour, foreſeeing the joys that are preparing for them on putting off mortality.

b, The *Manſuetus*, or mute ſwan, is the largeſt of the Britiſh birds. It is diſtinguiſhed externally from the wild ſwan; firſt, by its ſize being much larger; ſecondly, by its bill, which in this is red, and the tip and ſides black, and the ſkin between the eyes and bill is of the ſame colour. Over the baſe of the upper mandible, projects a black callous knob: the whole plumage, in old birds, is white; in young ones, aſh-coloured, till the ſecond year: the legs are duſky; but Dr. Plott mentions a variety found on the Trent near Rugely, with red legs.

The ſwan is held in high veneration by the Mahometans. It is a very ſtrong bird, and ſometimes exceeding fierce: has not unfrequently been known to throw down and trample under feet youths of thirteen or fourteen years of age. It is ſaid to be very long lived, and frequently to arrive at the hundredth year. The young are not perfect in plumage till the ſecond year. The ſwan lays the firſt egg in February, and continues laying every other day to the amount of ſix, ſeven, or eight eggs; theſe it places on a bed of graſs near the water, and ſits ſix weeks. It feeds on both fiſh and herbage.

No bird, perhaps, makes ſo inelegant a figure out of the water, or has command of ſuch beautiful attitudes on that element, as the ſwan: almoſt every poet has taken notice of it; but none with that juſtneſs of deſcription, and in ſo picturеſque a manner, as our Milton:

The ſwan, with arched neck
Between her white wings mantling, proudly rows,
Her ſtate with oary feet. *Par. Loſt.* B. vii.

In former times, it was ſerved up at every great feaſt, when the elegance of the table was meaſured by the ſize and quantity of the good cheer. Cygnets are to this day fattened at Norwich about Chriſtmas, and are ſold for a guinea a-piece. Swans were formerly held in ſuch eſteem in England, that by an act of Edward IV. c. 6. "no one that poſſeſſed a freehold of leſs clear yearly value than five marks, was permitted to keep any, *other than the ſon of our ſovereign lord the king*." And by the eleventh of Henry VII. c. 17. the puniſhment for taking their eggs was impriſonment for a year and a day, and a fine at the king's will. Though at preſent they are not ſo highly valued as a delicacy, yet great numbers are preſerved for their beauty; we ſee multitudes on the Thames and Trent, but no where in greater numbers than on the ſalt-water inlet of the ſea near Abbotſbury in Dorſetſhire. For repreſentation, ſee Plate V. Genus 32. Letter A.

The anſer, *ferus et manſuetus*; or grey lag, and tame gooſe. The *grey lag*, or *wild gooſe*, is two feet nine inches in length, and five feet in extent. The bill is large and elevated; of a fleſh colour, tinged with yellow; the head and neck cinerous; breaſt and belly whitiſh, clouded with grey or aſh colour; back, grey; the legs of a fleſh colour. This ſpecies reſides in the fens the whole year; breeds there, and hatches about eight or nine young, which are often taken, eaſily tamed, and eſteemed moſt excellent meat, ſuperior to the domeſtic gooſe. Towards winter they collect in great flocks, but in all ſeaſons live and feed in the fens. On the continent they are migratory, changing place in large flocks, often 500 or more: in this caſe, the flock is triangular in ſhape, with one point foremoſt; and as the gooſe which is firſt is tired ſooneſt, it has been ſeen to drop behind, and another to take his place. In very ſmall flocks, however, they are ſometimes ſeen to follow one another in a direct line.

The *manſuetus* is the grey lag in a ſtate of domeſtication, and from which it varies in colour. Tame geeſe are kept in great multitudes in the fens of Lincolnſhire: a ſingle perſon will have 1000 old geeſe, each of which will rear ſeven; ſo that towards the end of the ſeaſon he will become poſſeſſed of 8000. During the breeding ſeaſon theſe birds are lodged in the ſame houſes with the inhabitants, and even in their very bed-chambers: in every apartment are three rows of coarſe wicker pens, placed one above another; each bird has its ſeparate lodge divided from the other, which it keeps poſſeſſion of during the time of ſetting. A perſon called a *gozzard*, i. e. *gooſe herd*, attends the flock, and twice a day drives the whole to water; then brings them back to their habitations, helping thoſe that live in the upper ſtories to their neſts, without ever miſplacing a ſingle bird. The geeſe are plucked five times in the year: the firſt plucking is at Lady-day, for feathers and quills; and the ſame is renewed, for feathers only, four times more between that and Michaelmas. The old geeſe ſubmit quietly to the operation, but the young ones are very noiſy and unruly. If the ſeaſon proves cold, numbers of them die by this barbarous cuſtom.

The moſchata, or Muſcovy duck of Ray, has a naked papillous face, and is a native of India. It is larger than the wild duck, being in length two feet. This ſpecies is pretty common in a domeſticated ſtate in almoſt every nation; and the breed ought to be encouraged, as there is more fleſh on it than on the common duck, and of a very high flavour. The eggs are rounder than thoſe of a duck, and in young birds frequently incline to green. They lay more eggs, and ſit oftner, than other ducks. In an unconfined ſtate they make the neſt on the ſtumps of old trees, and perch during the heat of the day on the branches of ſuch as are well cloathed with leaves. When kept tame, they are ſufficiently docile; and the male will not unfrequently aſſociate and produce a mongrel breed with the common ducks. The name of Muſcovy duck was given to them from their exhaling a muſky odour, which proceeds from the gland placed on the rump in common with other birds.

The boſchas, or common wild duck, frequents the lakes of different countries, and feeds upon frogs and ſeveral ſorts of inſects. The wild-ducks pair in the ſpring; build their neſts among ruſhes near the water, and lay from 10 to 16 eggs. The female is a very artful bird, and does not always make the neſt cloſe to the water, but frequently at a good diſtance from it; in which caſe the duck will take the young in its beak or between its legs. It is known ſometimes to lay the eggs in a high tree, in a deſerted magpie's or crow's neſt. At moulting-time, when they cannot fly, they are caught in great numbers. They abound particularly in Lincolnſhire, the great magazine of wild fowl in this kingdom; where prodigious numbers are taken annually in the decoys. See DECOY.

Birds with flat bills, that find their food by groping, have three pair of nerves that extend to the end of their bills: theſe nerves are remarkably conſpicuous in the head and bill of the wild-duck, and are larger than thoſe of a gooſe or any other bird yet known: this is the reaſon they grope for food more than any other bird whatever. The common tame ſpecies of ducks take their origin from theſe, and may be traced to it by unerring characters. The drakes, however they vary in colours, always retain the curled feathers of the tail, and both ſexes the form of the bill, of the wild kind. Nature ſports in the colours of all domeſtic animals; and for a wiſe and uſeful end, That mankind may the more readily diſtinguiſh and claim their reſpective property. In France this ſpecies is not often ſeen, except in winter; appearing in October, and going north in ſpring. They are caught in various manners; among the reſt, in decoys, as in England; the chief place for which is Picardy, where prodigious numbers are taken, particularly on the river Somme. It is alſo cuſtomary there to wait for the flocks paſſing over certain known places, and the ſportſman, having a wicker cage, containing a quantity of tame birds, lets out one at a time, at a convenient ſeaſon, which enticing the paſſengers within gunſhot, five or ſix are often killed at once by an expert marksman. They are now and then taken alſo by a hook baited with a bit of ſheep's lights, which ſwimming on the water, the bird ſwallows the bait, and with it the hook. Various other means of catching ducks and geeſe are peculiar to certain nations; of which one ſeems worth mentioning from its ſingularity: The perſon wiſhing to take theſe, wades into the water up to the chin, and having his head covered with an empty calabaſh, approaches the place where the ducks are; when they, not regarding an object of this ſort, ſuffer the man freely to mix with the flock; after which he has only to pull them by the legs under the water, one after another, till he is ſatisfied; returning as unſuſpected by the remainder as when he firſt came among them. This method is frequently put in practice on the river Ganges, uſing the earthern veſſels of the Gentoos inſtead of the calabaſhes: theſe veſſels are what the Gentoos boil their rice in, and are called Kutcharee pots (they likewiſe make a diſh for their tables in them, which goes by the ſame name): after theſe are once uſed, they look upon them as defiled, and in courſe throw them into the river as uſeleſs; and the duck-takers find them convenient for their purpoſe, as the ducks, from conſtantly ſeeing the veſſels float down the ſtream, look upon them as objects of full as little regard as a calabaſh. The above, or ſome ſuch method, is alſo practiſed in China as well as India. The Chineſe, however, though they make great uſe of ducks, do not prefer the wild ſort, being in general extremly fond of tame ones: and it is ſaid that the major part of theſe are hatched by artificial heat; the eggs, being laid in boxes of ſand, are placed on a brick hearth, to which is given a proper heat during the time required for hatching. The ducklings are fed with little craw-fiſhes and crabs, boiled and cut ſmall, and afterwards mixed with boiled rice; and in about a fortnight ſhift for themſelves, when the Chineſe provide them an old ſtepmother, who leads them where they are to find provender for themſelves; being firſt put on board a ſampane or boat, which is deſtined for their habitation, and from which the whole flock, often to the amount of 300 or 400, go out to feed, and return at command. This method is uſed nine months out of the twelve (for in the colder months it does not ſucceed) and is ſo far from a novelty, that it may be every where ſeen; but more eſpecially about the time of cutting the rice and gleaning the crop, when the maſters of the duck ſampanes row up and down the river according to the opportunity of procuring food, which is found in plenty, at the tide of ebb, on the rich plantations, as they are overflowed at high water. It is curious to ſee how the ducks obey their maſter; for ſome thouſands, belonging to different boats, will feed at large on the ſame ſpot, and on a ſignal given will follow their leader to their reſpective ſampanes, without a ſtranger being found among them. This is ſtill more extraordinary, if we conſider the number of inhabited ſampanes on the Tigris, ſuppoſed to be no leſs than 400,000, which are moored in rows cloſe to each other, with a narrow paſſage at intervals for boats to paſs up and down the river. The Tigris, at Canton, is ſomewhat wider than the Thames of London, and the whole river is there covered in this manner for the extent of a leaſt a mile.

The galericulata, or Chineſe teal of Edwards, has a hanging creſt: and on the hinder part of the back, on both ſides, there is a crooked, flat, elevated feather; the creſt is green and red; and the back is brown, and ſpotted with blue; and erect feathers on the back are red and blunt; one edge of the inmoſt wing-feather, when the wings are ſhut, is raiſed over the back, and is red, and like a ſickle before. This moſt ſingular and elegant ſpecies is a native of China and Japan, where it is kept by the inhabitants for the ſake of its beauty. It is not near ſo common in China as many other kinds, or perhaps they are politically held dear to the European purchaſers; they are frequently expoſed to ſale at Canton in cages, and the common price is from ſix to ten dollars per pair: they are not unfrequently brought into England alive; but require care, as they ſeem more tender than our ſpecies. Attempts have been made to breed them in this country, but without ſucceſs, though they are familiar enough. The bird is known in Japan by the name of *Kimuſoſui*. The Engliſh in China give it the name of *mandarin duck*.

ANAEMIA, from ἀν and αἷμα, *blood*, in medicine, a diſeaſe of univerſal dropſy, wherein the whole ſubſtance of the body is ſtuffed or bloated with pituitous humours. For deſcription, cauſes, and cure, ſee the Syſtem, Genus 56 and 57.

ANASTOMASIS, or ANASTOMOSIS, in anatomy, is ſometimes uſed to expreſs ſuch aperture of the mouths of the veſſels as lets out their contents.

ANASTOMASIS is more frequently uſed to denote the opening of two veſſels into one another; or the union and juncture of the mouths of two veſſels, where by they come to communicate with one another. There are various anaſtomaſes of this kind, e. gr. of an artery with an artery, a vein with a vein, and of a vein with an artery. This circulation of the blood in the fœtus is effected by means of the anaſtomaſes, or inoſculations of the *vena cava* with the pulmonary vein; and of the pulmonary artery with the *aorta*. The circulation is alſo performed in adults by the anaſtomaſes, or continuation of the capillary arteries with the veins. See the Syſtem of ANATOMY.

ANATOMY, ἀνατομὴ, the art of diſſecting, or artificially ſeparating the parts of an animal body, to diſcover their ſituation, figures, connections, fabric and œconomy. The term is uſually applied to the examination of the ſtructure of human bodies. Where its ſubject is a deſcription of the ſtructure of the brute creation, it is denominated COMPARATIVE ANATOMY, of which we have given a copious Syſtem.

SYSTEM

SYSTEM OF ANATOMY.

INTRODUCTION.

I. *View of the subject in General.*

THE etymology of the word *Anatomy*, as before given, implies simply *diſſection*; but by this term ſomething more is uſually underſtood. It is every day made uſe of to expreſs a knowledge of the human body; and a perſon who is ſaid to underſtand anatomy, is ſuppoſed to be converſant with the ſtructure and arrangement of the different ſolid parts of the body.

It is commonly divided into *Anatomy*, properly ſo called; and *Comparative* Anatomy: the firſt of theſe is confined ſolely to the human body; the latter includes all animals, ſo far as a knowledge of their ſtructure may tend to perfect our ideas of the human body. See the Syſtem of COMPARATIVE *Anatomy*.

The term *anatomy* may alſo have another and more extenſive ſignification: it may be applied to expreſs not only a knowledge of the ſtructure and diſpoſition of the parts, but likewiſe of their œconomy and uſe. Conſidering it in this light, it will ſeldom fail to excite the curioſity of people of taſte, as a branch of philoſophy; ſince, if it is pleaſing to be acquainted with the ſtructure of the body, it is certainly more ſo to diſcover all the ſprings which give life and motion to the machine, and to obſerve the admirable mechaniſm by which ſo many different functions are executed.

Aſtronomy and anatomy, as Dr. Hunter, after Fontenelle, obſerves, are the ſtudies which preſent us with the moſt ſtriking views of the two greateſt attributes of the Supreme being. The firſt of theſe fills the mind with the idea of his immenſity; the largeneſs, diſtances, and numbers of the heavenly bodies; the laſt, aſtoniſhes with his intelligence and art in the variety and delicacy of animal mechaniſm. The human body has been commonly enough known by the name of *microcoſmus*, or the little world; as if it did not differ ſo much from the univerſal ſyſtem of nature in the ſymmetry and number of its parts as in their ſize.

Galen's excellent treatiſe *De uſu partium*, was compoſed as a proſe hymn to the Creator; and abounds with as irreſiſtible proofs of a ſupreme Cauſe and governing Providence, as we find in modern phyſico-th ology. And Cicero dwells more on the ſtructure and œconomy of animals than on all the productions of nature beſides, when he wants to prove the exiſtence of the gods from the order and beauty of the univerſe. He there takes a ſurvey of the body of a man in a moſt elegant ſynopſis of anatomy, and concludes thus: *Quibus rebus expoſitis, ſatis docuiſſe videor, hominis natura, quanto omnes anteiret animantes. Ex quo debet intelligi, nec figuram ſitumque membrorum, nec ingenii mentiſque vim talem effici potuiſſe fortuna.*

The ſatisfaction of mind which ariſes from the ſtudy of anatomy and the influence which it muſt naturally have upon our minds as philoſophers, cannot be better conveyed than by the following paſſage from the ſame author: *Quæ contuens animus, accepit ab his cognitionem deorum, ex qua oritur pietas: cui conjuncta juſtitia eſt, reliquæque virtutes: ex quibus vita beata exiſtit par et ſimilis deorum, nulla alia re niſi immortalitate, quæ nihil ad bene vivendum pertinet, cedens cœleſtibus.*

It would be endleſs to quote the animated paſſages which are to be found in the phyſicians, philoſophers, and theologiſts, who have conſidered the ſtructure and functions of animals with a view towards the Creator. It is a view which muſt ſtrike every one with a moſt awful conviction. Who can know and conſider the thouſand evident proofs of the aſtoniſhing works of the Creator, in forming and ſuſtaining an animal body, ſuch as ours, without feeling the moſt pleaſing enthuſiaſm? Can we ſeriouſly reflect upon this awful ſubject, without being almoſt loſt in adoration? without longing for another life after this, in which we may be gratified with the higheſt enjoyment, which our faculties and nature ſeem capable of, the ſeeing and comprehending the great wiſdom of the Creator, in forming the univerſe, and in directing all its operations?—But the more immediate purpoſes of anatomy concern thoſe who are to be the guardians of health, as this ſtudy is neceſſary to lay a foundation for all the branches of medicine. The more we know of our fabric, the more reaſon we have to believe, that if our ſenſes were more acute, and our judgment more enlarged, we ſhould be able to trace many ſprings of life which are now hidden from us; by the ſame ſagacity we ſhould diſcover the true cauſes and nature of diſeaſes; and thereby be enabled to reſtore the health of many, who are now, from our own confined knowledge, ſaid to labour under incurable diſorders. By ſuch an intimate acquaintance with the œconomy of our bodies, we ſhould diſcover even the ſeeds of diſeaſes, and deſtroy them before they had taken root in the conſtitution.

That anatomy is the very baſis of ſurgery, all muſt allow. It is diſſection alone that can teach us, where we may cut the living body with freedom and diſpatch; and where we may venture with great circumſpection and delicacy: at the ſame time it points out to us where we muſt not, upon any account, attempt it. This informs the *head*, gives dexterity to the *hand*, and familiarizes the *heart* with a ſort of neceſſary inhumanity, by the uſe of cutting inſtruments upon our fellow-creatures.

Beſides the knowledge of our body, through all the variety of its *ſtructure* and *operations* in a *ſound ſtate*, it is by anatomy only that we can arrive at the knowledge of the true nature of moſt of the diſeaſes which afflict humanity. The ſymptoms of many diſorders are often equivocal; and diſeaſes themſelves are thence frequently miſtaken, even by ſenſible, experienced, and attentive phyſicians. But by anatomical examination after death, we can with certainty find out the miſtake, and learn to avoid it in any ſimilar caſe. This uſe of anatomy has been ſo generally adopted by the moderns, that the caſes already publiſhed are almoſt innumerable: Mangetus Morgagni, indeed many of the beſt modern writers in phyſic, are full of them. And if we look among the phyſicians of the beſt character, and obſerve thoſe who have the *art* itſelf, rather than the *craft* of the profeſſion, at heart; we ſhall find them conſtantly taking pains to procure leave to examine the bodies of their patients after death.

After having conſidered the progreſs of anatomy; the various diſcoveries that have been made in it, from time to time; the great number of diligent obſervers who have applied themſelves to this art; and the importance of the ſtudy, not only for the prevention and cure of diſeaſes, but in furniſhing the livelieſt proofs of divine wiſdom; the following queſtions ſeem naturally to ariſe. For what purpoſe is there ſuch a variety of parts in the human body? Why ſuch a complication of nice and tender machinery? Why was there not rather a more ſimple, leſs delicate and leſs expenſive frame?

In order to acquire a ſatisfactory general idea of this ſubject, and find a ſolution of all ſuch queſtions, let us, in our imagination, *make* a man: in other words, let us ſuppoſe that the *mind*, or immaterial part, is to be placed in a corporeal fabric, in order to hold a correſpondence with other material beings by the invention of the body; and then conſider, *a priori*, what will be wanted for her accommodation. In this inquiry, we ſhall plainly ſee the neceſſity or advantage, and therefore the final cauſe, of moſt of the parts which we actually find in the human body. And if we conſider that, in order to anſwer ſome of the requiſites, human wit and invention would be very inſufficient; we need not be ſurpriſed if we meet with ſome parts of the body whoſe uſe we cannot yet perceive, and with ſome operations or functions which we cannot explain. We can ſee that the whole bears the moſt ſtriking characters of excelling wiſdom and ingenuity: but the imperfect ſenſes and capacity of *man* cannot pretend to reach every part of a machine, which nothing leſs than the intelligence and power of the *Supreme Being* could form and execute.

Firſt, then, the *mind*, the thinking, immaterial agent, muſt be provided with a place of immediate reſidence, which ſhall have all the requiſites for the union of ſpirit and body; accordingly ſhe is provided with the *brain*, where ſhe dwells as governor and ſuperintendant of the whole fabric. In the next place, as ſhe is to hold a correſpondence with all the material beings around her, ſhe muſt be ſupplied with organs fitted to receive the different kinds of impreſſions which they will make. In fact, therefore, we ſee that ſhe is provided with the organs of ſenſe, as we call them: the eye is adapted to light; the ear to ſound; the noſe to ſmell; the mouth to taſte; and the ſkin to touch. Further: She muſt be furniſhed with organs of communication between herſelf in the brain and thoſe organs of ſenſe, to give her information of all the impreſſions that are made upon them, and ſhe muſt have organs between herſelf in the brain and every other part of the body, fitted to convey her commands and influence over the whole. For theſe purpoſes the nerves are actually given. They are chords, which riſe from the brain, the immediate reſidence of the mind, and diſperſe themſelves in branches through all parts of the body. They convey all the different kinds of ſenſations to the mind, in the brain; and likewiſe carry out from thence all her commands or influence to the other parts of the body. They are intended to be occaſional monitors againſt all ſuch impreſſion as might endanger the well-being of the whole, or of any particular part; which vindicates the Creator of all things, in having actually ſubjected us to thoſe many diſagreeable and painful ſenſations which we are expoſed to from a thouſand accidents in life. Moreover, the mind, in this corporeal ſyſtem, muſt be endued with the power of moving from place to place, that ſhe may have intercourſe with a variety of objects; that ſhe may fly from ſuch as are diſagreeable, dangerous, or hurtful, and purſue ſuch as are pleaſant and uſeful to her. And accordingly ſhe is furniſhed with limbs, and with muſcles and tendons, the inſtruments of motion, which are found in every part of the fabric where motion is neceſſary.

But to ſupport, to give firmneſs and ſhape to the fabric; to keep the ſofter parts in their proper places; to give fixed points for, and the proper direction to its motions, as to protect ſome of the more important and tender organs from external injuries; there muſt be ſome firm prop-work interwoven through the whole. And, in fact, for ſuch purpoſes the bones are given. The prop-work muſt not be made into one rigid fabric, for that would prevent motion. Therefore there are a number of bones. Theſe pieces muſt all be firmly bound together, to prevent their diſlocation. And this end is perfectly well anſwered by the ligaments. The extremities of theſe bony pieces, where they move and rub upon one another, muſt have ſmooth and ſlippery ſurfaces for eaſy motion. This is moſt happily provided for, by the cartilages and mucus of the joints. The interſtices of all theſe parts muſt be filled up with ſome ſoft and ductile matter, which ſhall keep them in their places, unite them, and at the ſame time allow them to move a little upon one another. And theſe purpoſes are anſwered by the cellular membrane or adipoſe ſubſtance.

There

There muſt be an outward covering over the whole apparatus, both to give it compactneſs, and to defend it from a thouſand injuries; which, in fact, are the very purpoſes of the ſkin and other integuments. Laſtly, the mind being formed for ſociety and intercourſe with beings of her own kind, ſhe muſt be endued with powers of expreſſing and communicating her thoughts by ſome ſenſible marks or ſigns; which may be both eaſy to herſelf, and admit of great variety: and accordingly ſhe is provided with the organs and faculty of ſpeech, by which ſhe can throw out ſigns with amazing facility, and vary them without end.

Thus we have built up an animal body, which would ſeem to be pretty complete; but as it is the nature of matter to be altered and worked upon by matter, ſo in a very little time ſuch a living creature muſt be deſtroyed, if there is no proviſion for repairing the injuries which ſhe muſt commit upon herſelf, and thoſe which ſhe muſt be expoſed to from without. Therefore a treaſure of blood is actually provided in the heart and vaſcular ſyſtem, full of nutritious and healing particles, fluid enough to penetrate into the minuteſt parts of the animal; impelled by the heart, and conveyed by the arteries, it waſhes every part, builds up what was broken down, and ſweeps away the old and uſeleſs materials. Hence we ſee the neceſſity or advantage of the heart and arterial ſyſtem. What more there was of this blood than enough to repair the preſent damages of the machine, muſt not be loſt, but ſhould be returned again to the heart; and for this purpoſe the venous ſyſtem is actually provided. Theſe requiſites in the animal explain, a *priori*, the circulation of the blood.

The old materials which were become uſeleſs, and are ſwept off by the current of blood, muſt be ſeparated and thrown out of the ſyſtem. Therefore glands, the organs of ſecretion, are given for ſtraining whatever is redundant, vapid, or noxious, from the maſs of blood; and when ſtrained, they are thrown out by emunctories, called organs of excretion.

But, now, as the machine muſt be conſtantly wearing, the reparation muſt be carried on without intermiſſion, and the ſtrainers muſt always be employed. Therefore there is actually a perpetual circulation of the blood, and the ſecretions are always going on. Even all this proviſion, however, would not be ſufficient; for that ſtore of blood would ſoon be conſumed, and the fabric would break down, if there were not a proviſion made for freſh ſupplies. Theſe we obſerve, in fact, are profuſely ſcattered round her in the animal and vegetable kingdoms; and ſhe is furniſhed with hands, the fitteſt inſtruments that could have been contrived, for gathering them, and for preparing them in a variety of ways for the mouth. But theſe ſupplies, which we call food, muſt be conſiderably changed; they muſt be converted into blood. Therefore ſhe is provided with teeth for cutting and bruiſing the food, and with a ſtomach for melting it down: In ſhort, with all the organs ſubſervient to digeſtion. The finer parts of the aliments only can be uſeful in the conſtitution: theſe muſt be taken up and conveyed into the blood, and the dregs muſt be thrown off. With this view the inteſtinal canal is actually given. It ſeparates the nutritious part, which we call *chyle*, to be converted into the blood by the ſyſtem of abſorbent veſſels; and the feces paſs downwards, to be conducted out of the body.

Now we have got our animal not only furniſhed with what is wanted for its immediate exiſtence, but alſo with the powers of protracting that exiſtence to an indefinite length of time. But its duration, we may preſume, muſt neceſſarily be limited: for as it is nouriſhed, grows, and is raiſed up to its full ſtrength and utmoſt perfection; ſo it muſt, in time, in common with all material beings, begin to decay and then hurry on to final ruin. Hence we ſee the neceſſity of a ſcheme for renovation. Accordingly, Providence, to perpetuate, as well as preſerve his work, beſides giving a ſtrong appetite for life and ſelf-preſervation, has made animals male and female, and given them ſuch organs and paſſions as will ſecure the propagation of the ſpecies to the end of time.

Thus we ſee that, by the very imperfect ſurvey which human reaſon is able to take of this ſubject, the animal man muſt neceſſarily be complex in his corporeal ſyſtem, and in its operation. He muſt have one great and general ſyſtem, and vaſcular, branching through the whole for circulation: another, the nervous, with its appendages the organs of ſenſe for every kind of feeling: and a third, for the union and connection of all thoſe parts.

Beſides theſe primary and general ſyſtems, he requires others which may be more local or confined. One for ſtrength, ſupport, and protection; the bony compages: another for the requiſite motions of the parts among themſelves, as well as from moving from place to place; the muſcular part of the body: another to prepare nouriſhment for the daily recruit of the body; the digeſtive organs: and one for propagating the ſpecies; the organs of generation.

And in taking this general ſurvey of what would appear, *a priori*, to be neceſſary for adapting an animal to the ſituations of life, we obſerve, with great ſatisfaction, that man is accordingly made of ſuch ſyſtems, and for ſuch purpoſes. He has them all; and he has nothing more except the organs of reſpiration. Breathing it ſeemed difficult to account for *a priori*; we only knew it to be in fact eſſential and neceſſary to life. Notwithſtanding this, when we ſaw all the other parts of the body, and their functions, ſo well accounted for, and ſo wiſely adapted to their ſeveral purpoſes, there could be no doubt that reſpiration was ſo likewiſe. And accordingly, the diſcoveries of Dr. Prieſtly have lately thrown light upon this function alſo, as will be ſhown in its proper place.

Of all the different ſyſtems in the human body, the uſe and neceſſity are not more apparent, than the wiſdom and contrivance which has been exerted in putting them all into the moſt compact and convenient form: in diſpoſing them ſo, that they ſhall mutually receive, and give helps to one another; and that all, or many of the parts, ſhall not only anſwer their principal end or purpoſe, but operate ſucceſsfully and uſefully in a variety of ſecondary ways.

If we conſider the whole animal machine in this light, and compare it with any machine in which human art has exerted its utmoſt; (ſuppoſe the beſt conſtructed ſhip that ever was built) we muſt be convinced, beyond the poſſibility of doubt, that there are intelligence and power far ſurpaſſing what humanity can boaſt of.

One ſuperiority in the natural machine is peculiarly ſtriking. In machines of human contrivance or art, there is no internal power, no principle in the machine itſelf, by which it can alter and accommodate itſelf to any injury which it may ſuffer, or make up any injury which admits of repair. But in the natural machine, the animal body, this is moſt wonderfully provided for, by internal powers in the machine itſelf; many of which are not more certain and obvious in their effects, than they are above all human comprehenſion as to the manner and means of their operation. Thus, a wound heals up of itſelf; a broken bone is made firm again by a callus; a dead part is ſeparated and thrown off; noxious juices are driven out by ſome of the emunctories; a redundancy is removed by ſome ſpontaneous bleeding; a bleeding naturally ſtops of itſelf; and a great loſs of blood, from any cauſe, is in ſome meaſure compenſated, by a contracting power in the vaſcular ſyſtem, which accommodates the capacity of the veſſels to the quantity contained. The ſtomach gives information when the ſupplies have been expended: repreſents with great exactneſs, the quantity and the quality of what is wanted in the preſent ſtate of the machine; and in proportion as ſhe meets with neglect, riſes in her demand, urges her petition in a louder tone, and with more forcible arguments. For its protection, an animal body reſiſts heat and cold in a very wonderful manner, and preſerves an equal temperature in a burning and in a freezing atmoſphere.

A farther excellence or ſuperiority in the natural machine, if poſſible ſtill more aſtoniſhing, more beyond all human comprehenſion, than what we have been ſpeaking of, is the following: Beſides thoſe internal powers of ſelf-preſervation in each individual, when two of them co-operate, or act in concert, they are endued with powers of making other animals or machines like themſelves, which again are poſſeſſed of the ſame powers of producing others, and ſo of multiplying the ſpecies without end. Theſe are powers which mock all human invention or imitation. They are characteriſtics of the divine Architect.

II. *Hiſtory and Progreſs of Anatomy.*

This art ſeems to have been very ancient; though, for a long time, known only in an imperfect manner. The firſt men who lived muſt have ſoon acquired ſome notions of the ſtructure of their own bodies, particularly of the external parts, and of ſome even of the internal, ſuch as bones, joints, and ſinews, which are expoſed to the examination of the ſenſes in living bodies. This rude knowledge muſt have been gradually improved, by the accidents to which the body is expoſed, by the neceſſities of life, and by the various cuſtoms, ceremonies, and ſuperſtitions, of different nations. Thus, the obſervance of bodies killed by violence, attention to wounded men, and to many diſeaſes, the various ways of putting criminals to death, the funeral ceremonies, and a variety of ſuch things, muſt have ſhown men every day more and more of themſelves; eſpecially as curioſity and ſelf-love would here urge them powerfully to obſervation and reflection.

The brute creation having ſuch an affinity to man in outward form, motions, ſenſes, and ways of life; the generation of the ſpecies, and the effect of death upon the body, being obſerved to be ſo nearly the ſame in both; the concluſion was not only obvious, but unavoidable, that their bodies were formed nearly upon the ſame model. And the opportunities of examining the bodies of brutes were ſo eaſily procured, indeed ſo neceſſarily occurred in the common buſineſs of life, that the huntſman, in making uſe of his prey, the prieſt in ſacrificing, the augur in divination, and above all, the butcher, or thoſe who might out of curioſity attend upon his operations, muſt have been daily adding to the little ſtock of anatomical knowledge. Accordingly we find, in fact, that the South-ſea Iſlanders, who have been left to their own obſervation and reaſoning, without the aſſiſtance of letters, have yet a conſiderable ſhare of rude or wild anatomical knowledge. Dr. Hunter informs us, that when Omai was in his muſeum with Mr. Banks, though he could not explain himſelf intelligibly, they plainly ſaw that he knew the principal parts of the body, and ſomething likewiſe of their uſes; and manifeſted a great curioſity or deſire of having the functions of the internal parts of the body explained to him; particularly the relative functions of the two ſexes, which with him ſeemed to be the moſt intereſting object of the human mind.

We may further imagine, that the philoſophers of the moſt early ages, that is, the men of curioſity, obſervation, experience, and

and reflection, could not overlook an inſtance of natural organization, which was ſo intereſting, and at the ſame time ſo wonderful, more eſpecially ſuch of them as applied to the ſtudy and cure of diſeaſes. We know that phyſic was a branch of philoſophy till the age of Hippocrates. Thus the art muſt have been circumſtanced in its beginning. We ſhall next ſee, from the teſtimony of hiſtorians and other writers, how it actually appeared as an art, from the time that writing was introduced among men; how it was improved, and conveyed down to us through a long ſeries of ages.

Civilization, and improvements of every kind, would naturally begin in fertile countries and healthful climates, where there would be leiſure for reflection, and an appetite for amuſement. Accordingly, writing, and many other uſeful and ornamental inventions and arts, appear to have been cultivated in the eaſtern parts of Aſia long before the earlieſt times that are treated of by the Greek or other European writers; and that the arts and learning of thoſe eaſtern people were in ſubſequent times gradually communicated to adjacent countries, eſpecially by the medium of traffic. The cuſtoms, ſuperſtitions, and climate of eaſtern countries, however, appear to have been as unfavourable to practical anatomy, as they were inviting to the ſtudy of aſtronomy, geometry, poetry, and all the ſofter arts of peace. Animal bodies there run ſo quickly into naſeous putrefaction, that the early inhabitants muſt have avoided ſuch offenſive employments as anatomical inquiries, like their poſterity at this day. And in fact, it does not appear, by the writings of the Grecians, or Jews, or Phœnicians, or of other eaſtern countries, that anatomy was particularly cultivated by any of thoſe eaſtern nations. In tracing it backwards to its infancy, we cannot go farther into antiquity than the times of the Grecian philoſophers. As an art in the ſtate of ſome cultivation, it may be ſaid to have been brought forth and bred up among them as a branch of natural knowledge.

The æra of philoſophy, as it was called, began with Thales, the Mileſian, being declared, by a very general conſent of the people, the moſt wiſe of all the Grecians, 480 years before Chriſt. The philoſophers of his ſchool, which was called the Ionian, cultivated principally natural knowledge. Socrates, the ſeventh in ſucceſſion of their great teachers, introduced the ſtudy of morals, and was thence ſaid to bring down philoſophy from heaven to make men truly wiſe and happy. In the writings of his ſcholar and ſucceſſor, Plato, we ſee that the philoſophers had carefully conſidered the human body, both in its organization and functions; and though they had not arrived at the knowledge of the more minute and intricate parts, which required the ſucceſſive labour and attention of many ages, they had made up very noble and comprehenſive ideas of the ſubject in general. The anatomical deſcriptions of Xenophon and Plato have had the honour of being quoted by Longinus (§ xxxii.) as ſpecimens of ſublime writing; and the extract from Plato is ſtill more remarkable for its containing the rudiments of the circulation of the blood. "The heart (ſays Plato) is the centre or knot of the blood-veſſels; the ſpring or fountain of the blood, which is carried impetuouſly round; the blood is the *pabulum* or food of the fleſh; and, for the purpoſe of nouriſhment, the body is laid out into canals, like thoſe which are drawn through gardens, that the blood may be conveyed, as from a fountain, to every part of the pervious body."

Hippocrates was nearly contemporary with the great philoſophers of whom we have been ſpeaking, about 400 years before the Chriſtian æra. He is ſaid to have ſeparated the profeſſion of philoſophy and phyſic, and to have been the firſt who applied to phyſic alone as the buſineſs of his life. He is likewiſe generally ſuppoſed to be the firſt who wrote upon anatomy. We know of nothing that was written expreſsly upon the ſubject before; and the firſt anatomical diſſection which has been recorded, was made by his friend Democritus of Abdera. If, however, we read the works of Hippocrates with impartiality, and apply his accounts of the parts to what we now know of the human body, we muſt allow his deſcriptions to be imperfect, incorrect, ſometimes extravagent, and often unintelligible, that of the bones only excepted. He ſeems to have ſtudied theſe with more ſucceſs than the other parts, and tells us that he had an opportunity of ſeeing an human ſkeleton.

From Hippocrates to Galen, who flouriſhed towards the end of the ſecond century, in the decline of the Roman empire, that is, in the ſpace of 600 years, anatomy was greatly improved; the philoſophers ſtill conſidering it as a moſt curious and intereſting branch of natural knowledge, and the phyſicians as a principal foundation of their art. Both of them, in that interval of time, contributed daily to the common ſtock, by more accurate and extended obſervations, and by the lights of improving philoſophy. As theſe two great men had applied very particularly to the ſtudy of animal bodies, they not only made great improvements, eſpecially in phyſiology, but raiſed the credit of natural knowledge, and ſpread it as wide as Alexander's empire.

Few of Ariſtotle's writings were made public in his life-time. He affected to ſay that they would be unintelligible to thoſe who had not heard them explained at his lectures; and except the uſe which Theophraſtus made of them, they were loſt to the public for above 130 years after the death of Theophraſtus; and at laſt came out defective from bad preſervation, and corrupted by men, who, without proper qualifications, preſumed to correct and to ſupply what was loſt.

From the time of Theophraſtus, the ſtudy of natural knowledge at Athens was for ever on the decline: and the reputation of the Lyceum and Academy was almoſt confined to the ſtudies which are ſubſervient to oratory and public ſpeaking.

The other great inſtitution for Grecian education was at Alexandria in Egypt. The firſt Ptolemies, both from the love of literature, and to give true and permanent dignity to their empire, and to Alexander's favourite city, ſet up a grand ſchool in the palace itſelf, with a muſeum and a library, which, we may ſay, has been the moſt famed in the world. Anatomy, among other ſciences, was publicly taught; and the two diſtinguiſhed anatomiſts were Eraſiſtratus, the pupil and friend of Theophraſtus, and Herophilus. Their voluminous works are all loſt; but they are quoted by Galen in almoſt every page. Theſe profeſſors were probably the firſt who were authoriſed to diſſect human bodies; a peculiarity which marks ſtrongly the philoſophical magnanimity of the firſt Ptolemy, and fixes a great æra in the hiſtory of anatomy. And it was, no doubt, from this particular advantage which the Alexandrians had above all others, that their ſchool not only gained, but for many centuries preſerved, the firſt reputation for medical education. Ammianus Marcellinus, who lived about 650 years after the ſchools were ſet up, ſays, they were ſo famous in his time, that it was enough to ſecure credit to any phyſician, if he could ſay that he had ſtudied at Alexandria.

Herophilus has been ſaid to have anatomized 700 bodies. We muſt allow for exaggeration. Nay, it was ſaid, that both he and Eraſiſtratus made it a common practice to open living bodies, that they might diſcover the more ſecret ſprings of life. But this, no doubt, was only a vulgar opinion, ariſing from the prejudices of mankind; and accordingly, without any good reaſon, ſuch tales have been told of modern anatomiſts, and have been believed by the vulgar.

Among the Romans, though it is probable they had phyſicians and ſurgeons from the foundation of the city, yet we have no account of any of theſe applying themſelves to anatomy for a very long time. Archathagus was the firſt Greek phyſician eſtabliſhed in Rome, and he was baniſhed the city on account of the ſeverity of his operations. Archathagus, in the time of Pompey, attained ſuch a high reputation as to be ranked in the ſame claſs with Hippocrates. He ſeemed to have ſome notion of the air in reſpiration acting by its weight; and in accounting for digeſtion, he ſuppoſed the food to be no farther changed than by a communication into extremely ſmall parts, which being diſtributed to the ſeveral parts of the body, is aſſimilated to the nature of each. One Caſſius, commonly thought to be a diſciple of Aſclepiades, accounted for the right ſide of the body becoming paralytic on hurting the left ſide of the brain, in the ſame manner as has been done by the moderns, viz. from the croſſing of the nerves from the right to the left ſide of the brain.

From the time of Aſclepiades to the ſecond century, phyſicians were greatly encouraged at Rome; and in the writings of Celſus, Rufus, Pliny, Cœlius Aurelianus, and Araæteus, we find ſeveral anatomical obſervations, but moſtly very ſuperficial and inaccurate. Towards the end of the ſecond century lived Claudius Gallenus Pergamus, whoſe name is ſo well known in the medical world. He applied himſelf particularly to the ſtudy of anatomy, and did more in that way than all that went before him. He ſeemed, however, to have been at a great loſs for human ſubjects to operate upon; and therefore his deſcriptions of the parts are moſtly taken from brute animals. His works contain the fulleſt hiſtory of anatomiſts, and the moſt complete ſyſtem of the ſcience, to be met with any where before him, or for ſeveral centuries after; ſo that a number of paſſages in them were reckoned abſolutely unintelligible for many ages, until explained by the ſucceeding anatomiſts.

About the end of the fourth century, Nimeſius, biſhop of Emiſſa, wrote a treatiſe on the nature of man, in which it is ſaid were contained two celebrated modern diſcoveries; the one, the uſes of the bile, boaſted of by Sylvius de la Boe; and the other, the circulation of the blood. This laſt, however, is proved by Dr. Friend, in his Hiſtory of Phyſic, p. 229. to be falſely aſcribed to this author.

The Roman empire beginning now to be oppreſſed by the barbarians, and ſunk in groſs ſuperſtition, learning of all kinds decreaſed; and when the empire was totally overwhelmed by thoſe barbarous nations, every appearance of ſcience was almoſt extinguiſhed in Europe. The only remains of it were among the Arabians in Spain and in Aſia. The Saracens, who came into Spain, deſtroyed at firſt all the Greek books which the Vandals had ſpared: but though their government was in a conſtant ſtruggle and fluctuation during 800 years before they were driven out, they received a taſte for learning from their countrymen of the eaſt; ſeveral of their princes encouraged liberal ſtudies; public ſchools were ſet up at Cordovia, Toledo, and other towns, and tranſlations of the Greeks into the Arabic were univerſally in the hands of their teachers. Thus was the learning of the Grecians tranſferred to the Arabians. But though they had ſo good a foundation to build upon, this art was never improved while they were maſters of the world; for they were ſatisfied with commenting upon Galen; and ſeem to have made no diſſections of human bodies.

Abdollaliph, who was himſelf a teacher of anatomy, a man eminent in his time (at and before 1203) for his learning and curioſity; a great traveller, who had been bred at Bagdad, and had ſeen many of the great cities and principal places for ſtudy in the Saracen empire; who had a favourable opinion of original obſervation, in oppoſition to book-learning; who boldly corrected ſome of Galen's errors, and was perſuaded that many more might be detected; this man, we ſay, never made, or ſaw, or ſeemed to think of, a human diſſection. He diſcovered Galen's errors in the oſteology, by going to burying-grounds, with his ſtudents and others, where he examined and demonſtrated the bones; he earneſtly recommended that method of ſtudy, in preference even to the reading of Galen, and thought that many farther improvements might be made; yet he ſeemed not to have an idea that a freſh ſubject might be diſſected with that view.

Perhaps the Jewiſh tenets, which the Mahometans adopted, about uncleanlineſs and pollution, might prevent their handling dead bodies; or their opinion of what was ſuppoſed to paſs between an angel and the dead perſon, might make them think diſturbing the dead highly ſacrilegious. Such, however, as Arabian learning was, for many ages together there was hardly any other in all the weſtern countries of Europe. It was introduced by the eſtabliſhment of the Saracens in Spain in 711, and kept its ground till the reſtoration of learning in the end of the 15th century. The ſtate of anatomy in Europe, in the times of Arabian influence, may be ſeen by reading a very ſhort ſyſtem of anatomy drawn up by Mundinus, in the year 1315. It was extracted principally from what the Arabians had preſerved of Galen's doctrine; and, rude as it is, in that age, it was judged to be ſo maſterly a performance, that it was ordered by a public decree, that it ſhould be read in all the ſchools of Italy; and it actually continued to be almoſt the only book which was read upon the ſubject for above 200 years. Corteſius gives him the credit of being the great reſtorer of anatomy, and the firſt who diſſected human bodies among the moderns.

A general prejudice againſt diſſection, however, prevailed till the 16th century. The emperor Charles V. ordered a conſultation to be held by the divines of Salamanca, in order to determine whether or not it was lawful in point of conſcience to diſſect a dead body. In Muſcovy, till very lately, both anatomy and the uſe of ſkeletons were forbidden; the firſt as inhuman, and the latter as ſubſervient to witchcraft.

In the beginning of the 15th century, learning revived conſiderably in Europe, and particularly phyſic, by means of copies of the Greek authors brought from the ſack of Conſtantinople; after which the number of anatomiſts and anatomical books increaſed to a prodigious degree. The Europeans becoming thus poſſeſſed of the ancient Greek fathers of medicine, were for a long time ſo much occupied in correcting the copies they could obtain, ſtudying their meaning, and commenting upon them, that they attempted nothing of their own, eſpecially in anatomy.

And here the late Dr. Hunter introduces into the annals of this art, a genius of the firſt rate, Leonardo da Vinci, who had been formerly overlooked, becauſe he was of another profeſſion, and becauſe he publiſhed nothing upon the ſubject. He is conſidered by the Doctor as by far the beſt anatomiſt and phyſiologiſt of his time; and was certainly the firſt man we know of who introduced the practice of making anatomical drawings.

Vaſſare, in his lives of the painters, ſpeaks of Leonardo thus, after telling us that he had compoſed a book of the anatomy of a horſe for his own ſtudy: "He afterwards applied himſelf with more diligence to the human anatomy; in which ſtudy he reciprocally received and communicated aſſiſtance to Marc. Antonio della Torre, an excellent philoſopher, who then read lectures in Pavia, and wrote upon this ſubject; and who was the firſt, as I have heard, who began to illuſtrate medicine from the doctrine of Galen, and to give true light to anatomy, which till that time had been involved in clouds of darkneſs and ignorance. In this he availed himſelf exceedingly of the genius and labour of Leonardo, who made a book of ſtudies, drawn with red chalk, and touched with a pen, with great diligence, of ſuch ſubjects as he had himſelf diſſected; where he made all the bones, and to thoſe he joined, in their order, all the nerves, and covered them with the muſcles. And concerning thoſe, from part to part, he wrote remarks in letters of an ugly form, which are written by the left hand, backwards and not to be underſtood but by thoſe who know the method of reading them; for they are not to be read without a looking glaſs. Of theſe papers of the human anatomy, there is a great part in the poſſeſſion of M. Franceſo da Melzo a Milaneſe gentleman, who, in the time of Leonardo, was a moſt beautiful boy, and much beloved by him, as he is now a beautiful and genteel old man, who reads thoſe writings, and carefully preſerves them, as precious relicts, together with the portrait of Leonardo, of happy memory. It appears impoſſible that that divine ſpirit ſhould reaſon ſo well upon the arteries, and muſcles, and nerves, and veins; and with ſuch diligence of every thing, &c. &c." Thoſe very drawings and the writings are happily found to be preſerved in his Majeſty's great collection of original drawings, where the Doctor was permitted to examine them; and his ſentiments upon the occaſion he thus expreſſes: "I expected to ſee little more than ſuch deſigns in anatomy, as might be uſeful to a painter in his own profeſſion; but I ſaw, and indeed with aſtoniſhment, that Leonardo had been a general and a deep ſtudent. When I conſider what pains he has taken upon every part of the body, the ſuperiority of his univerſal genius, his particular excellence in mechanics and hydraulics, and the attention with which ſuch a man would examine and ſee objects which he was to draw, I am fully perſuaded that Leonardo was the beſt anatomiſt at that time in the world. We muſt give the 15th century the credit of Leonardo's anatomical ſtudies, as he was 55 years of age at the cloſe of that century."

In the beginning of the 16th century, Achillinus and Benedictus, but particularly Berengarius and Maſſa, followed out the improvement of anatomy in Italy, where they taught it, and publiſhed upon the ſubject. Theſe firſt improvers made ſome diſcoveries from their own diſſections: but it is not ſurpriſing that they ſhould have been diffident of themſelves, and have followed Galen almoſt blindly, when his authority had been ſo long eſtabliſhed, and when the enthuſiaſm for Greek authors was riſing to ſuch a pitch.

Soon after this, we may ſay about the year 1540, the great Veſalius appeared. He was ſtudious, laborious, and ambitious. From Bruſſels, the place of his birth, he went to Louvain, and thence to Paris, where anatomy was not yet making a conſiderable figure, and then to Louvain to teach; from which place, very fortunately for his reputation, he was called to Italy, where he met with every opportunity that ſuch a genius for anatomy could deſire; that is, books, ſubjects, and excellent draughtſmen. He was equally laborious in reading the ancients and in diſſecting bodies. And in making the compariſon, he could not but ſee, that there was great room for improvement, and that many of Galen's deſcriptions were erroneous. When he was but a young man, he publiſhed a noble ſyſtem of anatomy, illuſtrated with a great number of elegant figures. In this work he found ſo many occaſions of correcting Galen, that his contemporaries, partial to antiquity, and jealous of his reputation, complained that he carried his turn for improvement and criticiſms to licentiouſneſs. The ſpirit of oppoſition and emulation was preſently roufed; and Sylvius in France, Columbus, Fallopius, and Euſtachius in Italy, who were all in high anatomical reputation about the middle of the 16th century, endeavoured to defend Galen at the expence of Veſalius. In their diſputes they made their appeals to the human body: and thus in a few years the art was greatly improved. And Veſalius being detected in the very fault which he condemns in Galen, to wit, deſcribing from the diſſections of brutes, and not of the human body, it expoſed ſo fully that blunder of the older anatomiſts, that in ſucceeding times there has been little reaſon for ſuch complaint. Beſides the above, he publiſhed ſeveral other anatomical treatiſes. He has been particularly ſerviceable by impoſing names on the muſcles, moſt of which are retained to this day. Formerly they were diſtinguiſhed by numbers, which were differently applied by almoſt every author.

In 1561, Gabriel Fallopius, profeſſor of anatomy at Padua, publiſhed a treatiſe of anatomy under the title of *Obſervationes Anatomicæ*. This was deſigned as a ſupplement to Veſalius; many of whoſe deſcriptions he corrects, though he always makes mention of him in an honourable manner. Fallopius made many great diſcoveries, and his book is well worth the peruſal of every anatomiſt.

In 1563, Bartholomæus Euſtachius publiſhed his *Opuſcula Anatomicæ* at Venice, which have ever ſince been juſtly admired for the exactneſs of the deſcriptions, and the diſcoveries contained in them. He publiſhed afterwards ſome other pieces, in which there is little of anatomy, but never publiſhed the great work he had promiſed, which was to be adorned with copper-plates, repreſenting all the parts of the human body. Theſe plates, after lying buried in an old cabinet for upwards of 150 years, were at laſt diſcovered and publiſhed in the year 1714, by Lanciſi, the pope's phyſician; who added a ſhort explicatory text, becauſe Euſtachius's own writing could not be found.

From this time the ſtudy of anatomy gradually diffuſed itſelf over Europe; inſomuch, that for theſe hundred years it has been daily improving by the labour of a number of profeſſed anatomiſts almoſt in every country of Europe.

We may form a judgment about the ſtate of anatomy even in Italy, in the beginning of the 17th century, from the information of Corteſius. He had been profeſſor of anatomy at Bologna, and was then profeſſor of medicine at Maſſana; where though he had a great deſire to improve himſelf in the art, and to finiſh a treatiſe which he had begun on practical anatomy, in 24 years he could only twice procure an opportunity of diſſecting a human body, and then it was with difficulty and in hurry; whereas he had expected to have diſſected 20, he ſays, *once every year, according to the cuſtom of the famous academies of Italy*. In the very end of the 16th century, our great Harvey, as was the cuſtom of the times, went to Italy to ſtudy medicine, for Italy was ſtill the favourite ſeat of the arts. And in the very beginning of the 17th century, ſoon after Harvey's return to England, his maſter in anatomy, Fabricius ab Aquapendente, publiſhed an account of the valves in the veins, which he had diſcovered many years before, and no doubt taught in his lectures when Harvey attended them. This diſcovery evidently affected the eſtabliſhed doctrine of all ages, that the veins carried the blood from the liver to all parts of the body for nouriſhment. It ſet Harvey to work

work upon the uſe of the heart and vaſcular ſyſtems in animals; and, in the courſe of ſome years, he was ſo happy as to diſcover, and to prove beyond all poſſibility of doubt, the *circulation of the blood*. He taught his new doctrine in his lectures about the year 1616, and printed it in 1628. It was by far the moſt important ſtep that has been made in the knowledge of animal bodies in any age. It not only reflected uſeful lights upon what had been already found out in anatomy, but alſo pointed out the means of further inveſtigation. And accordingly we ſee that from Harvey to the preſent time, anatomy has been ſo much improved, that we may reaſonably queſtion if the ancients have been further outdone by the moderns in any other branch of knowledge. From one day to another there has been a conſtant ſucceſſion of diſcoveries, relating either to the ſtructure or functions of our body; and new anatomical proceſſes, both of inveſtigation and demonſtration, have been daily invented. Many parts of the body, which were not known in Harvey's time, have ſince then been brought to light: and of thoſe which were known, the internal compoſition and functions remained unexplained; and, indeed, muſt have remained unexplicable without the knowledge of the circulation. Harvey's doctrine at firſt met with conſiderable oppoſition; but in the ſpace of about 20 years it was ſo generally and ſo warmly embraced, that it was imagined every thing in phyſic would be explained. But time and experience have taught us, that we ſtill are, and probably muſt long continue to be, very ignorant; and that in the ſtudy of the human body, and of its diſeaſes, there will always be an extenſive field for the exerciſe of ſagacity.

After the diſcovery and knowledge of the circulation of the blood, the next queſtion would naturally have been about the paſſage and route of the nutritious part of the food or chyle from the bowels to the blood-veſſels: and by good fortune, in a few years after Harvey had made his diſcovery, Aſellius, an Italian phyſician, found out the lacteals, or veſſels which carry the chyle from the inteſtines; and printed his account of them, with coloured prints, in the year 1627, the very year before Harvey's book came out. For a number of years after theſe two publications, the anatomiſts in all parts of Europe were daily opening living dogs, either to ſee the lacteals, or to obſerve the phenomena of the circulation. In making an experiment of this kind, Pecquet, in France, was fortunate enough to diſcover the thoracic duct, or common trunk of all the lacteals, which conveys the chyle into the ſubclavian vein. He printed his diſcovery in the year 1651. And now the lacteals having been traced from the inteſtines to the thoracic duct, and that duct having been traced to its termination in a blood-veſſel, the paſſage of the chyle was completely made out. The ſame practice of opening living animals furniſhed occaſions of diſcovering the lymphatic veſſels. This good fortune fell to the lot of Rudbec firſt, a young Swediſh anatomiſt; and then to Thomas Bartholine, a Daniſh anatomiſt, who was the firſt that appeared in print upon the lymphatics. His book came out in the year 1653, that is, two years after that of Pecquet. And then it was very evident, that they had been ſeen before by Dr. Highmore, and others, who had miſtaken them for lacteals. But none of the anatomiſts of thoſe times could make out the origin of the lymphatics, and none of the phyſiologiſts could give a ſatisfactory account of their uſe. The circulation of the blood, and the paſſage of the chyle, having been ſatisfactorily traced out in full grown animals, the anatomiſts were naturally led next to conſider how theſe animal proceſſes were carried on in the child while in the womb of the mother. Accordingly the male and female organs, the appearances and contents of the pregnant uterus, the incubated egg, and every phenomenon which could illuſtrate generation, became the favourite ſubject for about 30 years with the principal anatomiſts of Europe. Thus it would appear to have been in theory; but Dr. Hunter believes, that in fact, as Harvey's maſter Fabricius, laid the foundation for the diſcovery of the circulation of the blood, by teaching him the valves of the veins, and thereby inviting him to conſider that ſubject; ſo Fabricius, by his lectures, and by his elegant work, *De formato fœtu, et de formatione ovi et pulli*, probably made that likewiſe a favourite ſubject of Dr. Harvey. But whether he took up the ſubject of generation in conſequence of his diſcovery of the circulation, or was led to it by his honoured maſter Fabricius, it is certain he ſpent a great deal of his time in the inquiry; and publiſhed his obſervations in a book *De generatione animalium*, in the year 1651, that is ſix years before his death.

In a few years after this, Swammerdam, Van Horn, Steno, and De Graaf, excited great attention to the ſubject of generation, by their ſuppoſed diſcovery, that the females of viviparous animals have ovaria, that is, cluſters of eggs in their loins, like oviparous animals; which, when impregnated by the male, are conveyed into the uterus; ſo that a child is produced from an egg as well as a chick; with this difference, that one is hatched within, and the other without, the body of the mother.

Malpighi, a great Italian genius, ſome time after, made conſiderable advances upon the ſubject of generation. He had the good fortune to be the firſt who uſed magnifying glaſſes with addreſs in tracing the firſt appearances in the formation of animals. He likewiſe made many other obſervations and improvements in the *minutiæ* of anatomy by his microſcopical labours, and by cultivating comparative anatomy. This diſtinguiſhed anatomiſt gave the firſt public ſpecimen of his abilities, by printing a diſſertation on the lungs, *anno* 1661; a period ſo remarkable for the ſtudy of nature, that it would be injuſtice to paſs it without particular notice.

At the ſame time flouriſhed Laurentius Bellinus at Florence, and was the firſt who introduced mathematical reaſoning in phyſic. In 1662, Simon Pauli publiſhed a treatiſe *De albandis oſſibus*. He had long been admired for the white ſkeletons he prepared; and at laſt diſcovered his method, which was by expoſing the bones all winter to the weather.

Johannes Swammerdam, of Amſterdam, alſo publiſhed ſome anatomical treatiſes; but was moſt remarkable for his knowledge of preſerving the parts of bodies entire for many years, by injecting their veſſels. He alſo publiſhed a treatiſe on reſpiration, wherein he mentioned his having figures of all the parts of the body, as big as the life, cut in copper, which he deſigned to publiſh, with a complete ſyſtem of anatomy. Theſe, however, were never made public by Swammerdam; but, in 1683, Gothofridus Bidloo, profeſſor of anatomy at Leyden, publiſhed a work intitled *Anatomia corporis humani*, where all the parts were delineated in very large plates, almoſt as big as the life. Mr. Cowper, an Engliſh ſurgeon, bought 300 copies of theſe figures; and in 1698 publiſhed them with an Engliſh text, quite different from Bidloo's Latin one; to which were added letters in Bidloo's figures, and ſome few figures of Mr. Cowper's own. To this work Mr. Cowper's name was prefixed, without the leaſt mention of Bidloo, except on purpoſe to confute him. Bidloo immediately publiſhed a very ill-natured pamphlet, called *Gulielmus Cowperus citatus coram tribunali*; appealing to the Royal Society, how far Cowper ought to be puniſhed as a plagiary of the worſt kind, and endeavouring to prove him an ignorant deceitful fellow. Cowper anſwered him in his own ſtyle, in a pamphlet called his *Vindiciæ*; endeavouring to prove, either that Bidloo did not underſtand his own tables, or that they were none of his. It was even alledged, that thoſe were the tables promiſed by Swammerdam, and which Bidloo had got from his widow. This, however, appears to have been only an invidious ſurmiſe, there being unqueſtionable evidence that they were really the performance of Bidloo.

Soon after, Iſbrandus Diembroeck, profeſſor of anatomy at Utrecht, began to appear as an author. His work contained very little original; but he was at great pains to collect from others whatever was valuable in their writings, and his ſyſtem was the common ſtandard among anatomical ſtudents for many years.

About the ſame time, Antonius Liewenhoeck, of Delf, improved conſiderably on Malpighi's uſe of Microſcopes. Theſe two authors took up anatomy where others had dropt it; and, by this new art, they brought a number of amazing things to light. They diſcovered the red globules of the blood; they were enabled to ſee the actual circulation of the blood in the tranſparent parts of living animals, and could meaſure the velocity of its motion; they diſcovered that the arteries and veins had no intermediate cells or ſpungy ſubſtance, as Harvey, and all the preceding anatomiſts, had ſuppoſed, but communicated one with the other by a continuation of the ſame tube. Liewenhoeck was in great fame likewiſe for his diſcovery of the animalcula in the ſemen. Indeed, there was ſcarcely a part of the body, ſolid or fluid, which eſcaped his examination; and he almoſt every where found, that what appeared to the naked eye to be rude undigeſted matter, was in reality a beautiful and regular compound.

After this period, Nuck added to our knowledge of the abſorbent ſyſtem already mentioned, by his injections of the lymphatic glands; Ruyſch, by his deſcription of the valves of the lymphatic veſſels; and Dr. Meckel, by his accurate account of the whole ſyſtem, and by tracing thoſe veſſels in many parts where they had not before been deſcribed.

Beſides theſe authors, Drs. Hunter and Munro have called the attention of the public to this part of anatomy, in their controverſy concerning the diſcovery of the office of the lymphatics. When the lymphatic veſſels were firſt ſeen and traced into the thoracic duct, it was natural for anatomiſts to ſuſpect, that as the lacteals abſorbed from the cavity of the inteſtines, the lymphatics which are ſimilar in figure and ſtructure, might poſſibly do the ſame office with reſpect to other parts of the body: and accordingly, Dr. Gliſſon, who wrote in 1654, ſuppoſes theſe veſſels aroſe from cavities, and that their uſe was to abſorb; and Frederic Hoffman has very explicitly laid down the doctrine of the lymphatic veſſels being a ſyſtem of abſorbents. But anatomiſts in general have been of a contrary opinion; for from experiments, particularly ſuch as were made by injections, they have been perſuaded that the lymphatic veſſels did not ariſe from cavities, and did not abſorb, but were merely continuations from ſmall arteries. The doctrine, therefore, that the lymphatics, like the lacteals, were abſorbents, as had been ſuggeſted by Gliſſon and by Hoffman, has been revived by Dr. Hunter and Dr. Monro, who have controverted the experiments of their predeceſſors in anatomy, and have endeavoured to prove that the lymphatic veſſels are not continued from arteries, but are abſorbents.

To this doctrine, however, ſeveral objections have been ſtarted particularly by Haller, (Elem. Phyſ. l. 24. § 2, 3.); and it has been found, that before the doctrine of the lymphatics being a ſyſtem of abſorbents can be eſtabliſhed, it muſt firſt be determined whether this ſyſtem is to be found in other animals beſides man

and

and quadrupeds. Mr. Hewſon claims the merit of having proved the affirmative of this queſtion, by diſcovering the lymphatic ſyſtem in birds, fiſh, and amphibious animals. See *Phil. Tranſ.* vol. lviii. and lxix. And latterly, Mr. Cruikſhank has traced the ramifications of that ſyſtem in almoſt every part of the body; and from his diſſection figures have been made, and lately publiſhed to the world. To Mr. Sheldon alſo we are much indebted for his illuſtration of this ſyſtem, which promiſes to give great ſatisfaction, but of which only a part has been yet publiſhed.

The gravid uterus is a ſubject likewiſe which has received conſiderable improvements, particularly relating to one very important diſcovery; viz. that the internal membrane of the uterus, which Dr. Hunter has named *decidua*, conſtitutes the exterior part of the fœcundines or after birth, and ſeparates from the reſt of the uterus every time that a woman either bears a child, or ſuffers a miſcarriage. This diſcovery includes another, to wit, that the placenta is partly made up of an excreſcence or efflorescence from the uterus itſelf.

Theſe diſcoveries are of the utmoſt conſequence, both in the phyſiological queſtion about the connection between the mother and child, and likewiſe in explaining the phenomena of births and abortions, as well as in regulating obſtetrical practice.

The anatomiſts of this century have improved anatomy, and have made the ſtudy of it much more eaſy, by giving us more correct as well as more numerous figures. It is amazing to think of what has been done in that time. We have had four large folio books of figures of the bones, viz. Cheſelden's, Albinus's, Sue's, and Trew's. Of the muſcles, we have had two large folios: one from Cowper, which is elegant; and one from Albinus, which, from the accuracy and labour of the work, we may ſuppoſe will never be outdone. Of the blood veſſels we have a large folio from Dr. Haller. We have had one upon the nerves from Dr. Meckel, and another by Dr. Monro, junior. We have had Albinus's, Roederer's, Jenty's, and Hunter's works upon the pregnant uterus; Weitbrecht and Leber on the joints and freſh bones; Soemerring on the brain; Zinn on the eye; Cotunnius, Meckel, junior, &c. on the ear; Walter on the nerves of the thorax and abdomen; Dr. Monro on the burſæ mucoſæ, &c.

It would be endleſs to mention the anatomical figures that have been publiſhed in this century, of particular and ſmaller parts of the body, by Morgagni, Ruyſch, Valſalva, Sanctorini, Heiſter, Vater, Cant, Zimmerman, Walterus, and others.

Thoſe elegant plates of the brain, however, juſt publiſhed by M. Vicq. d'Azyr, muſt not paſs without notice, eſpecially as they form part of an univerſal ſyſtem of anatomy and phyſiology, both human and comparative, propoſed to be executed in the ſame ſplendid ſtyle. Upon the brain alone 19 folio plates are employed; of which ſeveral are coloured. The figures are delineated with accuracy and clearneſs; but the colouring is rather beautiful than correct. Such parts of this work as may be publiſhed, cannot fail to be equally acceptable to the anatomiſt and the philoſopher; but the entire deſign is apparently too extenſive to be accompliſhed within the period of a ſingle life.

To the foreign treatiſes already mentioned, may be added thoſe recently publiſhed by Sabbatier and Plenck on anatomy in general. Among ourſelves, the writings of Keil, Douglas, Cheſelden, the firſt Monro, Winſlow, &c. are two well known to need deſcription. The laſt of theſe uſed to be recommended as a ſtandard for the ſtudents of anatomy; but it has of late given place to a more accurate and comprehenſive ſyſtem, in three volumes, publiſhed by Mr. Elliot of Edinburgh, upon a plan approved of by Dr. Monro, and executed by Mr. Fyfe. Dr. Simmons of London has alſo obliged the world with an excellent ſyſtem of anatomy; and another work, under the title of "Elements of anatomy and the animal Œconomy;" in which the ſubjects are treated with uncommon elegance and perſpicuity.

In the latter part of the laſt century, anatomy made two great ſteps, by the invention of injections, and the method of making what we commonly call *preparations*. Theſe two modern arts have really been of infinite uſe to anatomy; and beſides have introduced an elegance into our adminiſtrations, which in former times could not have been ſuppoſed to be poſſible. They aroſe in Holland under Swammerdam and Ruyſch, and afterwards in England under Cowper, St. André, and others, where they have been greatly improved.

The anatomiſts of former ages had no other knowledge of the blood-veſſels, than what they were able to collect from laborious diſſections, and from examining the ſmaller branches of them, upon ſome lucky occaſion, when they were found more than commonly loaded with red blood. But filling the vaſcular ſyſtem with a bright coloured wax, enables us to trace the large veſſels with great eaſe, renders the ſmaller much more conſpicuous, and makes thouſands of the very minute ones viſible, which, from their delicacy, and the tranſparency of their natural contents, are otherwiſe imperceptible.

The modern art of corroding the fleſhy parts with a menſtruum, and of leaving the moulded wax entire, is ſo exceedingly uſeful, and at the ſame time ſo ornamental, that it does great honour to the ingenious inventor Dr. Nicholls.

The wax-work art of the moderns might deſerve notice in any hiſtory of anatomy, if the maſters in that way had not been ſo careleſs in their imitation. Many of the wax figures are ſo tawdry, with a ſhow of unnatural colours, and ſo very incorrect in the circumſtances of figure, ſituation, and the like, that though they ſtrike a vulgar eye with admiration, they muſt appear ridiculous to an anatomiſt. But thoſe figures which are caſt in wax, plaſter, or lead, from the real ſubject, and which of late years have been frequently made here, are, of courſe, very correct in all the principal parts, and may be conſidered as no inſignificant acquiſition to modern anatomy. The proper or principal uſe of this art is, to preſerve a very perfect likeneſs of ſuch ſubjects as we but ſeldom can meet with, or cannot well preſerve in a natural ſtate; a ſubject in pregnancy, for example.

The modern improved methods of preſerving animal bodies, or parts of them, has been of the greateſt ſervice to anatomy; eſpecially in ſaving the time and labour of the anatomiſt in the nicer diſſections of the ſmall parts of the body. For now, whatever he has prepared with care, he can preſerve; and the object is ready to be ſeen at any time. And in the ſame manner he can preſerve anatomical curioſities or rarities of every kind; ſuch as parts that are uncommonly formed; parts that are diſeaſed; the parts of the pregnant uterus and its contents. Large collections of ſuch curioſities, which modern anatomiſts are ſtriving almoſt every where to procure, are of infinite ſervice to the art, eſpecially in the hands of teachers. They give ſtudents clear ideas about many things which it is very eſſential to know, and yet which it is impoſſible that a teacher ſhould be able to ſhow otherwiſe, were he ever ſo well ſupplied with freſh ſubjects.

III. *Plan of the following Syſtem.*

Having premiſed this general account of the ſubject, we ſhall next conſider the method to be obſerved in treating it.

The ſtudy of the *human* body, as already noticed, is commonly divided into two parts. The firſt, which is called *Anatomy*, relates to the matter and ſtructure of its parts; the ſecond, called *Phyſiology* and *Animal Oeconomy*, relates to the principles and laws of its internal operations and functions.

As the body is a compound of ſolids and fluids, *Anatomy* is divided into, 1. The Anatomy of the ſolids, and, 2. The Anatomy of the fluids.

I. The SOLIDS, by which we mean all parts of our body which are not fluid, are generally divided into two claſſes, viz. 1. The hard ſolids or bones. This part of anatomy is called *Oſteology*; which ſignifies the doctrine of the bones. 2. The ſofter ſolids; which part is called *Sarcology*, viz. the doctrine of fleſh.

This diviſion of the ſolids, we may obſerve, has probably taken its origin from the vulgar obſervation, that the body is made of bone and fleſh. And as there are many different kinds of what are called ſoft or fleſhy parts, Sarcology is ſubdivided into, (1.) *Angeiology*, or the doctrine of veſſels, by which is commonly underſtood *blood veſſels*: (2.) *Adenology*, of glands: (3.) *Neurology*, of nerves: (4.) *Myology*, of muſcles: and (5.) *Splanchnology*, of the viſcera or bowels. There is, beſides, that part which treats of the organs of the ſenſe and of the integuments.

This diviſion of the ſolids has been here mentioned rather for the ſake of explaining ſo many words, which are conſtantly uſed by anatomiſts, than for its importance or accuracy. For beſides many other objections that might be urged, there are in the body three ſpecies of ſolids, viz. griſtle or cartilage, hair, and nails; which are of an intermediate nature between bone and fleſh; and therefore cannot ſo properly be brought into the oſteology or the ſarcology. The cartilages were claſſed with the bones; becauſe the greateſt number of them are appendages to bones: and for the like reaſon the hair and the nails were claſſed with the integuments.

II. The FLUIDS of the human body may be divided into *three* kinds, which Dr. Hunter calls the *crude*, the *general*, or *perfect*, and the *local* or *ſecreted fluid*. 1. By the *crude* fluid is meant the chyle, and whatever is abſorbed at the ſurfaces of the body; in other words, what is recently taken into the body, and is not yet mixed with or converted into blood. 2. The *general* or *perfect* fluid is the blood itſelf; to wit, what is contained in the heart, arteries, and veins, and is going on in the round of the circulation. 3. The *local* or *ſecreted*, are thoſe fluids peculiar to particular parts of the body, which are ſtrained off from the blood, and yet are very different in their properties from the blood. They are commonly called *ſecretions*; and ſome are uſeful, others excrementitious.

In treating of the *Phyſiology*, it is very difficult to ſay what plan ſhould be followed; for every method which has been yet propoſed is attended with manifeſt inconvenience. The powers and operations of the machine have ſuch a dependance upon one another, ſuch connections and reciprocal influence, that they cannot well be underſtood or explained ſeparately. In this ſenſe our body may be compared to a circular chain of powers, in which nothing is firſt or laſt, nothing ſolitary or independent; ſo that wherever we begin, we find that there is ſomething preceding which we ought to have known. If we begin with the brain and the nerves, for example, we ſhall find that theſe cannot exiſt, even in idea, without the heart: if we ſet out with the heart and vaſcular ſyſtem, we ſhall preſently be ſenſible, that the brain and nerves muſt be ſuppoſed: or, ſhould we take up the mouth, and

follow

allow the courſe of the aliment, we ſhould ſee that the very firſt organ which preſented itſelf, ſuppoſed the exiſtence both of the heart and brain: Wherefore we ſhall incorporate the Phyſiology with the Anatomy, by attempting to explain the functions after we have demonſtrated the organs.

PART I. *OSTEOLOGY.*

We begin with the bones, which may be conſidered as the great ſupport of the body, tending to give it ſhape and firmneſs. But before we enter into the detail of each particular bone, it will be neceſſary to deſcribe their compoſition and connections, and to explain the nature of the different parts which have an immediate relation to them; as the cartilages, ligaments, periоſteum, marrow, and ſynovial glands.

SECT. I. OF THE BONES IN GENERAL, WITH THEIR APPENDAGES, &c.

The bones are of a firm and hard (a) ſubſtance, of a white colour, and perfectly inſenſible. They are the moſt compact and ſolid parts of the body, and ſerve for the attachment or ſupport of all the other parts.

Three different ſubſtances are uſually diſtinguiſhed in them; their exterior or bony part properly ſo called; their ſpongy cells; and their reticular ſubſtance. The firſt of theſe is formed of many laminæ or plates, compoſing a firm hard ſubſtance. The ſpongy or cellular part is ſo called on account of its reſemblance to a ſponge, from the little cells which compoſe it. This ſubſtance forms almoſt the whole of the extremities of cylindrical bones. The reticular part is compoſed of fibres, which croſs each other in different directions. This net-work forms the internal ſurface of thoſe bones which have cavities.

The flat bones, as thoſe of the head, are compoſed only of the laminæ and the cellular ſubſtance. This laſt is uſually found in the middle of the bone, dividing it into two plates, and is there called *diploë*.

Gagliardi, who pretended to have diſcovered an infinite number of claviculi (c), or bony proceſſes, which he deſcribes as traverſing the laminæ to unite them together, has endeavoured to ſupport this pretended diſcovery by the analogy of bones to the bark of trees, in which certain woody nails have been remarked; but this opinion ſeems to be altogether fanciful.

Some writers have ſuppoſed, that the bones are formed by layers of the periоſteum, which gradually oſſify, in the ſame manner as the timber is formed in trees by the hardening of the white ſubſtance that is found between the inner bark and the wood. M. Duhamel, who has adopted this opinion, fed different animals with madder and their ordinary food alternately during a certain time; and he aſſerts, that in diſſecting their bones, he conſtantly obſerved diſtinct layers of red and white, which correſponded with the length of time they had lived on madder or their uſual aliment. But it has ſince been proved by Detleff, that M. Duhamel's experiments were inaccurate, and that neither the periоſteum nor the cartilages are tinged by the uſe of madder, which is known to affect the bones only.

We uſually conſider in a bone, its body and its extremities. The ancients gave the name of diaphyſis to the body or middle part, and divided the extremities into apophyſis and epiphyſis. An apophyſis, or proceſs, as it is more commonly called, is an eminence continued from the body of the bone; whereas an epiphyſis is at firſt a ſort of an appendage to the bone, by means of an intermediate cartilage. Many epiphyſes, which appear as diſtinct bones in the fœtus, afterwards become apophyſes; for they are at length ſo completely united to the body of the bone, as not to be diſtinguiſhable from it in the adult ſtate. It is not unuſual, however, at the age of 18 and even 20 years, to find the extremities of bones ſtill in the ſtate of epiphyſis.

The names given to the proceſſes of bones are expreſſive of their ſhape, ſize, or uſe: thus if a proceſs is large, and of a ſpherical form, it is called *caput*, or *head*, if the head is flatted, it is termed *condyle*. Some proceſſes, from their reſemblance to a ſtiletto, a breaſt, or the beak of a crow, are called *ſtyloid*, *maſtoid*, or *coracoid*: others are ſtyled *ridges* or *ſpines*. The two proceſſes of the os femoris derive their name of *trochanters* from their uſe.

A bone has its cavities as well as proceſſes. Theſe cavities either extend quite through its ſubſtance, or appear only as depreſſions. The former are called *foramina* or *holes*, and theſe foramina are ſometimes termed *canals* or *conduits*, according to their form and extent. Of the depreſſions, ſome are uſeful in articulation. Theſe are called *cotyloid* when they are deep, as is the caſe with the os innominatum, where it receives the head of the os femoris; or *glenoid* when they are ſuperficial, as in the ſcapula, where it receives the os humeri. Of the depreſſions that are not deſigned for articulation, thoſe which have ſmall apertures are called *ſinuſes*; others that are large, and not equally ſurrounded by high brims, are ſtyled *foſſæ*; ſuch as are long and narrow, *furrows*; or if broad and ſuperficial without brims, *ſinuoſities*. Some are called *digital impreſſions*, from their reſemblance to the traces of a finger on ſoft bodies.

We ſhall abridge this article, which is exceedingly diffuſe in the generality of anatomical books, and will endeavour to deſcribe it with all the clearneſs it will allow.

The bones compoſing the ſkeleton are ſo conſtructed, that the end of every bone is perfectly adapted to the extremity of that with which it is connected, and this connection forms what is called their *articulation*.

Articulation is divided into *diarthroſis*, *ſynarthroſis*, and *amphiarthroſis*, or movable, immovable, and mixed articulation. Each of the two firſt has its ſubdiviſions. Thus the *diarthroſis*, or moveable articulation, includes, 1. The enarthroſis, as it is called, when a large head is admitted into a deep cavity, as in the articulation of the os femoris with the os innominatum. 2. Arthrodia, when a round head is articulated with a ſuperficial cavity, as is the caſe of the os humeri and ſcapula. 3. Ginglimus, or hinge-like articulation, as in the connection with the thigh-bone with the tibia. The enarthroſis and arthrodia allow of motion to all ſides; the ginglimus only of flexion and extenſion.

The *ſynarthroſis*, or immoveable articulation, includes, 1. The future, when the two bones are indented into each other, as is the caſe with the parietal bones. 2. Gomphoſis, when one bone is fixed into another, in the manner the teeth are placed in their ſockets.

The term *amphiarthroſis* is applied to thoſe articulations which partake both of the ſynarthroſis and diarthroſis, as is the caſe with the bones of the vertebræ, which are capable of motion in a certain degree, although they are firmly connected together by intermediate cartilages.

What is called *ſymphyſis* is the union of two bones into one; as in the lower jaw, for inſtance, which in the fœtus conſiſts of two diſtinct bones, but becomes one in a more advanced age, by the oſſification of the uniting cartilage. See ARTICULATION.

When bones are thus joined by the means of cartilages, the union is ſtyled *ſyncondroſis*; when by ligaments, *ſyneuroſis*.

Cartilages are white, ſolid, ſmooth, and elaſtic ſubſtances, between the hardneſs of bones and ligaments, and ſeemingly of a fibrous texture. We are not able to trace any veſſels into their ſubſtance by injection, nor are they ever found tinged in animals that have been fed with madder.

They may be diſtinguiſhed into, 1ſt, Thoſe which are connected with the bones; and, 2dly, Thoſe which belong to other parts of the body. The firſt ſerve either to cover the ends and cavities of bones intended for motion, as in the articulations, where by their ſmoothneſs they facilitate motions, which the bones alone could not execute with ſo much freedom; or they ſerve to unite bones together, as in the ſymphyſis pubis; or to lengthen them, as in the ribs.

Many of them oſſifying as we advance in life, their number is leſs in the adult than in the fœtus, and of courſe there are fewer bones in the old than in the young ſubject.

Of the ſecond claſs of cartilages, or thoſe belonging to the ſoft parts, we have inſtances in the larynx, where we find them uſeful in the formation of the voice, and for the attachment of muſcles. See CARTILAGE.

The *periоſteum* is a fine membrane, of a compact cellular texture, reflected from one joint to another, and ſerving as a common covering to the bones. It has ſanguiferous and lymphatic veſſels, and is ſupplied with nerves from the neighbouring parts. It adheres very firmly to their ſurface, and by its ſmoothneſs facilitates the motion of the muſcles. It likewiſe ſupports the veſſels that go to be diſtributed through the ſubſtance of the bones, and may ſerve to ſtrengthen the articulations. At the extremities of bones, where it is found covering a cartilage, it has by ſome been improperly conſidered as a diſtinct membrane, and named *perichondrium*. This, in its uſe and ſtructure, reſembles the periоſteum. Where it covers the bones of the ſkull, it has got the name of *pericranium*.

The periоſteum is not a production of the dura mater, as the ancients, and after them Havers, imagined; nor are the bones formed by the oſſification of this membrane, at leaſt when it is in a ſound ſtate, as ſome late writers have ſuppoſed.

The periоſteum is deficient in the teeth above the ſockets, and in thoſe parts of bones to which ligaments or tendons are attached. See PERIOSTEUM.

The *marrow* is a fat oily ſubſtance, filling the cavities of bones. In the great cavities of long bones, it is of a much firmer conſiſtence than in the cells of their ſpongy part. In the former it inclines ſomewhat to a yelloviſh tinge, and is of the conſiſtence of fat; in the latter it is more fluid, and of a red colour. This difference in colour and conſiſtence is owing to accidental cauſes; both kinds are of the ſame nature, and may both be deſcribed under the common name of marrow, though ſome writers give this name only to the fat-like ſubſtance, and call the other the medullary juice.

The marrow is contained in a very fine and tranſparent membrane, which is ſupplied with a great number of blood-veſſels, chiefly from the periоſteum. This membrana medullaris adheres to the inner ſurface of the bones, and furniſhes an infinite number of minute bags, or veſicles for incloſing the marrow, which is likewiſe ſupported in the cavities of the bones by the long filaments of their reticular ſubſtance.

(a) Mr. Scheele has lately diſcovered that bones contain the phoſphoric acid united with calcareous earth, and that to this combination they owe their firmneſs.

(c) In his *Anat. oſſium nov. invent. illuſtrat.* he deſcribes four kinds of theſe claviculi or nails, viz. the perpendicular, obliquer headed and, crooked.

Beſides the veſſels from the perioſteum, the membrana medullaris is furniſhed with others, which in the long bones may be ſeen paſſing in near the extremities of the bone, and ſending off numerous branches, that ramify through all the veſicles of this membrane.

The bones, and the cells containing the marrow, are likewiſe furniſhed with lymphatics. By their means, the marrow, like the fat, may be taken up in a greater quantity than it is ſecreted; and hence it is that ſo little is found in the bones of thoſe who die of lingering diſeaſes.

It is ſtill a matter of controverſy, Whether the marrow is ſenſible or not? We are certainly not able to trace any nerves to it; and from this circumſtance, and it analogy to fat, Haller has ventured to conſider it as inſenſible. On the other hand, Duverney aſſerts, that an injury done to this ſubſtance in a living animal was attended with great pain. In this diſpute phyſiologiſts do not ſeem to have ſufficiently diſcriminated between the marrow itſelf and the membranous cells in which it is contained. The former, like the fat, being nothing more than a ſecreted, and of courſe an unorganized matter, may with propriety be ranked among the inſenſible parts, as much as inſpiſſated mucus, or any other ſecreted matter in the body; whereas the membrana medullaris being vaſcular, though it poſſeſſes but an obſcure degree of feeling in a ſound ſtate, is not perfectly inſenſible.

The marrow was formerly ſuppoſed to be intended for the nouriſhment and renewal of the bones; but this doctrine is now pretty generally and deſervedly exploded. It ſeems probable that the marrow is to the bones what fat is to the ſoft parts. They both ſerve for ſome important purpoſes in the animal œconomy; but their particular uſe has never yet been clearly aſcertained. The marrow, from the tranſudation of the oil through the bones of a ſkeleton, is ſuppoſed to diminiſh their brittleneſs; and Havers, who has written profeſſedly on the bones, deſcribes the canals by which the marrow is conveyed through every part of their ſubſtance, and divides them into longitudinal and tranſverſe ones. He ſpeaks of the firſt as extending through the whole length of the bone; and of the latter, as the paſſages by which the longitudinal ones communicate with each other. The ſimilarity of theſe to the large cancelli in burnt bones, and the tranſudation of the oil through the bones of the ſkeleton, ſeems to prove that ſome ſuch paſſages do actually exiſt.

The *ſynovial glands* are ſmall bodies (D), ſuppoſed to be of a glandular ſtructure, and exceedingly vaſcular, ſecreting a fluid of a clear mucilaginous nature, which ſerves to lubricate the joints. They are placed in ſmall cavities in the articulations, ſo as to be capable of being gently compreſſed by the motion of the joint, which expreſſes their juice in proportion to the degree of friction. When the ſynovia is wanting, or is of too thick a conſiſtence, the joint becomes ſtiff, and incapable of flexion or extenſion. This is what is termed *anchyloſis*.

Ligaments are white, gliſtening, inelaſtic bands, of a compact ſubſtance, more or leſs broad or thick, and ſerving to connect the bones together. They are diſtinguiſhed by different names, adapted to their different forms and uſes. Thoſe of the joints are called either round or burſal. The round ligaments are white, tendinous, and inelaſtic. They are ſtrong and flexible, and are found only in the joint of the knee, and in the articulation of the os femoris with the os innominatum. The burſal or capſular ligaments ſurround the whole joint like a purſe, and are to be found in the articulations which allow motion every way, as in the articulation of the arm with the ſcapula.

Of thoſe ſacs called *burſæ mucoſæ*, a few were known to former anatomiſts, but by much the greater number have been ſince diſcovered by Dr. Monro (E), who obſerves, that they are to be met with in the extremities of the body only; that many of them are placed entirely on the inner ſides of the tendons between theſe and the bones. Many others cover not only the inner but the outſides of the tendons, or are interpoſed between the tendons and external parts, as well as between thoſe and the bones.

Some are ſituated between the tendons and external parts only or chiefly, ſome between contiguous tendons, or between the tendons or the ligaments and the joints. A few ſuch ſacs are obſerved where the proceſſes of bones play upon the ligaments, or where one bone plays upon another. Where two or more tendons are contiguous and afterwards ſeparate from each other, we generally find a common burſa divided into branches, with which it communicates; and a few burſæ of contiguous tendons communicate with each other. Some, in healthy children, communicate with the cavities of the joints; and in many old people he has ſeen ſuch communications formed by uſe, or worn by friction, independent of diſeaſe.

Their proper membrane is thin and tranſparent, but very denſe, and capable of confining air or any other fluid. It is joined to the neighbouring parts by the common cellular ſubſtance. Between the burſa and the hard ſubſtance of bone, a thin layer of cartilage, or of tough membrane, is very generally interpoſed. To the cellular ſubſtance on the outſide of the burſa, the adipoſe ſubſtance is connected; except where the burſa covers a tendon, cartilage, or bone, much expoſed to preſſure or friction.

In ſeveral places a maſs of fat, covered with the continuation of the membrane of the burſa, projects into its cavity. The edges of this are divided into fringes.

The inner ſide of the membrane is ſmooth, and is extremely ſlippery from the liquor ſecreted in it.

The ſtructure of the burſæ bears a ſtrong reſemblance to the capſular ligaments of the joints. 1. The inner layer of the ligament, like that of the burſæ, is thin and denſe. 2. It is connected to the external ligaments by the common cellular ſubſtance. 3. Between it and the bones, layers of cartilage, or the articular cartilages, are interpoſed. 4. At the ſides of the joints, where it is not ſubjected to violent preſſure and friction, the adipoſe ſubſtance is connected with the cellular membrane. 5. Within the cavities of the joints we obſerve maſſes of fat projecting, covered with ſimilar blood-veſſels, and with ſimilar fimbriæ hanging from their edges. 6. In the knee the upper part of ſuch a maſs of fat forms what has been called the *mucilaginous gland of the joint*; and the under part projects into the burſa behind the ligament which ties the patella to the tibia. 7. The liquor which lubricates the burſæ has the ſame colour, conſiſtence, and properties as that of the joints, and both are affected in the ſame manner by heat, mineral acids, and ardent ſpirits. 8. In ſome places the burſæ conſtantly communicate with the cavities of the joints, in others they generally do ſo; from which we may infer a ſameneſs of ſtructure.

When we examine the fimbriæ common to the fatty bodies of the joints and burſæ, and which have been ſuppoſed to be the ducts of glands lodged within the maſſes of fat, we are not able to diſcover any glandular appearance between them. And although we obſerve many veſſels diſperſed upon the membranes of the fatty bodies and fimbriæ; and that we cannot doubt that theſe fimbriæ conſiſt of ducts which contains lubricating liquor, and can even preſs ſuch a liquor from them; yet their cavities and orifices are ſo minute, that they are not diſcoverable even by the aſſiſtance of magnifying-glaſſes. Theſe fimbriæ appear, therefore, to be ducts, like thoſe of the urethra, which prepare a mucilaginous liquor without the aſſiſtance of any knotty or glandular organ.

Upon the whole, the ſynovia ſeems to be furniſhed by inviſible exhalent arteries, by the ducts of the fimbriæ, and by oil exuding from the adipoſe follicles by paſſages not yet diſcovered.

The word *ſkeleton*, which by its etymology implies ſimply a dry preparation, as uſually applied to an aſſemblage of all the bones of an animal united together in their natural order. It is ſaid to be a natural ſkeleton when the bones are connected together by their own proper ligaments; and an artificial one, when they are joined by any other ſubſtance, as wire, &c. See SKELETON.

The ſkeleton is generally divided into the head, trunk, and extremities. The firſt diviſion includes the bones of the cranium and face. The bones of the trunk are the ſpine, ribs, ſternum, and bones of the pelvis.

The upper extremity on each ſide conſiſts of the two bones of the ſhoulder, viz. the ſcapula and clavicle; the bone of the arm, or os humeri; the bones of the fore-arm, and thoſe of the hand.

The lower extremity on each ſide of the trunk conſiſts of the thigh bone, and the bones of the leg and foot.

SECT. II. OF THE BONES OF THE HEAD.

The head is of a roundiſh figure, and ſomewhat oval (F). Its greateſt diameter is from the forehead to the occiput; its upper part is called *vertex*, or crown of the head; its anterior or fore-part, the face; and the upper part of this *ſinciput*, or forehead; its ſides the temples; its poſterior, or hind-part, the *occiput*; and its inferior part the *baſis*.

The bones of the head may be divided into thoſe of the cranium and face.

Art. I. *Bones of the Cranium and Face.*

There are eight bones of the cranium, viz. the coronal bone, or os frontis; the two parietal bones, or oſſa bregmatis; the os occipitis; the two temporal bones; the ſphenoid bone; and the os ethmoides, or cribriforme. Of theſe, only the os occipitis and oſſa bregmatis are conſidered as proper to the cranium; the reſt being common both to the cranium and face. Theſe bones are all harder at their ſurface than in their middle; and on this account they are divided into two tables, and a middle ſpongy ſubſtance called *diploe*. In this, as in all the other bones, we ſhall conſider its figure, ſtructure proceſſes, depreſſions, and cavities; and the manner in which it is articulated with the other bones.

(D) It is now much doubted, however, whether the appearances in the joints, which are uſually called *glands*, are any thing more than aſſemblages of fat.

(E) See *Deſcription of the Burſæ Mucoſæ*, &c.

(F) The bones of the fœtus being perfectly diſtinct, and the muſcles in young perſons not acting much, the ſhape of the head has been ſuppoſed to depend much on the management of children when very young. Veſalius, who has remarked the difference in people of different nations, obſerves, for inſtance, that the head of a Turk is conical, from the early uſe of the turban; whilſt that of an Engliſhman is flattened by the chin-ſtay. Some of the lateſt phyſiologiſts ſuppoſe, with good reaſon, that this difference is chiefly owing to certain natural cauſes with which we are as yet unacquainted.

The

The *os frontis* has ſome reſemblance in ſhape to the ſhell of the cockle. Externally it is convex, its concave ſide being turned towards the brain. This bone, in the places where it is united to the temporal bones, is very thin, and has there no diploë. It is likewiſe exceedingly thin in that part of the orbit of the eye which is neareſt to the noſe. Hence it is, that a wound in the eye, by a ſword, or any other pointed inſtrument, is ſometimes productive of immediate death. In theſe caſes, the ſword paſſing through the weak part of the bone, penetrates the brain, and divides the nerves at their origin; or perhaps opens ſome blood-veſſel, the conſequences of which are ſoon fatal. We obſerve on the exterior ſurface of this bone five apophyſes or proceſſes, which are eaſily to be diſtinguiſhed. One of theſe is placed at the bottom and narroweſt part of the bone, and is called the naſal proceſs, from its ſupporting the upper end of the bones of the noſe. The four others are called angular or orbitar proceſſes. They aſſiſt to form the orbits, which are the cavities on which the eyes are placed. In each of theſe orbits there are two proceſſes, one at the interior or great angle, and the other at the exterior or little angle of the orbit. They are called the angular proceſſes. Between theſe a ridge is extended in form of an arch, and on this the eye-brows are placed. It is called the orbitar or ſupercilliary ridge, and in ſome meaſure covers and defends the globe of the eye. There is a hole in this for the paſſage of the frontal veſſels and nerves. This arch is interrupted near the noſe by a ſmall pit, in which the tendon of the muſculus obliquus major of this eye is fixed. From the under part of each ſupercilliary ridge a thin plate runs a conſiderable way backwards, and has the name of *orbiter*; the external and fore-part of this plate forms a ſinuoſity for lodging the lachrymal gland. Between the orbitar plates there is a large diſcontinuation of the bone, which is filled up by the cribiform part of the os ethmoides.

On examining the inner ſurface of this bone at its under and middle part, we obſerve an elevation in form of a ridge, which has been called the *ſpinous proceſs*; it aſcends for ſome way, dividing the bone into two conſiderable foſſæ, in which the anterior lobes of the brain are placed. To a narrow furrow in this ridge is attached the extremity of the falx, as the membrane is called, which divides the brain into two hemiſpheres. The furrow becoming gradually wider, is continued to the upper and back part of the bone. It has the falx fixed to it, and part of the longitudinal ſinus lodged in it. Beſides the two foſſæ, there are many depreſſions, which appear like digital impreſſions, and owe their formation to the prominent circumvolutions of the brain.

In the fœtus, the forehead is compoſed of two diſtinct bones; ſo that in them the ſagittal future reaches from the os occipitis to the noſe. This bone is almoſt every where compoſed of two tables and a diploë. Theſe two tables ſeparating from each other under the eyes, form two cavities, one on each ſide of the face, called the frontal ſinuſes. Theſe ſinuſes are lined with a ſoft membrane, called *membrana pituitaria*. In theſe ſinuſes a mucus is ſecreted, which is conſtantly paſſing through two ſmall holes into the noſtrils, which it ſerves to moiſten.

The *os frontis* is joined by future to many of the bones of the head, viz. to the parietal, maxillary, and temporal bones; to the os ethmoides; os ſphenoides; os unguis; and oſſa naſi. The future which connects it with the parietal bones is called the *coronal future*.

The *parietal bones* are two in number; they are very thin, and even tranſparent in ſome places. The particular figure of each of theſe bones is that of an irregular ſquare, bordered with indentations through its whole circumference, except at its lower part. It will be eaſily conceived, that theſe bones, which compoſe the ſuperior and lateral part of the cranium, and cover the greateſt part of the brain, form a kind of vault. On their inner ſurface we obſerve the marks of the veſſels of the dura mater; and at the upper edge of the groove for the ſuperior longitudinal ſinus.

The *oſſa parietalia* are joined to each other by the ſaggittal future; to the os ſphenoides and oſſa temporum by the ſquamus future; to the os occipitis by the lambdoidal future (a), ſo called from its reſemblance to the Greek letter lambda; and to the os frontis by the coronal future.

In the fœtus, the parietal bones are ſeparated from the middle of the divided os frontis by a portion of the cranium then unoſſified.

The *occipital bone* forms the poſterior and inferior parts of the ſkull; it approaches nearly to the ſhape of a lozenge, and is indented throughout three parts of its circumference.

There is a conſiderable hole in the inferior portion of this bone, called the *foramen magnum*, through which the medulla oblongata paſſes into the ſpine. The nervi acceſſorii, and vertebral arteries, likewiſe paſs through it. Behind the condyles are two holes for the paſſage of cervical veins into the lateral ſinuſes; and above them are two others for the paſſage of the eighth pair and acceſſory nerves out of the head. At the ſides, and a little on the anterior part of the foramen magnum, are two proceſſes, called the condyles, one on each ſide; they are of an oval figure, and are covered with cartilage. The external ſurface of this bone has a large tranſverſe arched ridge, under which the bone is very irregular, where it affords attachment to ſeveral muſcles. On examining its inner ſurface, we may obſerve two ridges in form of a croſs; one aſcending from near the foramen magnum to the top of the bone; the upper end of this, in which the falx is fixed, is hollow, for lodging the ſuperior longitudinal ſinus, and the under end has the third proceſs of the dura mater fixed to it. The other ridge, which runs horizontally, is likewiſe hollow, for containing the lateral ſinuſes. Four foſſæ are formed by the croſs, two above and two below. In the former are placed the poſterior lobes of the brain, and in the latter the lobes of the cerebellum.

At the baſis of the cranium we obſerve the cuneiform proceſs (which is the name given to the great apophyſis at the fore part of this bone); it ſerves for the reception of the medulla oblongata.

The *os occipitis* is of greater ſtrength and thickneſs than either of the other bones of the head, though irregularly ſo; at its inferior part, where it is thineſt, it is covered by a great number of muſcles. This bone, from its ſituation, being more liable to be injured by falls than any other bone of the head, nature has wiſely given it the greateſt ſtrength at its upper part, where it is moſt expoſed to danger. It is joined to the parietal bones by the lambdoidal future, and to the oſſa temporum by the additamentum of the temporal future. It is likewiſe connected to the os ſphenoides by the cuneiform proceſs. It is by means of the os occipitis that the head is united to the trunk, the two condyles of this bone being connected to the ſuperior oblique proceſſes of the firſt vertebræ of the neck.

There are two temporal bones, one on each ſide. We may diſtinguiſh in them two parts; one of which is called the *ſquamous* or *ſcaly part*, and the other *pars petroſa*, from its hardneſs. This laſt is ſhaped like a pyramid. Each of theſe diviſions affords proceſſes and cavities: externally there are three proceſſes; one anterior, called the *zygomatic proceſs*; one poſterior, called the *maſtoid*, or *mamillary proceſs*, from its reſemblance to a nipple; and one inferior, called the *ſtyloid proceſs*, becauſe it is ſhaped like a ſtiletto, or dagger.

The cavities are, 1. The meatus auditorius externus. 2. A large foſſa, which ſerves for the articulation of the lower jaw; it is before the meatus auditorius, and immediately under the zygomatic proceſs. 3. The ſtylo-maſtoid hole, ſo called from its ſituation between the ſtyloid and maſtoid proceſſes; it is likewiſe ſtyled the aqueduct of Falloppius, and affords a paſſage to the portio dura of the auditory or ſeventh pair of nerves. 4. Below and on the fore-part of the laſt foramen, we obſerve part of the jugular foſſa, in which the beginning of the internal jugular vein is lodged. Anterior and ſuperior to this foſſa is the orifice of a foramen, through which paſſes the carotid artery. This foramen runs firſt upwards and then forwards, forming a kind of elbow, and terminates at the end of the os petroſum. At this part of each temporal bone, we may obſerve the opening of the Euſtachian tube, a canal which paſſes from the ear to the back part of the noſe.

In examining the internal ſurface of theſe bones, we may remark the triangular figure of their petrous part which ſeparates two foſſæ; one ſuperior and anterior; the other inferior and poſterior; the latter of theſe compoſes part of the foſſa in which the cerebellum is placed; and the former, a portion of the leaſt foſſa for the baſis of the brain. On the poſterior ſide of the pars petroſa we obſerve the meatus auditorius internus, into which enters the double nerve of the ſeventh pair. On the under ſide of this proceſs, part of the hole appears, which is common to the temporal and occipital bones; through it the lateral ſinus, the eighth pair, and acceſſory nerves, paſs out of the head.

The *pars petroſa* contains ſeveral little bones, called the bones of the ear; which, as they do not enter into the formation of the cranium, ſhall be deſcribed when we are treating of the organs of hearing.

The *oſſa temporum* are joined to the *oſſa malarum* by the zygomatic futures: to the parietal bones, by the ſquamous futures; to the os occipitis, by the lambdoidal future; and to the ſphenoid bone, by the future of that name. This bone, from its ſituation amidſt the other bones of the head, has been ſometimes called *cuneiforme*. It is of a very irregular figure, and has been compared to a bat with its wings extended. It is commonly divided into its middle part or body, and its ſides or wings.

The fore-part of the body has a ſpine or ridge, which makes part of the ſeptum narium. The upper part of each wing forms a ſhare of the temple. The fore-part of this belongs to the orbit; while the under and back part, termed *ſpinous proceſs*, is lodged in the baſe of the ſkull at the point of the pars petroſa. But two of the moſt remarkable proceſſes are the pterygoid or alliform, one on each ſide of the body of the bone, and at no

(a) The lambdoidal future ſometimes very irregular, being compoſed of many ſmall futures, which ſurround ſo many little bones called *oſſa triquetra* though perhaps improperly, as they are not always triangular.

great diſtance from it. Each of theſe proceſſes is divided into two wings, and of theſe the exterior one is the wideſt. The other terminates in a hook-like proceſs. The internal ſurface of this bone affords three foſſæ. Two of theſe are formed by the wings of the bone, and make part of the leſſer foſſæ of the baſis of the cranium. The third, which is ſmaller, is on the top of the body of the bone and is called *ſella turcica*, from its reſemblance to a Turkiſh ſaddle. This foſſa, in which the pituitary gland is placed, has poſteriorly and anteriorly proceſſes called the *clinoid proceſſes*. There are twelve holes in this bone, viz. ſix on each ſide. The firſt is the paſſage of the optic nerve and ocular artery; the ſecond, or large ſlit, tranſmits the third, fourth, ſixth, and firſt part of the fifth pair of nerves with the ocular vein; the third hole gives paſſage to the ſecond branch of the fifth pair, and the fourth hole to the third branch of the fifth pair of nerves. The fifth hole is the paſſage of the artery of the dura mater. The ſixth hole is ſituated above the pterygoid proceſs of the ſphenoid bone: through it a reflected branch of the ſecond part of the fifth pair paſſes.

Within the ſubſtance of the os ſphenoides there are two ſinuſes ſeparated by a bony plate. They are lined with the pituitary membrane; and, like the frontal ſinuſes, ſeparate a mucus which paſſes into the noſtrils.

The *os ſphenoides* is joined to all the bones of the cranium; and likewiſe to the oſſa maxillaria, oſſa malarum, oſſa palati, and vomer. This bone makes part of the baſis of the ſkull, aſſiſts in forming the orbits, and affords attachment to ſeveral muſcles.

The *os ethmoides* is ſituated at the fore-part of the baſis of the cranium, and is of a very irregular figure. From the great number of holes with which it is pierced, it is ſometimes called *os cribriforme*, or ſieve-like bone. It conſiſts of a middle part and two ſides. The middle part is formed of a thin bony plate, in which are an infinite number of holes, that afford a paſſage to filaments of the olfactory nerve. From the middle of this plate, both on the outſide and from within, there riſes up a proceſs, which may be eaſily diſtinguiſhed. The inner one is called *criſta galli*, from its ſuppoſed reſemblance to a cock's comb. To this proceſs the falx of the dura mater is attached. The exterior proceſs, which has the ſame common baſis as the criſta galli, is a fine lamella, which is united to the vomer, and divides the cavity of the noſtrils, though unequally, it being generally a little inclined to one ſide. The lateral parts of this bone are compoſed of a cellular ſubſtance; and theſe cells are ſo very intricate, that their figure or number cannot be deſcribed. Many writers have on this account called this part of the bone the *labyrinth*. Theſe cells are externally covered with a very thin bony lamella. This part of the bone is called the *os planum*, and forms part of the orbit. The different cells of this bone, which are numerous, and which are every where lined with the pituitary membrane, evidently ſerve to enlarge the cavity of the noſe, in which the organ of ſmelling reſides. This bone is joined to the os ſphenoides, os frontis, oſſa maxillaria, oſſa palati, oſſa naſi, oſſa unguis, and vomer.

The ancients, who conſidered the brain as the ſeat of all the humours, imagined that this viſcus diſcharged its redundant moiſture through the holes of the ethmoid bone. And the vulgar ſtill think, that abſceſſes of the brain diſcharge themſelves through the mouth and ears, and that ſnuff is liable to get into the head; but neither ſnuff nor the matter of an abſceſs are more capable of paſſing through the cribriform bone, than the ſerolity which they ſuppoſed was diſcharged through it in a common cold. All the holes of the ethmoid bone are filled up with the branches of the olfactory nerve. Its inner part is likewiſe covered with the dura mater, and its cells are every where lined with the pituitary membrane; ſo that neither matter, nor any other fluid, can poſſible paſs through this bone, either externally or internally. Matter is indeed ſometimes diſcharged through the noſtrils; but the ſeat of the diſeaſe is in the ſinuſes of the noſe, and not in the brain; and impoſthumations are obſerved to take place in the ear, which ſuppurate and diſcharge themſelves externally.

Before we leave the bones of the head, we wiſh to make ſome general obſervations on its ſtructure and figure. As the cranium might have been compoſed of a ſingle bone, and articulation of its ſeveral bones being abſolutely without motion, it may be aſked, perhaps, Why ſuch a multiplicity of bones, and ſo great a number of futures? Many advantages may poſſibly ariſe from this plurality of bones and futures, which may not yet have been obſerved. We are able, however, to point out many uſeful ends, which could only be accompliſhed by this peculiarity of ſtructure. In this, as in all other works of nature, the great wiſdom of the Creator is evinced, and cannot fail to excite our admiration and gratitude.

The cranium, by being divided into ſeveral bones, grows much faſter, and with greater facility, than if it was compoſed of one piece only. In the fœtus, the bones, as we have before obſerved, are perfectly diſtinct from each other. The oſſification begins in the middle of each bone, and proceeds gradually to the circumference. Hence the oſſification, and of courſe the increaſe of the head, is carried on from an infinite number of points at the ſame time, and the bones conſequently approach each other in the ſame proportion. To illuſtrate this doctrine more clearly, if it can want further illuſtration, ſuppoſe it neceſſary for the parietal bones, which compoſe the upper part of the head, to extend their oſſification, and form the fore part of the head likewiſe; is it not evident, that this proceſs would be much more tedious than it is now, when the os frontis and the parietal bones are both growing at the ſame time? Hence it happens, that the heads of young people, in which the bones begin to touch each other, increaſe ſlowly; and that the proportionate increaſe of the volume of the head is greater in three months in the fœtus, than it is perhaps in twenty-four months at the age of fourteen or fifteen years.

The futures, excluſive of their advantages in ſuſpending the proceſſes of the dura mater, are evidently of great utility in preventing the too great extent of fractures of the ſkull. Suppoſe, for inſtance, that by a fall or blow, one of the bones of the cranium becomes fractured, the fiſſure, which in a head compoſed of only one bone, would be liable to extend itſelf through the whole of it, is checked, and ſometimes perhaps ſtopped, by the firſt future it meets, and the effects of the injury are confined to the bone on which the blow was received. Ruyſch indeed, and ſome others, will not allow the futures to be of any ſuch uſe; but caſes have been met with where they ſeemed to have had this effect, and in young ſubjects their utility in this reſpect muſt be ſtill more obvious.

The ſpherical ſhape of the head ſeems likewiſe to render it more capable of reſiſting external violence than any other ſhape would do. In a vault, the parts mutually ſupport and ſtrengthen each other, and this happens in the cranium.

Art. 2. *Proper Bones of the Face.*

The face, which conſiſts of a great number of bones, is commonly divided into the upper and lower jaws. The upper jaw conſiſts of thirteen bones, excluſive of the teeth. Of theſe, ſix are placed on each ſide of the maxilla ſuperior, and one in the middle. The bones, which are in pairs, are the oſſa malarum, oſſa maxillaria, oſſa naſi, oſſa unguis, oſſa palati, and oſſa ſpongioſa inferiora. The ſingle bone is the vomer. Theſe are the prominent ſquare bones which are placed under the eyes, forming part of the orbits and the upper part of the cheeks. Each of them affords three ſurfaces; one exterior, and a little convex; a ſecond ſuperior, and concave, forming the inferior part and ſides of the orbit; and a third poſterior, irregular, and hollowed for the lodgment of the lower part of the temporal muſcle.

The angles of each bone form four proceſſes, two of which may be called *orbitar proceſſes*; of theſe the upper one is joined by future to the os frontis, and that below to the maxillary bone. The third is connected with the os ſphenoides by means of the tranſverſe future; and the fourth is joined to the zygomatic proceſs of the temporal bone, with which it forms the zygoma. Theſe bones, which are of a very irregular figure, are ſo called becauſe they form the moſt conſiderable portion of the upper jaw. They are two in number, and generally remain diſtinct through life. Of the many proceſſes which are to be ſeen on theſe bones, and which are connected with the bones of the face and ſkull, we ſhall deſcribe only the moſt remarkable.

One of theſe proceſſes is at the upper and fore part of the bone, making part of the ſide of the noſe, and called the *naſal proceſs*. Another forms a kind of circular ſweep at the inferior part of the bone, in which are the alveoli or ſockets for the teeth: this is called the *alveolar proceſs*. A third proceſs is united to the os malæ on each ſide. Between this and the naſal proceſs there is a thin plate, which forms a ſhare of the orbit, and lies over a paſſage for the ſuperior maxillary veſſels and nerves. The alveolar proceſs has poſteriorly a conſiderable tuberoſity on its internal ſurface, called the *maxillary tuberoſity*.

Behind the alveolar proceſs we obſerve two horizontal lamellæ, which uniting together, form part of the roof of the mouth, and divide it from the noſe. The hollowneſs of the roof of the mouth is owing to this partition's being ſeated ſome what higher than the alveolar proceſs. At the fore part of the horizontal lamellæ there is a hole called *foramen incifivum*, through which ſmall blood-veſſels and nerves go between the mouth and noſe. In viewing theſe bones internally, we obſerve a foſſa in the inferior portion of the naſal proceſs, which, with the os unguis and os ſpongioſum inferius, forms a paſſage for the lachrymal duct. Where theſe two bones are united to each other, they project ſomewhat upwards and forwards, leaving between them a furrow, into which the lower portion of the ſeptum naſi is admitted. Each of theſe bones being hollow, a conſiderable ſinus is formed under its orbitar part. This cavity, which is uſually named after Highmore, though it was deſcribed by Fallopius, and others before his time, is lined with the pituitary membrane. It is intended for the ſame purpoſes as the other ſinuſes of the noſe, and opens into the noſtrils.

The

The *ossa maxillaria* are connected with the greater part of the bones of the face and cranium, and assist in forming not only the cheeks, but likewise the palate, nose, and orbits.

The *ossa nasi* form two irregular squares. They are thicker and narrower above than below. Externally they are somewhat convex, and internally slightly concave. These bones constitute the upper part of the nose. At their fore part they are united to each other, above to the os frontis, by their sides to the ossa maxillaria superiora, posteriorly and interiorly to the septum narium, and below to the cartilages that compose the rest of the nostrils. These little transparent bones owe their name to their supposed resemblance to a finger-nail. Sometimes they are called *ossa lachrymalia*, from their concurring with the nasal process of each maxillary bone in forming a lodgement for the lachrymal sac and duct.

The *ossa unguis* are of an irregular figure. Their external surface consists of two smooth parts, divided by a middle ridge. One of these parts, which is concave and nearest to the nose, serves to support the lachrymal sac and part of the lachrymal duct. The other, which is flat, forms a small part of the orbit. Each of these bones is connected with the os frontis, os ethmoides, and os maxillare superius.

The *ossa palati* are situated at the back part of the roof of the mouth, between the os sphenoides and the ossa maxillaria superiora, are of an irregular shape, and serve to form the nasal and maxillary fossa, and a small portion of the orbit. Where they are united to each other, they rise up into a spine on their internal surface. This spine appears to be a continuation of that of the superior maxillary bones, and helps to form the septum narium. These bones are joined to the ossa maxillaria superiora, os ethmoides, os sphenoides, and vomer.

The *vomer* derives its name from its resemblance to a ploughshare. It is a long and flat bone, somewhat thicker at its back than at its fore part. At its upper part we observe a furrow extending through its whole length. The posterior and largest part of this furrow receives a process of the sphenoid bone. From this the furrow advances forwards, and becoming narrower and shallower, receives some part of the nasal lamella ethmoidea; the rest serves to support the middle cartilage of the nose. The inferior portion of this bone is placed on the nasal spine of the maxillary and palate bones, which we mentioned in our description of the ossa palati. The vomer is united to the os sphenoides, os ethmoides, ossa maxillaria superiora, and ossa palati. It forms part of the septum narium, by dividing the back part of the nose into two nostrils.

The *ossa spongiosa inferiora* seem not to deserve to be distinguished as distinct bones, except in young subjects. They consist of a spongy lamella in each nostril, which is united to the spongy lamina of the ethmoid bone, of which they are by some considered as a part. Each of these lamellæ is longest from behind forward; with its convex surface turned towards the septum narium, and its concave part towards the maxillary bone, covering the opening of the lachrymal duct into the nose. These bones are covered with the pituitary membrane; and, besides their connection with the ethmoid bone, are joined to the ossa maxillary superiora, ossa palati, and ossa unguis.

The *maxilla inferior*, or lower jaw, which in its shape resembles a horse-shoe, consists of two distinct bones in the fœtus: but these unite together soon after birth, so as to form only one bone. The upper edge of this bone, like the os maxillare superius, has an alveolar process, furnished with sockets for the teeth. On each side, the posterior part of the bone rises almost perpendicularly into two processes. The highest of these, called the coronoid process, is pointed and thin, and serves for the insertion of the temporal muscle. The other, or condyloid process, as it is called, is shorter and thicker, and ends in an oblong rounded head, which is received into a fossa of the temporal bone, and is formed for a moveable articulation with the cranium. This joint is furnished with a moveable cartilage. At the bottom of each coronoid process, on its inner part, we observe a foramen extending under the roots of all the teeth, and terminating at the outer surface of the bone near the chin. Each of these canals transmits an artery, vein, and nerve, from which branches are sent off to the teeth.

The lower jaw is capable of a great variety of motion. By sliding the condyles from the cavity towards the eminences on each side, we bring it horizontally forwards, as in biting; or we may bring the condyles only forward, and tilt the rest of the jaw backward, as in opening the mouth. We are likewise able to slide the condyles alternately backwards and forwards from the cavity to the eminence, and *vice versa*, as in grinding the teeth. The cartilages, by adapting themselves to the different inequalities in these several motions of the jaw, serve to secure the articulation, and to prevent any injuries from friction.

The alveolar processes are composed of an outer and inner bony plate, united together by thin partitions, which at the fore part of the jaw divide the processes into as many sockets as there are teeth. But at the back part of the jaw, where the teeth have more than one root, we find a distinct cell for each root. In both jaws these processes begin to be formed with the teeth; they likewise accompany them in their growth, and gradually disappear when the teeth are removed.

Art. 3. *Of the Teeth.*

The teeth are bones of a particular structure, formed for the purposes of mastication and the articulation of the voice. It will be necessary to consider their composition and figure, their number and arrangement, and the time and order in which they appear. In each tooth we may distinguish a body, a neck, and a root or fangs. The body of the tooth is that part which appears above the gums. The root is fixed into the socket, and the neck is the middle part between the two. The teeth are composed of two substances, viz. enamel and bone. The enamel, or the vitreous or cortical part of the tooth, is a white and very hard and compact substance peculiar to the teeth, and appears fibrous or striated when broken. This substance is thickest on the grinding surface, and becoming gradually thinner, terminates insensibly at the neck of the tooth. Ruysch affirmed, that he could trace the arteries into the hardest part of the teeth; Liewenhoeck suspected the fibres of the enamel to be so many vessels; and Monro says, he has frequently injected the vessels of the teeth in children, so as to make the inside of the cortex appear perfectly red. But it is certain, that it is not tinged by a madder diet, and that no injection will ever reach it, so that it has no appearance of being vascular. The bony part, which composes the inner substance of the body, neck, and root of the tooth, resembles other bones in its structure, but it is much harder than the most compact part of bones in general. As a tooth when once formed receives no tinge from a madder diet, and as the minutest injections do not penetrate into its substance, this part of a tooth has, like the enamel, been supposed not to be vascular. But when we consider that the fangs of a tooth are invested by a periosteum, and that the swellings of these fangs are analogous to the swellings of other bones, we may reasonably conclude, that there is a similarity of structure; and that this bony part has a circulation through its substance, although from its hardness we are unable to demonstrate its vessels.

In each tooth we find an inner cavity, into which enter an artery, vein, and nerve. This cavity begins by a small opening, and becoming larger, terminates in the body of the tooth. In advanced life this hole sometimes closes, and the tooth is of course rendered insensible.

The periosteum surrounds the teeth from their fangs to a little beyond their bony sockets, where we find it adhering to the gums. This membrane, while it incloses the teeth, serves at the same time to line the sockets, so that it may be considered as common to both. The teeth are likewise secured in their sockets by means of the gums; a red, vascular, firm, and elastic substance, that possesses but little sensibility. In the gums of infants we find a hard ridge extending through their whole length, but no such ridge is to be seen in old people who have lost their teeth. The number of the teeth in both jaws at full maturity, usually varies from twenty-eight to thirty-two. They are commonly divided into three classes, viz. incisores, canini, and grinders or molares (H). The incisores are the four teeth in the fore part of each jaw. They have each of them two surfaces; one anterior and convex, the other posterior and slightly concave, both of which terminate in a sharp edge. They are called *incisores* from their use in dividing the food. They are usually broader and thicker in the upper than in the under jaw; and, by being placed somewhat obliquely, generally fall over the latter.

The *canini* derive their name from their resemblance to a dog's tusks, being the longest of all the teeth. We find one on each side of the incisores, so that there are two canini in each jaw. Their fang resembles that of the incisores, but is much larger; and in their shape they appear like an incisore with its edge worn off, so as to terminate in a narrow point. These teeth not being calculated for cutting and dividing the food like the incisores, or for grinding it like the molares, seem to be intended for laying hold of substances (I).

The *molares* or grinders, of which there are ten in each jaw, are so called, because from their shape and size they are fitted for grinding the food. Each of the incisores and canini is furnished only with one fang; but in the molares of the under jaw we constantly find two fangs, and in those of the upper jaw three fangs. These fangs are sometimes separated into two points, and each of these points has sometimes been described as a distinct fang. The two first of the molares, or those nearest to the canine teeth on each side, differ from the

(H) Mr. Hunter has thought proper to vary this division. He retains the old name of *incisores* to the four fore teeth, but he distinguishes the canine teeth by the name of the *cuspidati*. The two teeth which are next to these, and which have been usually ranked with the molares, he calls the *bicuspides*; and he gives the name of *grinders* only to the three last teeth on each side.

(I) Mr. Hunter remarks of these teeth, that we may trace in them a similarity in shape, situation, and use, from the most imperfectly carnivorous animal, which we believe to be the human species, to the lion, which is the most perfectly carnivorous.

other three, and are with great propriety named *bicuſpides* by Mr. Hunter. They have ſometimes only one root, and ſeem to be of a middle nature between the inciſores and the larger molares. The two next are much larger. The fifth or laſt grinder on each ſide is ſmaller and ſhorter than the reſt; and from its not cutting the gum till after the age of twenty, and ſometimes not till much later in life, is called *dens ſapientiæ*.

There is in the ſtructure and arrangement of all theſe teeth an art which cannot be ſufficiently admired. To underſtand it properly, it will be neceſſary to conſider the under jaw as a kind of lever, with its fixed points at its articulations with the temporal bones:—it will be right to obſerve, too, that its powers ariſe from its different muſcles, but in elevation chiefly from the temporalis and maſſeter; and that the aliment conſtitutes the object of reſiſtance. It will appear, then, that the molares, by being placed neareſt the centre of motion, are calculated to preſs with a much greater force than the other teeth, independent of their grinding powers which they poſſeſs by means of the pterygoid muſcles; and that it is for this reaſon we put between them any hard body we wiſh to break. The canini and inciſures are placed farther from this point, and of courſe cannot exert ſo much force; but they are made for cutting and tearing the food, and this form ſeems to make amends for their deficiency in ſtrength.

There are examples of children who have come into the world with two, three, and even four teeth: but theſe examples are very rare; and it is ſeldom before the ſeventh, eighth or ninth month after birth, that the inciſores, which are the firſt formed, begin to paſs through the gum. The ſymptoms of dentition, however, in conſequence of irritation from the teeth, frequently take place in the fourth or fifth month.—About the twentieth or twenty-fourth month, the canini and two molares make their appearance.

The dangerous ſymptoms that ſometimes accompany dentition, are owing to the preſſure of the teeth on the gum, which they irritate ſo as to excite pain and inflammation. This irritation ſeems to occaſion a gradual waſting of the gum at the part, till at length the tooth makes its appearance. The ſymptoms are more or leſs alarming, in proportion to the reſiſtance which the gum affords to the teeth, and according to the number of teeth which may chance to ſeek a paſſage at the ſame time. Were they all to appear at once, children would fall victims to the pain and exceſſive irritation; but Nature has ſo very wiſely diſpoſed them, that they uſually appear one after the other, with ſome diſtance of time between each. The firſt inciſor that appears is generally in the lower jaw, and is followed by one in the upper jaw. Sometimes the canini, but more commonly one of the molares, begins to paſs through the gum firſt. Theſe 20 teeth, viz. 8 inciſores, 4 canini, and 8 molares, are called *temporary* or *milk teeth*, becauſe they are all ſhed between the age of 7 and 14, and are ſucceeded by what are called the *permanent* or *adult teeth*. The latter are of a firmer texture, and have larger fangs. Theſe adult teeth being placed in a diſtinct ſet of alveoli, the upper ſockets gradually diſappear, as the under ones increaſe in ſize, till at length the temporary, or upper teeth, having no longer any ſupport, conſequently fall out. To theſe 20 teeth which ſucceed the temporary ones, 12 others are afterwards added, viz. 3 molares on each ſide in both jaws: and in order to make room for this addition, we find that the jaws gradually lengthen in proportion to the growth of the teeth; ſo that with 20 teeth, they ſeem to be as completely filled as they are afterwards with 32. This is the reaſon why the face is rounder and flatter in children than in adults.

With regard to the formation of the teeth, we may obſerve, that in a fœtus of four months, the alveolar proceſs appears only as a ſhallow longitudinal groove, divided by minute ridges into a number of intermediate depreſſions; in each of which we find a ſmall pulpy ſubſtance, ſurrounded by a vaſcular membrane. This pulp gradually oſſifies, and its lower part is lengthened out to form the fang. When the bony part of the tooth is formed, its ſurface begins to be incruſted with the enamel. How the latter is formed and depoſited, we are not yet able to determine. The rudiments of ſome of the adult teeth begin to be formed at a very early period, for the pulp of one of the inciſores may generally be perceived in a fœtus of eight months, and the oſſification begins in it ſoon after birth. The firſt bicuſpis begins to oſſify about the fifth or ſixth, and the ſecond about the ſeventh year. The firſt adult grinder cuts the gum about the 12th, the ſecond about the 18th, and the third, or *dens ſapientiæ*, uſually between the 20th and 30th year.

The teeth, like other bones, are liable to be affected by diſeaſe. Their removal is likewiſe the natural conſequence of old age; for as we advance in life, the alveoli fill up, and the teeth, eſpecially the inciſores, fall out. When this happens, the chin projects forward, and the face is much ſhortened.

Art. 4. *Of the Os Hyoides* (κ).

The *os hyoides*, which is placed at the root of the tongue, was ſo called by the ancients on account of its ſuppoſed reſemblance to the Greek letter υ. It will be neceſſary to diſtinguiſh in it, its body, horns, and appendices. The body, which is the middle and broadeſt part of the bone, is ſo placed that it may be eaſily felt at the fore part of the throat. Anteriorly it is irregularly convex, and its inner ſurface is unequally concave. Its cornua, or horns, which are flat and a little bent, being much longer than the body part, may be deſcribed as forming the ſides of the υ. The appendices, or little horns, as they are called by M. Winſlow, and ſome other writers, are two proceſſes which riſe up from the articulations of the cornua with the body, and are uſually connected with the ſtyloid proceſs on each ſide by means of a ligament. The uſes of this bone are to ſupport the tongue, and afford attachment to a great number of muſcles; ſome of which perform the motions of the tongue, while others act on the larynx and fauces.

SECT. III. OF THE BONES OF THE TRUNK.

The trunk of the ſkeleton conſiſts of the ſpine, the thorax, and the pelvis.

Art. 1. *Of the Spine.*

The ſpine is compoſed of a great number of bones called *vertebræ*, forming a long bony column, in figure not much unlike the letter *ſ*. This column, which extends from the head to the lower part of the body, may be ſaid to conſiſt of two irregular and unequal pyramids, united to each other in that part of the loins where the laſt lumbar vertebra joins the os ſacrum. The vertebræ of the upper and longeſt pyramid are called *true vertebræ*, in contradiſtinction to thoſe of the lowermoſt pyramid, which, from their being immoveable in the adult, are ſtyled *falſe vertebræ*. It is upon the bones of the ſpine that the body turns; and it is to this circumſtance they owe their name, which is derived from the Latin verb *vertere*, to turn.

The true vertebræ are divided into three claſſes of *cervical*, *dorſal*, and *lumbar vertebræ*.—The falſe vertebræ conſiſt of the *os ſacrum* and *os coccygis*. In each vertebra, as in other bones, it will be neceſſary to remark the body of the bone, its proceſſes, and cavities. The body, which is convex before, and concave behind, where it aſſiſts in forming the cavity of the ſpine, may be compared to part of a cylinder cut off tranſverſely.

Each vertebra affords ſeven proceſſes. The firſt is at the back part of the vertebra, and from its ſhape and direction is named the *ſpinous proceſs*. On each ſide of this are two others, which from their ſituation with reſpect to the ſpine, are called *tranſverſe proceſſes*. The four others are ſtyled *oblique* or *articular proceſſes*. They are much ſmaller than the ſpinous or tranſverſe ones. Two of them are placed on the upper, and two on the lower part of each vertebra, riſing from near the baſis of each tranſverſe proceſs. They have gotten the name of *oblique proceſſes*, from their ſituation with reſpect to the proceſſes with which they are articulated; and they are ſometimes ſtyled *articular proceſſes*, from the manner in which they are articulated with each other; the two ſuperior proceſſes of one vertebra being articulated with the two inferior proceſſes of the vertebra above it. Each of theſe proceſſes is covered with a cartilage at its articulation, and their articulations with each other are by a ſpecies of ginglimus.

In each vertebra, between its body and its proceſſes, we find a hole large enough to admit a finger. Theſe holes or foramina, correſpond with each other through all the vertebræ, and form the long bony channel in which the ſpinal marrow is placed. We may likewiſe obſerve four notches in each vertebra. Two of theſe notches are at the upper, and two at the lower part of the bone, between the oblique proceſſes and the body of the vertebra. Each of theſe notches meeting with a ſimilar opening in the vertebra above or below it, forms a foramen for the paſſage of blood-veſſels, and of the nerves out of the ſpine.

The bones of the ſpine are united together by means of a ſubſtance, which in young ſubjects appears to be of a ligamentous, but in adults more of a cartilaginous nature. This intervertebral ſubſtance, which forms a kind of partition between the ſeveral vertebræ, is thicker and more flexible between the lumbar vertebræ than in the other parts of the ſpine, the moſt conſiderable motions of the trunk being performed on thoſe vertebræ. This ſubſtance being very elaſtic, the extenſion and flection of the body, and its motion backwards and forwards, or to either ſide, are performed with great facility. This elaſticity ſeems to be the reaſon why people who have been long ſtanding, or have carried a conſiderable weight, are found to be ſhorter than when they have been long in bed. In the two firſt inſtances the intervertebral cartilages (as they are uſually called) are evidently more expoſed to compreſſion than when we are in bed in an horizontal poſture. In advanced life theſe cartilages become ſhrivelled, and of courſe loſe much of their elaſticity. This may ſerve to account for the decreaſe in ſtature and the ſtooping forward which are uſually to be obſerved in old people.

(κ) This bone is very ſeldom preſerved with the ſkeleton, and cannot be included amongſt the bones of the head or in any other diviſion of the ſkeleton. Thomas Bartholin has perhaps very properly deſcribed it among the parts contained in the mouth; but the generality of anatomical writers have placed it, as it is here, after the bones of the face.

Beſides

Beſides the connection of the ſeveral vertebræ by means of this intervertebral ſubſtance, there are likewiſe many ſtrong ligaments, both external and internal, which unite the bones of the ſpine to each other. Their union is alſo ſtrengthened by a variety of ſtrong muſcles that cover and ſurround the ſpine. The bones of the ſpine are found to diminiſh in denſity, and to be leſs firm in their texture in proportion as they increaſe in bulk; ſo that the lowermoſt vertebræ, though the largeſt, are not ſo heavy in proportion as the upper ones. By this means the ſize of theſe bones is increaſed without adding to their weight, a circumſtance of no little importance in a part like the ſpine, which, beſides flexibility and ſuppleneſs, ſeems to require lightneſs as one of its eſſential properties. In very young children, each vertebræ conſiſts of three bony pieces united by cartilages which afterwards oſſify.

There are ſeven *vertebræ* of the *neck*—they are of a firmer texture than the other bones of the ſpine. Their tranſverſe proceſſes are forked for the lodgement of muſcles, and at the bottom of each we obſerve a foramen, through which paſs the cervical artery and vein. The firſt and ſecond of theſe vertebræ muſt be deſcribed more particularly. The firſt approaches almoſt to an oval ſhape—On its ſuperior ſurface it has two cavities which admit the condyles of the occipital bone with which it is articulated. This vertebræ, which is called *atlas* from its ſupporting the head, cannot well be deſcribed as having either body or ſpinous proceſs, being a kind of bony ring. Anteriorly, where it is articulated to the odontoid proceſs of the ſecond vertebra, it is very thin. On its upper ſurface it has two cavities which admit the condyles of the occipital bone. By this connection the head is allowed to move forwards and backwards, but has very little motion in any other direction. The ſecond vertebra has gotten the name of *dentata*, from its having, at its upper and anterior part, a proceſs called the *odontoid* or *tooth-like proceſs*, which is articulated with the atlas, to which this ſecond vertebra may be ſaid to ſerve as an axis. This odontoid proceſs is of a cylindrical ſhape, ſomewhat flattened, however, anteriorly and poſteriorly. At its fore part where it is received by the atlas, we may obſerve a ſmooth, convex, articulating ſurface. It is by means of this articulation that the head performs its rotatory motion, the atlas in that caſe moving upon this odontoid proceſs as upon a pivot. But when this motion is in any conſiderable degree, or, in other words, when the head moves much either to the right or left, all the cervical vertebræ ſeem to aſſiſt, otherwiſe the ſpinal marrow would be in danger of being divided tranſverſely by the firſt vertebra.

The ſpinous proceſs of each of the cervical vertebræ is ſhorter and their articular proceſſes more oblique, than in the other bones of the ſpine. Theſe 12 vertebræ are of a middle ſize between thoſe of the neck and loins. At their ſides we may obſerve two depreſſions, one at the upper and the other at the lower part of the body of each vertebra; which uniting with ſimilar depreſſions in the vertebræ above and below, form articulating ſurfaces, covered with cartilages, for receiving the heads of the ribs; and at the fore part of their tranſverſe proceſs (excepting the two laſt) we find an articulating ſurface for receiving the tuberoſity of the ribs.

The *lumbar vertebræ* differ only from thoſe of the back in their being larger, and in having their ſpinous proceſſes at a greater diſtance from each other. The moſt conſiderable motions of the trunk are made on theſe vertebræ: and theſe motions could not be performed with ſo much eaſe, were the proceſſes placed nearer to each other.

The *os ſacrum*, which is compoſed of five or ſix pieces in young ſubjects, becomes one bone in more advanced age. It is nearly of a triangular figure, its inferior portion being bent a little forwards. Its ſuperior part has two oblique proceſſes which are articulated with the laſt of the lumbar vertebræ; and it has likewiſe commonly three ſmall ſpinous proceſſes, which gradually become ſhorter, ſo that the lowermoſt is not ſo long as the ſecond, nor the ſecond as the uppermoſt. Its tranſverſe proceſſes are formed into one oblong proceſs, which becomes gradually ſmaller as it deſcends. Its concave or anterior ſide is uſually ſmooth, but its poſterior convex ſide has many prominences (the moſt remarkable of which are the ſpinous proceſſes juſt now mentioned), which are filled up and covered with the muſcular and tendinous parts behind.

This bone has five pair of holes, which afford a paſſage to blood-veſſels, and likewiſe to the nerves that are derived from the ſpinal marrow, which is continued even here, being lodged in a triangular cavity, that becomes ſmaller as it deſcends, and at length terminates obliquely at the lower part of this bone. Below the third diviſion of the os ſacrum, this canal is not completely bony as in the reſt of the ſpine, being ſecured at its back part only by a very ſtrong membrane, ſo that a wound at this part muſt be extremely dangerous. The os ſacrum is united laterally to the oſſa innominata or hip-bones, and below to the coccyx.

The *os coccyx*, which, like the os ſacrum, is in young people made up of three or four diſtinct parts, uſually becomes one bone in the adult ſtate. It ſerves to ſupport the inteſtinum rectum; and, by its being capable of ſome degree of motion at its articulation with the ſacrum, and being like that bone bent forwards, we are enabled to ſit with eaſe. This bone is nearly of a triangular ſhape, being broadeſt at its upper part, and from thence growing narrower to its apex, where it is not bigger than the little finger. It has got its name from its ſuppoſed reſemblance to a cuckow's beak. It differs greatly from the vertebræ, being commonly without any proceſſes, and having no cavity for the ſpinal marrow, or foramina for the tranſmiſſion of nerves.

The ſpine of which we have now finiſhed the anatomical deſcription, is deſtined for many great and important uſes. The medulla ſpinalis is lodged in its bony canal ſecure from external injury. It ſerves as a defence to the abdominal and thoracic viſcera, and at the ſame time ſupports the head, and gives a general firmneſs to the whole trunk. We have before compared it to the letter *ſ*, and its different turns will be found to render it not very unlike the figure of that letter.—In the neck we ſee it projecting ſomewhat forward to ſupport the head, which without this aſſiſtance would require a greater number of muſcles—Lower down, in the thorax, we find it taking a curved direction backwards, and of courſe increaſing the cavity of the cheſt. After this, in the loins, it again projects forwards in a direction with the centre of gravity, by which means we are eaſily enabled to keep the body in an erect poſture, for otherwiſe we ſhould be liable to fall forward. Towards its inferior extremity, however, it again recedes backward, and thus aſſiſts in forming the pelvis, the name given to the cavity in which the urinary bladder, inteſtinum rectum, and other viſcera are placed. If this bony column had been formed only of one piece, it would have been much more eaſily fractured than it is now; and by confining the trunk to a ſtiff ſituation, a variety of motions would have been altogether prevented, which are now performed with eaſe by the great number of bones of which it is compoſed. It is firm, and yet to this firmneſs there is added a perfect flexibility. If it be required to carry a load upon the head, the neck becomes ſtiff with the aſſiſtance of its muſcles, and accommodates itſelf to the load, as if it was compoſed only of one bone—In ſtooping likewiſe, or in turning to either ſide, the ſpine turns itſelf in every direction, as if all its bones were ſeparated from each other.

In a part of the body, like the ſpine, that is made up of ſo great a number of bones, and intended for ſuch a variety of motion, there muſt be a greater danger of diſlocation than fracture; but we ſhall find, that this is very wiſely guarded againſt in every direction by the proceſſes belonging to each vertebra, and by the ligaments, cartilages, &c. by which theſe bones are connected with each other.

Art. 2. *Of the Bones of the Thorax.*

The *thorax*, or cheſt, is compoſed of many bones, *viz.* the ſternum which is placed at its anterior part, twelve ribs on each ſide which make up its lateral parts, and the dorſal vertebræ which conſtitute its poſterior part. Theſe laſt have been already deſcribed.

The *ſternum* is the long bone which extends itſelf from the upper to the lower part of the breaſt anteriorly, and to which the ribs and the clavicles are articulated. In children it is compoſed of ſeveral bones united by cartilages; but as we advance in life, moſt of theſe cartilages oſſify, and the ſternum in the adult ſtate is found to conſiſt only of three pieces, and ſometimes becomes one bone. It is however generally deſcribed as being compoſed of three parts—one ſuperior, which is broad, thick, and ſhort: and one in the middle, which is thinner, narrower, and longer than the other. It terminates at its lower part by a third piece, which is called the *xyphoid* or *ſword-like cartilage*, from its ſuppoſed reſemblance to the blade of a ſword, and becauſe in young ſubjects it is commonly in a cartilaginous ſtate. We have already obſerved, that this bone is articulated with the clavicle on each ſide. It is likewiſe joined to the fourteen true ribs, *viz.* ſeven on its right and ſeven on its left ſide.

The ribs are bones ſhaped like a bow, forming the ſides of the cheſt. There are twelve on each ſide. They are diſtinguiſhed into true and falſe ribs: The ſeven upper ribs which are articulated to the ſternum are called *true ribs*, and the five lower ones that are not immediately attached to that bone are called *falſe ribs*. On the inferior and interior ſurface of each rib, we obſerve a ſinuoſity for the lodgement of an artery, vein, and nerve. The ribs are not bony through their whole length, their anterior part being cartilaginous. They are articulated with the vertebræ and ſternum. Every rib (or at leaſt the greater number of them) has at its poſterior part two proceſſes; one at its extremity called the head of the rib, by means of which it is articulated with the body of two vertebræ; and another, called its tuberoſity, by which it is articulated with the tranſverſe proceſs of the loweſt of theſe two vertebræ. The firſt rib is not articulated by its extremity to two vertebræ, being ſimply attached to the upper part of the firſt vertebra of the back. The ſeven ſuperior or true ribs are articulated anteriorly with the ſternum by their cartilages; but the falſe ribs are ſupported in a different manner—the eighth, which is the firſt of theſe ribs being attached by its cartilage to the ſeventh; the ninth to the eighth

eighth, &c. The two lowermoſt ribs differ likewiſe from all the reſt in the following particulars: They are articulated only with the body of a vertebra, and not with a tranſverſe proceſs; and anteriorly, their cartilage is looſe, not being attached to the cartilages of the other ribs; and this ſeems to be, becauſe the moſt conſiderable motions of the trunk are not performed on the lumbar vertebræ alone, but likewiſe on the two laſt vertebræ of the back: ſo that if theſe two ribs had been confined at the fore part like the other ribs, and had been likewiſe articulated with the bodies of two vertebræ, and with the tranſverſe proceſſes, the motion of the two laſt vertebræ, and conſequently of the whole trunk, would have been impeded. The ribs help to form the cavity of the thorax; they afford attachment to different muſcles; they are uſeful in reſpiration; and they ſerve as a ſecurity to the heart and lungs.

Art. 3. *Of the Bones of the Pelvis.*

The *pelvis* is compoſed of the *os ſacrum*, *os coccygis*, and two *oſſa innominata*. The two firſt of theſe bones were included in the account of the ſpine, to which they more properly belong. In children, each os innominatum is compoſed of three diſtinct bones; but as we advance in life the intermediate cartilages gradually oſſify, and the marks of the original ſeparation diſappear, ſo that they become one irregular bone; ſtill however continuing to retain the names of ilium, iſchium, and pubis, by which their diviſions were originally diſtinguiſhed, and to be deſcribed as three different bones by the generality of anatomiſts. The os ilium forms the upper and moſt conſiderable part of the bone, the os iſchium its lower and poſterior portion, and the os pubis its fore part.

The *os ilium* or haunch bone, is articulated poſteriorly to the os ſacrum by a firm cartilaginous ſubſtance, and is united to the os pubis before and to the os iſchium below. Its ſuperior portion is thin, and terminates in a ridge called the criſta or ſpine of the ilium, and more commonly known by the name of the haunch. This criſta riſes up like an arch, being turned ſomewhat outwards, ſo as to reſemble the wings of a phaeton. Externally this bone is unequally prominent and hollowed for the lodgement of muſcles; internally we find it ſmooth and concave. At its lower part there is a conſiderable ridge on its inner ſurface. This ridge extends from the os ſacrum, and correſponds with a ſimilar prominence both on that bone and the iſchium; and forms with the inner part of the oſſa pubis what in midwifery is termed the brim of the pelvis.

The *criſta*, or ſpine, which at firſt is an epiphyſis, has two conſiderable tuberoſities; one anteriorly, and the other poſteriorly, which is the largeſt of the two. Theſe, from their projecting more than the parts of the bone below them, have gotten the name of ſpinal proceſſes. From the anterior ſpinous proceſs, the ſarterious and tenſor vaginæ femoris muſcles have their origin; and below the poſterior proceſs we obſerve a conſiderable niche in the bone, which, in the recent ſubject, is formed into a large foramen, by means of a ſtrong ligament that is ſtretched over its lower part from the os ſacrum to the ſharp-pointed proceſs of the iſchium. This hole affords a paſſage to the great ſciatic nerve, and to the poſterior crural veſſels under the pyriform muſcle, part of which likewiſe paſſes out here.

The *os iſchium*, or hip bone, which is of a very irregular figure conſtitutes the lower lateral parts of the pelvis, and is commonly divided into its body, tuberoſity, and ramus. The body forms the lower and moſt conſiderable portion of the acetabulum, and ſends a ſharp-pointed proceſs backwards, called the ſpine of the iſchium. To this proceſs the ligament adheres, which was juſt now ſpoken of, as forming a foramen for the paſſage of the ſciatic nerve.—The tuberoſity, which is the loweſt part of the trunk, and ſupports us when we ſit, is large and irregular, affording origin to ſeveral muſcles. From this tuberoſity we find the bone becoming thinner and narrower. This part, which has the name of ramus or branch, paſſes forwards and upwards, and concurs with the ramus of the os pubis, to form a large hole called the *foramen magnum iſchii*, or *thyroideum*, as it is ſometimes named from its reſemblance to a door or ſhield. This hole, which in the recent ſubject is cloſed by a ſtrong membrane called the obturator ligament, affords through its whole circumference attachment to muſcles. At its upper part, where we obſerve a niche in the bone, it gives paſſage to the obturator veſſels and nerves, which go to the inner part of the thigh. Nature ſeems every where to avoid an unneceſſary weight of bone, and this foramen, no doubt, ſerves to lighten the bones of the pelvis.

The *os pubis* or ſhare-bone, which with its fellow forms the fore-part of the pelvis is the ſmalleſt diviſion of the os innominatum. It is united to its fellow by means of a ſtrong cartilage, which forms what is called the ſymphiſis pubis. In each os pubis we may diſtinguiſh the body of the bone, its angle, and ramus. The body or outer part is united to the os ilium, the angle comes forwards to form the ſymphyſis, and the ramus is a thin proceſs which unites with the ramus of the iſchium, to form the foramen thyroideum.

The three bones we have deſcribed as compoſing each os innominatum, all aſſiſt in forming the acetabulum, in which the head of the os femoris is received. This cavity is every where lined with a ſmooth cartilage, excepting at its inner part, where we may obſerve a little foſſa, in which are lodged the mucilaginous glands of the joint. We may likewiſe notice the pit or depreſſion made by the round ligament, as it is improperly called, which, by adhering to this cavity and to the head of the thigh-bone, helps to ſecure the latter in the ſocket. Theſe bones, which are united to each other and to the ſpine by many very ſtrong ligaments, ſerve to ſupport the trunk, and to connect it with the lower extremities; and at the ſame time to form the pelvis or baſon, in which are lodged the inteſtines and urinary bladder, and in women the uterus; ſo that the ſtudy of this part of oſteology is of the utmoſt importance in midwifery.

It is worthy of obſervation, that in women the os ſacrum is uſually ſhorter, broader, and more hollowed, the oſſa ilia more expanded, and the inferior opening of the pelvis larger than in men.

SECT. IV. OF THE EXTREMITIES.

The parts of the ſkeleton conſiſt of the upper extremity and the lower.

The Upper Extremity
Conſiſts of the ſhoulder, the arm, and the hand.

Art. 1. *Of the Shoulder.*

The ſhoulder conſiſts of two bones, the *clavicula* and the *ſcapula*.

The former, which is ſo named from its reſemblance to the key in uſe amongſt the ancients, is a little curved at both its extremities like an Italic *ſ*. It is likewiſe called *jugulum*, or collar-bone, from its ſituation. It is about the ſize of the little finger, but longer, and being of a very ſpongy ſubſtance, is very liable to be fractured. In this, as in other long bones, we may diſtinguiſh a body and two extremities. The body is rather flattened than rounded. The anterior extremity is formed into a ſlightly convex head, which is nearly of a triangular ſhape. The inferior ſurface of the head is articulated with the ſternum. The poſterior extremity, which is flatter and broader than the other, is connected to a proceſs of the ſcapula, called *acromion*. Both theſe articulations are ſecured by ligaments, and in that with the ſternum we meet with a moveable cartilage, to prevent any injury from friction.

The *clavicula* ſerves to regulate the motions of the ſcapula, by preventing it from being brought too much forwards, or carried too far backwards. It affords origin to ſeveral muſcles, and helps to cover and protect the ſubclavian veſſels, which derive their name from their ſituation under this bone.

The *ſcapula*, or ſhoulder-blade, which is nearly of a triangular ſhape, is fixed to the poſterior part of the true ribs, ſomewhat in the manner of a buckler. It is of a very unequal thickneſs, and like all other broad, flat bones, is ſomewhat cellular. Exteriorly it is convex, and interiorly concave, to accommodate itſelf to the convexity of the ribs. We obſerve to this bone three unequal ſides, which are thicker and ſtronger than the body of the bone, and are therefore termed its *coſtæ*. The largeſt of the three, called alſo the baſis, is turned towards the vertebræ. Another which is leſs than the former, is below this; and the third, which is the leaſt of the three, is at the upper part of the bone. Externally the bone is elevated into a conſiderable ſpine, which riſing ſmall at the baſis of the ſcapula, becomes gradually higher and broarder, and divides the outer ſurface of the bone into two foſſæ. The ſuperior of theſe, which is the ſmalleſt, ſerves to lodge the ſupra ſpinatus muſcle; and the inferior foſſæ, which is much larger than the other, gives origin to the infra ſpinatus. This ſpine terminates in a broad and flat proceſs at the top of the ſhoulder, called the *proceſſus acromion*, to which the clavicle is articulated. This proceſs is hollowed at its lower part to allow a paſſage to the ſupra and infra ſpinati muſcles. The ſcapula has likewiſe another conſiderable proceſs at its upper part, which, from its reſemblance to the beak of a bird, is called the *coracoid proceſs*. From the outer ſide of this coracoid proceſs, a ſtrong ligament paſſes to the proceſſus acromion, which prevents a luxation of the os humeri upwards. A third proceſs begins by a narrow neck, and ends in a cavity called *glenoid*, for the connection of the os humeri. The ſcapula is articulated with the clavicle and os humeri, to which laſt it ſerves as a fulcrum; and by varying its poſition it affords a greater ſcope to the bones of the arm in their different motions. It likewiſe gives origin to ſeveral muſcles, and poſteriorly ſerves as a defence to the trunk.

Art. 2. *Bones of the Arm.*

The arm is commonly divided into two parts, which are articulated to each other at the elbow. The upper part retains the name of arm, properly ſo called and the lower part is uſually called the fore-arm.

The arm is compoſed of a ſingle bone called *os humeri*. This bone, which is almoſt of a cylindrical ſhape, may be divided into its body and its extremities. The upper extremity begins by a large, round ſmooth head, which is admitted into the glenoid cavity of the ſcapula. On the upper and fore part of the bone there is a groove for lodging the long head of the biceps muſcle of the arm; and on each ſide of the groove, at

Muscles of the Diaphragm, Liver, Pharynx, &c.
See System of Anatomy, Part 2, Section 2.

Fig. 10.

Fig. 9.

Fig. 8.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 4.

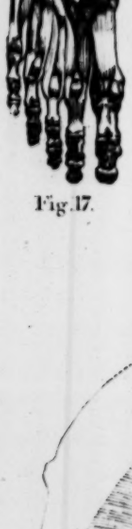


Fig. 17.

Fig. 16.

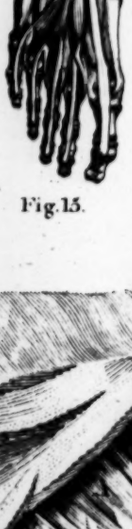


Fig. 15.

Fig. 14.

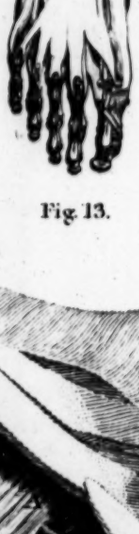


Fig. 13.

Fig. 2.

Fig. 12.

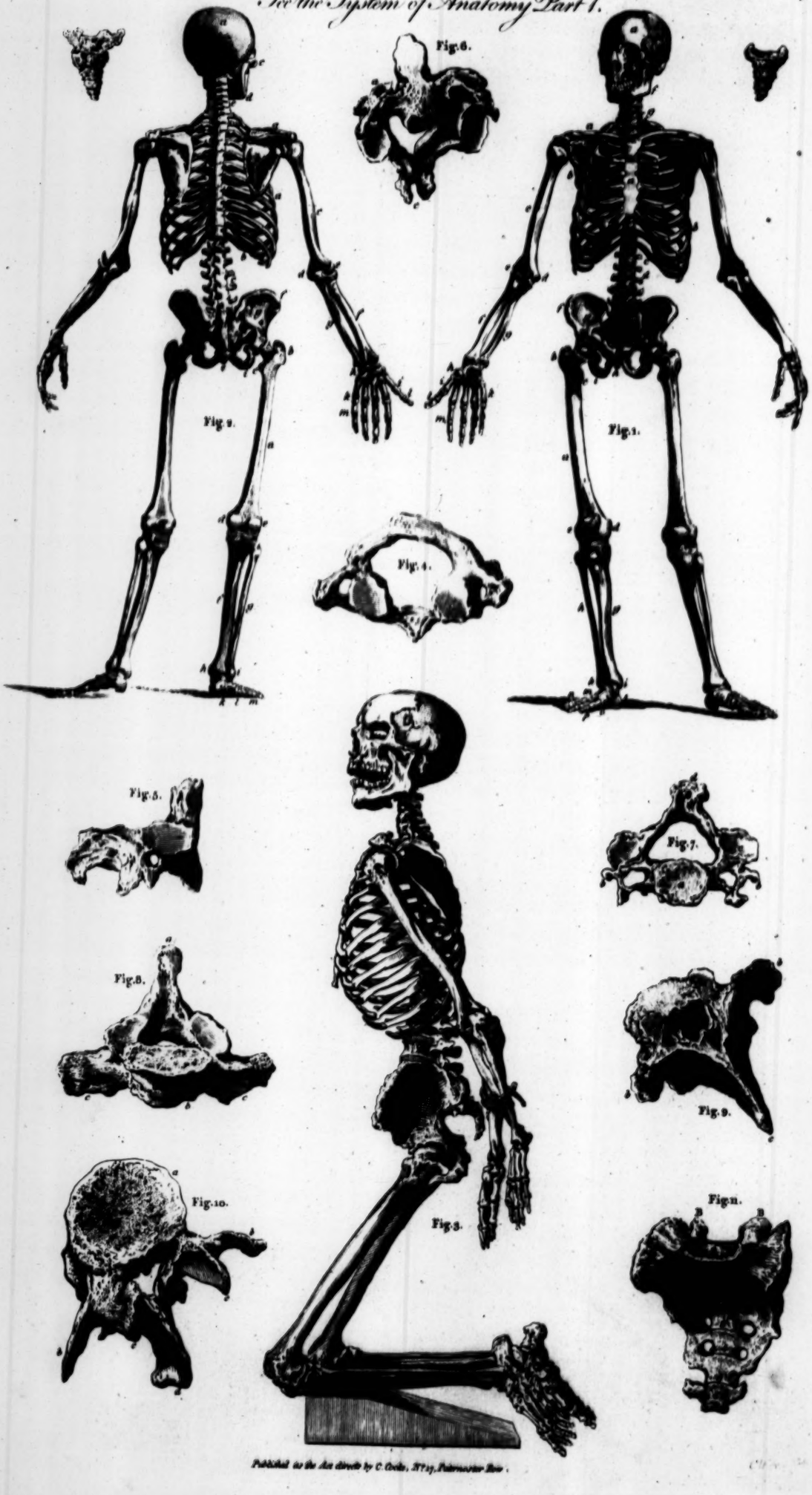
Fig. 1.

Fig. 11.

Fig. 3. *The Diaphragm*

Front, Back and Side Views of the Bones, with various detached parts of the Spine.

See the System of Anatomy Part 1.



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at the upper end of the bone, there is a tubercle to which the ſpinati muſcles are fixed.

The lower extremity has ſeveral proceſſes and cavities. The principal proceſſes are its two condyles, one exterior and the other interior, and of theſe the laſt is the largeſt. Between theſe two we obſerve two lateral protuberances, which, together with a middle cavity, forms as it were a kind of pully upon which the motions of the fore-arm are chiefly performed. At each ſide of the condyles, as well exteriorly as interiorly, there is another eminence which gives origin to ſeveral muſcles of the hand and fingers. Poſteriorly and ſuperiorly, ſpeaking with reſpect to the condyles, we obſerve a deep foſſa which receives a conſiderable proceſs of the ulna; and anteriorly and oppoſite to this foſſa, we obſerve another, which is much leſs, and receives another proceſs of the ſame bone.

The body of the bone has at its upper and anterior part a furrow which begins from behind the head of the bone, and ſerves to lodge the tendon of a muſcle. The body of the os humeri is hollow through its whole length, and like all other long bones has its marrow. This bone is articulated at its upper part to the ſcapula. This articulation, which allows motion every way, is ſurrounded by a capſular ligament that is ſometimes torn in luxation, and becomes an obſtacle to the eaſy reduction of the bone. Its lower extremity is articulated with the bones of the fore-arm.

The fore-arm is compoſed of two bones, the *ulna* and *radius*.

The *ulna* or elbow-bone is much leſs than the os humeri, and becomes gradually ſmaller as it deſcends to the wriſt. At its upper part it has two proceſſes and two cavities. Of the two proceſſes, the largeſt, which is ſituated poſteriorly, and called the *olecranon*, is admitted into the poſterior foſſa of the os humeri. The other proceſs is placed anteriorly, and is called the *coronoid proceſs*. In bending the arm it enters into the anterior foſſa of the os humeri. This proceſs being much ſmaller than the other, permits the fore-arm to bend inwards; whereas the olecranon, which is ſhaped like a hook, reaches the bottom of its foſſa in the os humeri as ſoon as the arm becomes ſtraight, and will not permit the fore-arm to be bent backwards. The ligaments likewiſe oppoſe this motion.

Between the two proceſſes we have deſcribed, there is a conſiderable cavity called the ſygmoid cavity, divided into two foſſæ by a ſmall eminence, which paſſes from one proceſs to the other; it is by means of this cavity and the two proceſſes, that the ulna is articulated with the os humeri by ginglimus.

At the bottom of the coronoid proceſs interiorly, there is a ſmall ſygmoid cavity, which ſerves for the articulation of the ulna with the radius. The body of the ulna is of a triangular ſhape: its lower extremity terminates by a ſmall head and a little ſtyloid proceſs. The ulna is articulated above to the os humeri—both above and below to the radius, and to the wriſt at its lower extremity. All theſe articulations are ſecured by means of ligaments. The chief uſe of this bone ſeems to be to ſupport and regulate the motions of the radius.

The *radius*, which is ſo named from its ſuppoſed reſemblance to the ſpoke of a wheel, is placed at the inſide of the fore-arm. It is ſomewhat larger than the ulna, but not quite ſo long as that bone. Its upper part is cylindrical, hollowed ſuperiorly to receive the outer condyle of the os humeri. Laterally it is admitted into the little ſygmoid cavity of the ulna, and the cylindrical part of the bone turns in this cavity in the motions of pronation and ſupination (L.) This bone follows the ulna in flexion and extenſion, and may likewiſe be moved round its axis in any direction. The lower extremity of the radius is much larger and ſtronger than its upper part; the ulna, on the contrary, is ſmaller and weaker below than above; ſo that they ſerve to ſupply each others deficiencies in both thoſe parts. On the external ſide of this bone, we obſerve a ſmall cavity which is deſtined to receive the lower end of the ulna; and its lower extremity is formed into a large cavity, by means of which it is articulated with the bones of the wriſt, and on this account it is ſometimes called *manubrium manus*. It ſupports the two firſt bones of the wriſt on the ſide of the thumb, whereas the ulna is articulated with that bone of the wriſt which correſponds with the little finger.

Through the whole length both of this bone and the ulna, a ridge is obſerved which affords attachment to an interoſſeous ligament. This ligament fills up the ſpace between the two bones.

Art. 3. *Bones of the Hand.*

The *carpus* or wriſt conſiſts of eight ſmall bones of an irregular ſhape, and diſpoſed in two unequal rows. Thoſe of the upper row are articulated with the bones of the fore-arm, and thoſe of the lower one with the metacarpus. The ancient anatomiſts deſcribed theſe bones numerically; Lyſerus ſeems to have been the firſt who gave to each of them a particular name. The names he adopted are found on the figure of the bones, and are now pretty generally received, except the firſt, which inſtead of *κολυμβοειδες* (the name given to it by Lyſerus, on account of its ſinus, that admits a part of the os magnum) has by later writers been named *Scaphoides* or *Naviculare*. This, which is the outermoſt of the upper row, (conſidering the thumb as the outer ſide of the hand) is articulated with the radius; on its inner ſide it is connected with the os lunare, and below to the trapezium and trapezoides. Next to this is a ſmaller bone, called the *os lunare*; becauſe its outer ſide, which is connected with the ſcaphoides, is ſhaped like a creſcent. This is likewiſe articulated with the radius. On its inner ſide it joins the os cuneiforme, and anteriorly, the os magnum and os unciforme.

The os cuneiforme, which is the third bone in the upper row, is compared to a wedge, from its being broader above, at the back of the hand, than it is below. Poſteriorly it is articulated with the ulna, and anteriorly with the os unciforme. Theſe three bones form an oblong articulating ſurface, covered by a cartilage, by which the hand is connected with the fore-arm.

The os piſiforme, or pea-like bone, which is ſmaller than the three juſt now deſcribed, though generally claſſed with the bones of the upper row, does not properly belong to either ſeries, being placed on the under ſurface of the os cuneiforme, ſo as to project into the palm of the hand. The four bones of the ſecond row correſpond with the bones of the thumb and fingers; the firſt, ſecond, and fourth, are from their ſhapes named *trapezium*, *trapezoides*, and *unciforme*; the third from its being the largeſt bone of the carpus, is ſtyled *os magnum*.

All theſe bones are convex towards the back, and ſlightly concave towards the palm of the hand; their articulating ſurfaces are covered with cartilages, and ſecured by many ſtrong ligaments, particularly by two ligamentous expanſions, called the external and internal annular ligaments of the wriſt. The former extends in an oblique direction from the os piſiforme to the ſtyloid proceſs of the radius, and is an inch and a half in breadth; the latter or internal annular ligament is ſtretched from the os piſiforme and os unciforme, to the os ſcaphoides and trapezium. Theſe annular ligaments likewiſe ſerve to bind down the tendons of the wriſt and fingers.

The *metacarpus* conſiſts of four bones, which ſupport the fingers; externally they are a little convex, and internally ſomewhat concave, where they form the palm of the hand. They are hollow, and of a cylindrical ſhape. At each extremity they are a little hollowed for their articulation; ſuperiorly with the bones of the carpus, and inferiorly with the firſt phalanx of the fingers, in the ſame manner as the ſeveral phalanges of the fingers are articulated with each other.

The five fingers of each hand are compoſed of fifteen bones, diſpoſed in three ranks called phalanges: The bones of the firſt phalanx, which are articulated with the metacarpus, are the largeſt, and thoſe of the laſt phalanx the ſmalleſt. All theſe bones are larger at their extremities than in their middle part.

We obſerve at the extremities of the bones of the carpus, metacarpus, and fingers, ſeveral iuequalities that ſerve for their articulation with each other; and theſe articulations are ſtrengthened by means of the ligaments which ſurround them. It will be eaſily underſtood that this multiplicity of bones in the hand (for there are 27 in each hand) is eſſential to the different motions we wiſh to perform. If each finger was compoſed only of one bone inſtead of three, it would be impoſſible for us to graſp any thing.

The Lower Extremities.

Each lower extremity is divided into four parts, viz. the *os femoris* or thigh bone; the *rotula*, or knee-pan; the leg; and the foot.

Art. 4. *Of the Thigh.*

The thigh is compoſed only of the *os femoris*, which is the largeſt and ſtrongeſt bone we have. It will be neceſſary to diſtinguiſh its body and extremities: Its body is of a cylindrical ſhape, is convex before and concave behind, where it ſerves to lodge ſeveral muſcles. Throughout two-thirds of its length we obſerve a ridge called *linea aſpera*, which originates from the trochanters, and after running for ſome way downwards, divides into two branches, that terminate in the tuberoſities at the lower extremity of the bone. At its upper extremity we muſt deſcribe the neck and ſmooth head of the bone, and likewiſe two conſiderable proceſſes: The head, which forms the greater portion of a ſphere unequally divided, is turned inwards and received into the great cotyloid cavity of the os innominatum. At this part of the bone there is a little foſſa to be obſerved, to which the round ligament is attached, and which we have already deſcribed as tending to ſecure the head of this bone in the great acetabulum. The neck is almoſt horizontal conſidered with reſpect to its ſituation with the body of the bone. Of the two proceſſes, the external one, which is the largeſt, is called trochanter major; and the other, which is placed on the inſide of the bone, trochanter minor. They both afford attachment to muſcles. The articulation of the os femoris with the trunk is ſtrengthened by means of a capſular ligament, which adheres every where round the edge of the great coty-

(L) The motions of pronation and ſupination may be eaſily deſcribed. If the palm of the hand, for inſtance, is placed on the ſurface of a table, the hand may be ſaid to be in a ſtate of pronation; but if the back part of the hand is turned towards the table, the hand will be then in a ſtate of ſupination.

hold cavity of the os innominatum, and furrounds the head of the bone.

The os femoris moves upon the trunk in every direction. At the lower extremity of the bone are two proceſſes called the condyles, and an intermediate ſmooth cavity, by means of which it is articulated with the leg by ginglimus. All round the under end of the bone there is an irregular ſurface where the capſular ligament of the joint has its origin, and where blood-veſſels go into the ſubſtance of the bone. Between the condyles there is a cavity poſteriorly, in which the blood-veſſels and nerves are placed, ſecure from the compreſſion to which they would otherwiſe be expoſed in the action of bending the leg, and which would not fail to be hurtful.

At the ſide of each condyle externally, there is a tuberoſity, from whence the lateral ligaments originate, which are extended down to the tibia. A ligament likewiſe ariſes from each condyle poſteriorly. One of theſe ligaments paſſes from the right to the left, and the other from the left to the right, ſo that they interſect each other, and for that reaſon are called the *croſs ligaments*. The lateral ligaments prevent the motion of the leg upon the thigh to the right or left; and the croſs ligaments, which are alſo attached to the tibia, prevent the latter from being brought forwards.

In new-born children all the proceſſes of this bone are cartilaginous.

Art. 5. *The Rotula, or Knee-pan.*

The *rotula*, *patella*, or knee-pan, as it is differently called, is a flat bone about four or five inches in circumference, and is placed at the fore-part of the joint of the knee. In its ſhape it is ſomewhat like the common figure of the heart, with its point downwards. It is thinner at its edge than in its middle part; at its fore-part it is ſmooth and ſomewhat convex; its poſterior ſurface, which is more unequal, affords an elevation in the middle which is admitted between the two condyles of the os femoris This bone is retained in its proper ſituation by a ſtrong ligament which every where furrounds it, and adheres both to the tibia and os femoris; it is likewiſe firmly connected with the tibia by means of a ſtrong tendinous ligament of an inch in breadth, and upwards of two inches in length, which adheres to the lower part of the patella, and to the tuberoſity at the upper end of the tibia. On account of this connection, it is very properly conſidered as an appendage to the tibia, which it follows in all its motions, ſo as to be to it what the olecranon is to the ulna. There is this difference, however, that the olecranon is a fixed proceſs; whereas the patella is moveable, being capable of ſliding from above downwards and from below upwards. This mobility is eſſential to the rotatory motion of the leg. In very young children this bone is entirely cartilaginous.

The principal uſe of the patella ſeems to be to defend the articulation of the knee from external injury; it likewiſe tends to increaſe the power of the extenſor muſcles of the leg, by removing their direction farther from the centre of motion in the manner of a pulley.

Art. 6. *Of the Leg.*

The leg is compoſed of two bones: of theſe the inner one, which is the largeſt, is called *tibia*; the other is much ſmaller, and named *fibula*.

The *tibia*, which is ſo called from its reſemblance to the muſical pipe of the ancients, has three ſurfaces, and is not very unlike a triangular priſm. Its poſterior ſurface is the broadeſt; anteriorly it has a conſiderable ridge called the ſhin, between which and the ſkin there are no muſcles. At the upper extremity of this bone are two ſurfaces, a little concave, and ſeparated from each other by an intermediate elevation. The two little cavities receive the condyles of the os femoris, and the eminence between them is admitted into the cavity which we ſpoke of as being between the two condyles; ſo that this articulation affords a ſpecimen of the complete ginglimus. Under the external edge of the upper end of this bone is a circular flat ſurface, which receives the head of the fibula. At the lower and inner portion of the tibia, we obſerve a conſiderable proceſs called *malleolus internus*. The baſis of the bone terminates in a large tranſverſe cavity, by which it is articulated with the uppermoſt bone of the foot. It has likewiſe another cavity at its lower end and outer ſide, which is ſomewhat oblong, and receives the lower end of the fibula. The tibia is hollow through its whole length.

The *fibula* is a ſmall long bone ſituated on the outſide of the tibia. Its ſuperior extremity does not reach quite ſo high as the upper part of the tibia, but its lower end deſcends ſomewhat lower. Both above and below, it is articulated with the tibia by means of the lateral cavities we noticed in our deſcription of that bone. Its lower extremity is ſtretched out into a coronoid proceſs, which is flattened at its inſide, and is convex externally, forming what is called the *malleolus externus* or *outer ancle*. This is rather lower than the malleolus internus of the tibia. The body of this bone, which is irregularly triangular, is a little hollow at its internal ſurface, which is turned towards the tibia; and it affords like that bone, through its whole length, attachment to a ligament, which from its ſituation is called the interoſſeous ligament.

Art. 7. *Of the Foot.*

The foot conſiſts of the *tarſus*, *metatarſus*, and toes.

The *tarſus* is compoſed of ſeven bones, viz. the aſtragalus, os calcis, os naviculare, os cuboides, and three others called cuneiform bones.

The *aſtragalus* is a large bone with which both the tibia and fibula are articulated. It is the uppermoſt bone of the foot; it has ſeveral ſurfaces to be conſidered; its upper, and ſomewhat poſterior part, which is ſmooth and convex, is admitted into the cavity of the tibia. Its lateral parts are connected with the malleoli of the two bones of the leg; below, it is articulated with the os calcis, and its interior ſurface is received by the os naviculare. All theſe articulations are ſecured by means of ligaments.

The *os calcis*, or *calcaneum*, which is of a very irregular figure, is the largeſt bone of the foot. Behind, it is formed into a conſiderable tuberoſity called the heel: without this tuberoſity, which ſupports us in an erect poſture, and when we walk, we ſhould be liable to fall backwards. On the internal ſurface of this bone, we obſerve a conſiderable ſinuoſity, which affords a paſſage to the tendon of a muſcle: and to the poſterior part of the os calcis, a ſtrong tendinous cord called *tendo achillis* (M) is attached, which is formed by the tendons of ſeveral muſcles united together. The articulation of this with the other bones is ſecured by means of ligaments.

The *os naviculare*, or *ſcaphoides*, (for theſe two terms have the ſame ſignification), is ſo called on account of its reſemblance to a little bark. At its poſterior part, which is concave, it receives the aſtragalus; anteriorly it is articulated with the cuneiform bones, and laterally it is connected with the os cuboides.

The *os cuboides* forms an irregular cube. Poſteriorly it is articulated with the os calcis; anteriorly it ſupports the two laſt bones of the metatarſus, and laterally it joins the third cuneiform bone and the os naviculare.

Each of the *oſſa cuneiformia*, which are three in number, reſembles a wedge, and from this ſimilitude their name is derived. They are placed next to the metatarſus by the ſides of each other, and are uſually diſtinguiſhed into *os cuneiforme externum*, *medium* or *minimum*, and *internum* or *maximum*. The ſuperior ſurface of theſe bones, from their wedge-like ſhape, is broader than that which is below, where they help to form the ſole of the foot; poſteriorly they are united to the os naviculare, and anteriorly they ſupport the three firſt metatarſal bones.

When theſe ſeven bones compoſing the tarſus are viewed together in the ſkeleton, they appear convex above, where they help to form the upper part of the foot; and concave underneath, where they form the hollow of the foot, in which the veſſels, tendons, and nerves of the foot are placed ſecure from preſſure. They are united to each other by very ſtrong ligaments, and their articulation with the foot is ſecured by a capſular and two lateral ligaments: each of the latter is covered by an annular ligament of conſiderable breadth and thickneſs which ſerves to bind down the tendons of the foot, and at the ſame time to ſtrengthen the articulation. The os cuneiforme externum is joined laterally to the os cuboides.

Theſe bones complete our account of the tarſus. Though what we have ſaid of this part of the oſteology has been very ſimple and conciſe, yet many readers may not clearly underſtand it: but if they will be pleaſed to view theſe bones in their proper ſituation in the ſkeleton, all that we have ſaid of them will be eaſily underſtood.

The *metatarſus* is made up of five bones, whereas the metacarpus conſiſts only of four. The cauſe of this difference is, that in the hand the laſt bone of the thumb is not included among the metacarpal bones; whereas in the foot the great toe has only two bones. The firſt of theſe bones ſupports the great toe and is much larger than the reſt, which nearly reſemble each other in ſize. Theſe bones are articulated by one extremity with the cuneiform bones and the os cuboides, and by their other end with the toes.

Each of the toes, like the fingers, conſiſts of three bones, except the great toe, which is formed of two bones. Thoſe of the other four are diſtinguiſhed into three phalanges. Although the toes are more confined in their motion than the fingers, yet they appear to be perfectly fitted for the purpoſes they are deſigned for. In walking, the toes bring the centre of gravity perpendicular to the advanced foot; and as the ſoles of the foot are naturally concave, we can at pleaſure increaſe this concavity, and form a kind of vault, which adjuſts itſelf to the different inequalities that occur to us in walking; and which, without this mode of arrangement, would incommode us exceedingly, eſpecially when bare-footed.

Art. 8. *Of the Oſſa Seſamoidea.*

Beſides the bones we have already deſcribed, there are ſeveral ſmall ones that are met with only in the adult ſkeleton, and in perſons who are advanced in life; which, from their ſuppoſed general reſemblance to the ſeeds of the ſeſamum, are

(M) This tendon is ſometimes ruptured by jumping, dancing, or other violent efforts.

called

called *offa ſeſamoidea*. They are commonly to be ſeen at the firſt joint of the great toe, and ſometimes at the joints of the thumb; they are likewiſe now and then to be found at the lower extremity of the fibula, upon the condyles of the thigh-bone, under the os cuboides of the tarſus, and in other parts of the body. Their ſize and number ſeem conſtantly to be increaſed by age and hard labour; and as they are generally found in ſituations where tendons and ligaments are moſt expoſed to the action of muſcles, they are now generally conſidered as oſſified portions of ligaments or tendons.

The upper ſurface of theſe bones is uſually convex, and adherent to the tendon that covers it; the ſide which is next to the joint is ſmooth and flat. Though their formation is accidental, yet they ſeem to be of ſome uſe, by raiſing the tendons farther from the the centre of motion, and conſequently increaſing the power of the muſcles. In the great toe and thumb they are likewiſe uſeful, by forming a groove for the flexor tendons.

EXPLANATION OF PLATE I. *On the Bones.*

Figure I. repreſents a front view of the human ſkeleton, with ſome of the ligaments and cartilages, which connect the bones to each other.

Head and Neck.

a, Os frontis. *b*, Os parietale. Between *a* and *b*, part of the coronal ſuture.

c, The pars ſquamoſa of the temporal bone. Between *b* and *c* the ſquamous ſuture. Below the pars ſquamoſa, the zygoma; and lower down, above *f*, the maſtoid proceſs. Between the pars ſquamoſa and the cavity, which contains the eye-ball, called orbit, the temporal proceſs of the ſphenoid bone is ſeen.

d, Os malæ. Above *d*, a portion of the tranſverſe ſuture.

e, Os maxillare ſuperius, with the eight teeth of the right ſide. The naſal proceſs of the ſuperior maxillary bone has the os naſi, joined by the lateral naſal ſuture, to its inſide, and at the outſide, within the orbit, the os unguis. The oſſa naſi are joined to each other before, by the anterior naſal ſuture.

f, Os maxillare inferius, with ſixteen teeth; the four anterior named inciſores, the two corner ones canini, and the five poſterior on each ſide, molares. Oppoſite to *f*, the angle of the lower jaw; above *f*, the condyloid proceſs, by which the jaw is connected to the temporal bone, at the root of the zygoma; and behind the os malæ, the coronoid proceſs.

g, The ſeven cervical vertebræ, with their intermediate cartilages. Oppoſite to *g*, their tranſverſe proceſſes.

Trunk.

a, Sternum. *a*, Its middle piece, to which one half of the cartilage that connects the ſecond rib, the whole of the cartilages of the third, fourth, fifth, ſixth, and one half of the ſeventh, are fixed. Above *a*, the firſt or upper triangular piece, to which the clavicle, and one half of the cartilage that connects the ſecond rib, are fixed. Below *a*, the extremity, or third piece of the ſternum, named cartilago enſiformis, to which one half of the cartilage that connects the ſeventh rib, is fixed.

b, The ſeventh, or laſt true rib. *c*, The twelfth, or laſt of the five falſe ribs. *d*, The five lumbar vertebræ, with their intermediate cartilages. Oppoſite to *d*, their tranſverſe proceſſes. *e*, The os ſacrum, with its five diviſions. *f*, Os innominatum, divided into, *g*, Os ilium; *h*, Os pubis; *i*, Os iſchium. Oppoſite to *i*, the foramen thyroideum.

Superior Extremity.

a, The clavicle fixed before, to the firſt piece of the ſternum, and outwards to the acromion of the ſcapula.

b, The ſcapula. Above *b*, the cervix of the ſcapula. Oppoſite to it, the inferior coſta; and below the outward extremity of the clavicle, the ſuperior coſta and coracoid proceſs, are ſeen.

c, The os humeri. The upper end of it, (which is connected to the cavity of the ſcapula, named glenoid, below the acromion), is named its head or ball; on each ſide of which is ſeen a tubercle, named external and internal, and between theſe, a groove for lodging the long head of the biceps flexor cubiti.

d, The internal condyle. *e*, The external condyle. Between *d* and *e*, the trochlea, upon which the ulna moves.

f, The radius. The upper end, which moves on the external condyle of the os humeri, is named its head; below that, the tubercle for the inſertion of the biceps flexor cubiti, and between theſe the cervix. The inferior end of it is connected to the carpus.

g, Ulna. The upper end of it forms the coronoid proceſs, for the inſertion of the brachialis muſcle. The inferior end has a proceſs, named ſtyloid, which is connected to the carpus by a ligament.

h The carpus, formed of eight bones. *i*, The metacarpal bone of the thumb. *k*, The metacarpal bones of the four fingers. *l*, The two joints of the thumb. *m*, The three joints or phalanges of the fore-finger; and the ſame are ſeen in each of the other three.

Inferior Extremity.

a, The os femoris. The upper end of it is named its head or ball, which is lodged in a deep ſocket of the os innominatum, named acetabulum. Between the head and trochanter major, the cervix.

b, Trochanter major. *c*, Trochanter minor. *d*, Internal condyle. *e*, External condyle. *f*, Patella. The place where it moves upon the os femoris, is named trochlea. *g*, Tibia. Between the tibia and the condyles of the os femoris, the ſemilunar cartilages are ſeen; and below the joint the tubercle of the tibia. *h*, Fibula. *i*, Malleolus internus. *k*, Malleolus externus. *l*, Os calcis. Between *l* and *m*, the other ſix bones of the tarſus. *m*, The metatarſal bones of the four toes. *n*, The three joints, or phalanges of the four toes. *o*, The metatarſal bone of the toe. *p*, The two joints of the great toe.

Figure II. repreſents a back view of the human ſkeleton, with ſome of the ligaments and cartilages which connect the bones.

Head and Neck.

a, Os parietale, joined to its fellow by the ſagittal ſuture.

b, The os occipitis, joined to the parietal bones by the lamboid ſuture, which is between *a* and *b*. *c*, Os malæ. *d*, Maxilla inferior, with a view of the teeth of both jaws from behind. *e*, The ſeven cervical vertebræ.

Trunk.

a, The ſeventh, or laſt true rib. *b*, The twelfth, or laſt rib.

c, The five lumbar vertebræ. *d*, Os ſacrum. *e*, Os coccygis.

f, Os innominatum, divided into, *g*, Os ilium. *h*, Os pubis. *i*, Os iſchium.

Superior Extremity.

a, The clavicle, joined outwards to the acromion of the ſcapula.

b, The ſcapula. *c*, Os humeri. *d*, Internal condyle.

e, External condyle. *f*, Radius. *g*, Ulna, its upper end, named Olecranon; and near the wriſt, its ſtyloid proceſs.

h, The eight bones of the carpus. *i*, The metatarſal bone of the thumb. *k*, The metatarſal bones of the four fingers. *l*, The two joints of the thumb. *m*, The three joints, or phalanges of the four fingers.

Inferior Extremity.

a, Os femoris. *b*, Trochanter major, and at the inſide of it, the cervix. *c*, Trochanter minor. *d*, Internal condyle.

e, External condyle. *f*, Tibia. *g*, Fibula. *h*, Malleolus internus. *i*, Malleolus externus. *k*, The ſeven bones of the tarſus. *l*, The metatarſus. *m*, The joints or phalanges of the toes.

Figure III. repreſents a ſkeleton of an adult put into this poſture to ſhew it in a greater ſcale. It was thought better not to figure it, the bones being explained in *fig.* 1, and 2, the deſign of this figure being to ſhew a ſide view of the ſkeleton, without being defaced with references.

Figure IV. repreſents the under ſide of the firſt vertebra of the neck.

Figure V. repreſents a ſide view of the ſecond vertebra.

Figure VI. repreſents *a*, The proceſſus dentatus of the ſecond vertebra. *b*, The under ſide of the oblique proceſs. *c*, The ſpinal proceſs.

Figure VII. repreſents *a*, The under ſide of the body of the ſeventh vertebra of the neck. *b*, The tranſverſe proceſſes. *c*, The oblique proceſſes. *d*, The ſpinal proceſs.

Figure VIII. repreſents *a*, The ſpinal proceſs of the ſecond vertebra of the back. *b*, The under and fore ſide of the body of the vertebra. *c*, The tranſverſe proceſſes.

Figure IX. repreſents *a*, The upper oblique proceſſes of the third vertebra of the back. *b*, The tranſverſe proceſſes. *c*, The ſpinal proceſs.

Figure X. repreſents *a*, The body of the third vertebra of the loins. *b*, The tranſverſe proceſſes. *c*, The upper oblique proceſſes. *d*, The ſpinal proceſs.

Figure XI. repreſents the fore-ſide of the os ſacrum. 1, 2, 3, 4, 5, 6, are parts of the os ſacrum, which, in young ſubjects, are diſtinct bones.

A, Part of the os ſacrum, which articulate with the ſpongy body of the loweſt vertebra of the loins.

B, B, Two proceſſes of the os ſacrum, which articulate with the inferior oblique proceſs of the laſt vertebra of the loins.

C, C, The channel through which the medulla ſpinalis paſſes.

PART II.

Of the SOFT PARTS in General;

Of the COMMON INTEGUMENTS, with their Appendages;

And of the MUSCLES;

ANATOMICAL writers uſually proceed to a deſcription of the muſcles after having finiſhed the oſteology; but we ſhall deviate a little from the common method, with a view to deſcribe every thing clearly and diſtinctly, and to avoid a tautology which would otherwiſe be unavoidable. All the parts of the body are ſo intimately connected with each other, that it ſeems impoſſible to convey a juſt idea of any one of them, without being in ſome meaſure obliged to ſay ſomething of others; and on this account we wiſh to mention in this place the names and ſituation of the principal viſcera of the body, that when mention is hereafter made of any of them in the

the courſe of the work, the reader may at leaſt know where they are placed. After this little digreſſion, the common integuments, and after them the muſcles, will be deſcribed; we then propoſe to enter into an examination of the ſeveral viſcera and their different functions. In deſcribing the brain, occaſion will be taken to ſpeak of the nerves and animal ſpirits. The circulation of the blood will follow the anatomy of the heart, and the ſecretions and other matters will be introduced in their proper places.

The body is divided into three great cavities. Of theſe the uppermoſt is formed by the bones of the cranium, and incloſes the brain and cerebellum. The ſecond is compoſed of the vertebræ of the back, the ſternum, and true ribs, with the additional aſſiſtance of muſcles, membranes, and common integuments, and is called the *thorax*—It contains the heart and lungs. The third, and inferior cavity, is the abdomen. It is ſeparated from the thorax by means of the diaphragm, and is formed by the lumbar vertebræ, the os ſacrum, the oſſa innominata, and the falſe ribs, to which we may add the peritonæum, and a variety of muſcles. This cavity incloſes the ſtomach, inteſtines, omentum or cawl, liver, pancreas, ſpleen, kidneys, urinary bladder, and parts of generation.

Under the diviſion of common integuments, are uſually included the epidermis, or ſcarf-ſkin, the reticulum mucoſum of Malpighi, the cutis or true ſkin, and the membrana adipoſa. The hair and nails, as well as the ſebaceous glands, may be conſidered as appendages to the ſkin.

SECT. I. OF THE SKIN.

Art. 1. *Of the* SCARF-*ſkin.*

THE *epidermis*, *cuticula*, or *ſcarf-ſkin*, is a fine, tranſparent, and inſenſible pellicle, deſtitute of nerves and blood-veſſels, which inveſts the body, and everywhere covers the true ſkin. This ſcarf-ſkin, which ſeems to be very ſimple, appears, when examined with a microſcope, to be compoſed of ſeveral laminæ or ſcales which are increaſed by preſſure, as we may obſerve in the hands and feet, where it is frequently much thickened, and becomes perfectly callous. It ſeems to adhere to the cutis by a number of very minute filaments, but may eaſily be ſeparated from it by heat, or by maceration in water. Some anatomical writers have ſuppoſed that it is formed by a moiſture exhaled from the whole ſurface of the body, which gradually hardens when it comes into contact with the air. They were perhaps induced to adopt this opinion, by obſerving the ſpeedy regeneration of this part of the body when it has been by any means deſtroyed, it appearing to be renewed on all parts of the ſurface at the ſame time; whereas other parts which have been injured, are found to direct their growth from their circumference only towards their centre. But a demonſtrative proof that the epidermis is not a fluid hardened by means of the external air, is, that the fœtus in utero is found to have this covering. Leeuwenhoeck ſuppoſed its formation to be owing to the expanſion of the extremities of the excretory veſſels, which are found everywhere upon the ſurface of the true ſkin. Ruyſch attributed its origin to the nervous papillæ of the ſkin; and Heiſter thinks it probable, that it may be owing both to the papillæ and the excretory veſſels. The celebrated Morgagni, on the other hand, contends, that it is nothing more than the ſurface of the cutis, hardened and rendered inſenſible by the liquor amnii in utero, and by the preſſure of the air. This is a ſubject, however, on which we can advance nothing with certainty.

The cuticle is pierced with an infinite number of pores, or little holes, which afford a paſſage to the hairs, ſweat, and inſenſible perſpiration, and likewiſe to warm water, mercury, and whatever elſe is capable of being taken in by the abſorbents of the ſkin. The lines which we obſerve on the epidermis belong to the true ſkin. The cuticle adjuſts itſelf to them, but does not form them.

Art. 2. *Of the Rete Mucoſum.*

Between the epidermis and cutis we meet with an appearance to which Malpighi, who firſt deſcribed it, gave the name of *rete mucoſum*, ſuppoſing it to be of a membranous ſtructure, and pierced with an infinite number of pores; but the fact is, that it ſeems to be nothing more than a mucous ſubſtance which may be diſſolved by macerating it in water, while the cuticle and cutis preſerve their texture. The colour of the body is found to depend on the colour of this rete mucoſum; for in negroes it is obſerved to be perfectly black, whilſt the true ſkin is of the ordinary colour. The bliſters which raiſe the ſkin when burnt or ſcalded, have been ſuppoſed by ſome to be owing to a rarefaction of this mucus; but they are more probably occaſioned by an increaſed action of the veſſels of the part, together with an afflux and effuſion of the thinner parts of the blood.

Art. 3. *Of the* CUTIS, *or True Skin.*

The *cutis* is compoſed of fibres cloſely compacted together, as we may obſerve in leather, which is the prepared ſkin of animals. Theſe fibres form a thick net-work, which every where admits the filaments of nerves, and an infinite number of blood-veſſels and lymphatics. The cutis, when the epidermis is taken off, is found to have, throughout its whole ſurface, innumerable papillæ, which appear like very minute granulations, and ſeem to be calculated to receive the impreſſions of the touch, being the moſt eaſily obſerved where the ſenſe of feeling is the moſt delicate, as in the palms of the hands and on the fingers. Theſe papillæ are ſuppoſed by many anatomical writers to be continuations of the pulpy ſubſtance of nerves, whoſe coats have terminated in the cellular texture of the ſkin. The great ſenſibility of theſe papillæ evidently proves them to be exceedingly nervous; but ſurely the nervous fibrillæ of the ſkin are of themſelves ſcarcely equal to the formation of theſe papillæ, and it ſeems to be more probable that they are formed like the reſt of the cutis. Theſe papillæ being deſcribed, the uſes of the epidermis and the reticulum mucoſum will be more eaſily underſtood; the latter ſerving to keep them conſtantly moiſt, while the former protects them from the external air, and modifies their too great ſenſibility.

Art. 4. *Of the* GLANDS *of the Skin.*

In different parts of the body we meet, within the ſubſtance of the ſkin, with certain glands or follicles, which diſcharge a fat and oily humour that ſerves to lubricate and ſoften the ſkin. When the fluid they ſecrete has acquired a certain degree of thickneſs, it approaches to the colour and conſiſtence of ſuet; and from this appearance they have derived their name of *ſebaceous glands*. They are found in the greateſt number in the noſe, ear, nipple, axilla, groin, ſcrotum, vagina, and prepuce.

Beſides theſe ſebaceous glands, we read, in anatomical books, of others that are deſcribed as ſmall ſpherical bodies placed in all parts of the ſkin, in much greater abundance than thoſe juſt now mentioned, and named *miliary*, from their ſuppoſed reſemblance to millet ſeed. Steno, who firſt deſcribed theſe glands, and Malpighi, Ruyſch, Verheyen, Winſlow, and others who have adopted his opinions on this ſubject, ſpeak of them as having excretory ducts, that open on the ſurface of the cuticle, and diſtil the ſweat and matter of inſenſible perſpiration; and yet, notwithſtanding the poſitive manner in which theſe pretended glands have been ſpoken of, we are now ſufficiently convinced that their exiſtence is altogether imaginary.

Art. 5. *Of the* INSENSIBLE *Perſpiration and* SWEAT.

The matter of inſenſible perſpiration, or in other words, the ſubtile vapour that is continually exhaling from the ſurface of the body, is not ſecreted by any particular glands, but ſeems to be derived wholly from the extremities of the minute arteries that are every where diſperſed through the ſkin. Theſe exhaling veſſels are eaſily demonſtrated in the dead ſubject, by throwing water into the arteries; for then ſmall drops exude from all parts of the ſkin, and raiſe up the cuticle, the pores of which are cloſed by death; and in the living ſubject, a looking-glaſs placed againſt the ſkin, is ſoon obſcured by the vapour. Bidloo fancied he had diſcovered ducts leading from the cutis to the cuticle, and tranſmitting this fluid; but in this he was miſtaken. When the perſpiration is by any means increaſed, and ſeveral drops that were inſenſible when ſeparate, are united together and condenſed by the external air, they form upon the ſkin ſmall but viſible drops called *ſweat* (N). This particularly happens after much exerciſe, or whatever occaſions an increaſed determination of fluids to the ſurface of the body; a greater quantity of perſpirable matter being in ſuch caſes carried through the paſſages that are deſtined to convey it off.

It has been diſputed, indeed, whether the inſenſible perſpiration and ſweat are to be conſidered as one and the ſame excretion, differing only in degrees; or whether they are two diſtinct excretions derived from different ſources. In ſupport of the latter opinion, it has been alledged, that the inſenſible perſpiration is agreeable to nature and eſſential to health, whereas ſweat may be conſidered as a ſpecies of diſeaſe. But this argument proves nothing; and it ſeems probable, that both the inſenſible vapour and the ſweat are exhaled in a ſimilar manner, though they differ in quantity, and probably in their qualities; the former being more limpid, and ſeemingly leſs impregnated with ſalts than the latter: at any rate we may conſider the ſkin as an emunctory through which the redundant water, and ſometimes the other more ſaline parts of the blood, are carried off. But the inſenſible perſpiration is not confined to the ſkin only—a great part of what we are conſtantly throwing off in this way is from the lungs. The quantity of fluid exhaled from the human body by this inſenſible perſpiration is very conſiderable. Sanctorius (O) an Italian phyſician, who

(N) Leeuwenhoeck aſſerts, that one drop of ſweat is formed by the conflux of 15 drops of perſpirable vapour.

(O) The inſenſible perſpiration is ſometimes diſtinguiſhed by the name of this phyſician, who was born in the territories of Venice, and was afterwards a profeſſor in the univerſity of Padua. After eſtimating the aliment he took in, and the ſenſible ſecretions and diſcharges, he was enabled to aſcertain with great accuracy the weight or quantity of inſenſible perſpiration by means of a ſtatical chair which he contrived for this purpoſe; and from his experiments, which were conducted with great induſtry and patience, he was led to determine what kinds of ſolid or liquid aliment increaſed or diminiſhed it. From theſe experiments he formed a ſyſtem, which he publiſhed at Venice in 1614, in the form of aphoriſms, under the title of "Ars de Medicina Statica."

indefatigably

indefatigably paſſed a great many years in a ſeries of ſtatical experiments, demonſtrated long ago what has been confirmed by later obſervations, that the quantity of vapour exhaled from the ſkin and from the ſurface of the lungs, amounts nearly to 5-8ths of the aliment we take in. So that if in the warm climate of Italy a perſon eats and drinks the quantity of eight pounds in the courſe of a day, five pounds of it will paſs off by inſenſible perſpiration, while three pounds only will be evacuated by ſtool, urine, ſaliva, &c. But in countries where the degree of cold is greater than in Italy, the quantity of perſpired matter is leſs; in ſome of the more northern climates, it being found not to equal the diſcharge by urine. It is likewiſe obſerved to vary according to the ſeaſon of the year and according to the conſtitution, age, ſex, diſeaſes, diet, exerciſe, paſſions, &c. of different people.

From what has been ſaid on this ſubject, it will be eaſily conceived, that this evacuation cannot be either much increaſed or diminiſhed in quantity without affecting the health. The perſpirable matter and the ſweat are in ſome meaſure analagous to the urine, as appears from their taſte and ſaline nature (p). And it is worthy of obſervation, that when either of theſe ſecretions is increaſed in quantity, the other is diminiſhed; ſo that they who perſpire the leaſt, uſually paſs the greateſt quantity of urine, and vice verſa.

Art. 6. *Of the* NAILS.

The nails are of a compact texture, hard and tranſparent like horn. Their origin is ſtill a ſubject of diſpute. Malpighi ſuppoſed them to be formed by a continuation of the papillæ of the ſkin: Ludwig, on the other hand, maintained, that they were compoſed of the extremities of blood-veſſels and nerves; both theſe opinions are now deſervedly rejected. They ſeem to poſſeſs many properties in common with the cuticle; like it they are neither vaſcular nor ſenſible, and when the cuticle is ſeparated from the true ſkin by maceration or other means, the nails come away with it. They appear to be compoſed of different layers, of unequal ſize, applied one over the other. Each layer ſeems to be formed of longitudinal fibres.

In each nail we may diſtinguiſh three parts, viz. the root, the body or middle, and the extremity. The root is a ſoft, thin, and white ſubſtance, terminating in the form of a creſcent; the epidermis adheres very ſtrongly to this part; the body of the nail is broader, redder, and thicker, and the extremity is of ſtill greater firmneſs. The nails increaſe from their roots, and not from their upper extremity. Their principal uſe is to cover and defend the ends of the fingers and toes from external injury.

Art. 7. *Of the* HAIR.

The hairs, which from their being generally known do not ſeem to require any definition, ariſe from diſtinct capſules or bulbs ſeated in the cellular membrane under the ſkin (q). Some of theſe bulbs incloſe ſeveral hairs. They may be obſerved at the roots of the hairs which form the beard or whiſkers of a cat. The hairs, like the nails, grow only from below by a regular propulſion from their root, where they receive their nouriſhment. Their bulbs, when viewed with a microſcope, are found to be of various ſhapes. In the head and ſcrotum they are roundiſh; in the eye-brows they are oval; in the other parts of the body they are nearly of a cylindrical ſhape. Each bulb ſeems to conſiſt of two membranes, between which there is a certain quantity of moiſture. Within the bulb the hair ſeparates into three or four fibrillæ; the bodies of the hairs, which are the parts without the ſkin, vary in ſoftneſs and colour according to the difference of climate, age, or temperament of body (r). Their general uſe in the body does not ſeem to be abſolutely determined; but hairs in particular parts, as on the eye-brows and eye-lids, are deſtined for particular uſes, which will be mentioned when thoſe parts are deſcribed.

Art. 8. *Of the* CELLULAR MEMBRANE *and* FAT.

The cellular membrane is found to inveſt the moſt minute fibres we are able to trace; ſo that by modern phyſiologiſts, it is very properly conſidered as the univerſal connecting medium of every part of the body. It is compoſed of an infinite number of minute cells united together, and communicating with each other. The two diſeaſes peculiar to this membrane are proofs of ſuch a communication; for in the *emphyſema* all its cells are filled with air, and in the anaſarca they are univerſally diſtended with water. Beſides theſe proofs of communication from diſeaſe, a familiar inſtance of it may be obſerved amongſt butchers, who uſually puncture this membrane, and by inflating it with air add to the good appearance of their meat.

The cells of this membrane ſerve as reſervoirs to the oily part of the blood or *Fat*, which ſeems to be depoſited in them, either by tranſudation through the coats of the arteries that ramify through theſe cells, or by particular veſſels, continued from the end of arteries. Theſe cells are not of a glandular ſtructure, as Malpighi and others after him have ſuppoſed. The fat is abſorbed and carried back into the ſyſtem by the lymphatics. The great waſte of it in many diſeaſes, particularly in the conſumption, is a ſufficient proof that ſuch an abſorption takes place. The fulneſs and ſize of the body are in a great meaſure proportioned to the quantity of fat contained in the cells of this membrane. In the living body it ſeems to be a fluid oil, which concretes after death. In granivorous animals, it is found to be of a firmer conſiſtence than in man. It is not confined to the ſkin alone, being met with every where in the interſtices of muſcles, in the omentum, about the kidnies, at the baſis of the heart, in the orbits, &c. The chief uſes of the fat ſeem to be to afford moiſture to all the parts with which it is connected; to facilitate the action of the muſcles; and to add to the beauty of the body, by making it every where ſmooth and equal.

SECT. II. OF THE MUSCLES.

THE muſcles are the organs of motion. The parts that are uſually included under this name conſiſt of diſtinct portions of fleſh, ſuſceptible of contraction and relaxation; the motions of which, in a natural and healthy ſtate, are ſubject to the will, and for this reaſon they are called *voluntary* muſcles. But beſides theſe, there are other parts of the body that owe their power of contraction to their muſcular fibres; thus the heart is of a muſcular texture, forming what is called a hollow muſcle; and the urinary bladder, ſtomach, inteſtines, &c. are enabled to act upon their contents, merely becauſe they are provided with muſcular fibres. Theſe are called *involuntary* muſcles, becauſe their motions are not dependent on the will. The muſcles of reſpiration, being in ſome meaſure influenced by the will, are ſaid to have a *mixed* motion.

The names by which the voluntary muſcles are diſtinguiſhed, are founded on their ſize, figure, ſituation, uſe, or the arrangement of their fibres, or their origin and inſertion. But beſides theſe particular diſtinctions, there are certain general ones that require to be noticed. Thus, if the fibres of a muſcle are placed parallel to each other in a ſtraight direction, they form what is ſtyled a *rectilinear* muſcle; if the fibres croſs and interſect each other, they conſtitute a *compound* muſcle; a *radiated* one, if the fibres are diſpoſed in the manner of rays; or a *penniform* muſcle, if, like the plume of a pen, they are placed obliquely with reſpect to the tendon. Muſcles that act in oppoſition to each other, are called *antagoniſtæ*; thus every extenſor or muſcle has a flexor for its antagoniſt, and *vice verſa*. Muſcles that concur in the ſame action are ſtyled *congeneres*.

The muſcles being attached to the bones, the latter may be conſidered as levers that are moved in different directions by the contraction of thoſe organs.

That end of a muſcle which adheres to the moſt fixed part is uſually called the *origin*, and that which adheres to the more moveable part, the *inſertion* of the muſcle.

In every muſcle we may diſtinguiſh two kinds of fibres; the one ſoft, of a red colour, ſenſible, and irritable, called fleſhy fibres; the other of a firmer texture, of a white gliſtening colour, inſenſible, without irritability or the power of contracting, and named tendinous fibres. They are occaſionally intermixed, but the fleſhy fibres generally prevail in the belly or middle part of a muſcle, and the tendonous ones in the extremities. If theſe tendonous fibres are formed into a round ſlender chord, they form what is called the *tendon* of the muſcle; on the other hand, if they are ſpread into a broad flat ſurface, the extremity of the muſcle is ſtyled *aponeuroſis*. The tendons of many muſcles, eſpecially when they are long and expoſed to preſſure or friction in the grooves formed for them in the bones, are ſurrounded by a tendonous ſheath or *faſcia*, in which we ſometimes find a ſmall mucous ſac or *burſa mucoſa*, which obviates any inconvenience from friction. Sometimes we find whole muſcles, and even ſeveral muſcles covered by a faſcia of the ſame kind, that affords origin to many of their fibres, dipping down between them, adhering to the ridges of bones, and thus preventing them from ſwelling too much when in action. The moſt remarkable inſtance of ſuch a covering is the *faſcia lata* of the thigh. Each muſcle is incloſed by a thin covering of cellular membrane, which has been

(p) Minute cryſtals have been obſerved to ſhoot upon the cloaths of men who work in glaſs-houſes. *Haller. Elem. Phyſ.*

(q) Malpighi, and after him the celebrated Ruyſch, ſuppoſed the hairs to be continuations of nerves, being of opinion that they originated from the papillæ of the ſkin, which they conſidered as nervous; and as a corroborating proof of what they advanced, they argued the pain we feel in plucking them out; but later anatomiſts ſeem to have rejected this doctrine, and conſider the hairs as particular bodies, not ariſing from the papillæ (for in the parts where the papillæ abound moſt there are no hairs), but from bulbs or capſules, which are peculiar to them.

(r) The hairs likewiſe differ from each other, and may not be improperly divided into two claſſes; one of which may include the hair of the head, chin, pubes, and axillæ; and the other, the ſofter hairs, which are to be obſerved almoſt every where on the ſurface of the body.

ſometimes improperly conſidered as peculiar to the muſcles, and deſcribed under the name of *propria membrana muſculoſa*. This cellular covering dips down into the ſubſtance of the muſcle, connecting and ſurrounding the moſt minute fibres we are able to demonſtrate, and affording a ſupport to their veſſels and nerves.

Leeuwenhoeck fancied he had diſcovered, by means of his microſcope, the ultimate diviſion of a muſcle, and that he could point out the ſimple fibre, which appeared to him to be an hundred times leſs than an hair; but he was afterwards convinced how much he was miſtaken on this ſubject, and candidly acknowledged, that what he had taken for a ſimple fibre was in fact a bundle of fibres. It is eaſy to obſerve ſeveral of theſe faſciculi or bundles in a piece of beef, in which, from the coarſeneſs of its texture, they are very evident.

The red colour which ſo particularly diſtinguiſhes the muſcular or fleſhy parts of animals, is owing to an infinite number of blood-veſſels that are diſperſed through their ſubſtance. When we macerate the fibres of a muſcle in water, it becomes of a white colour like all other parts of the body diveſted of their blood. The blood-veſſels are accompanied by nerves, and they are both diſtributed in ſuch abundance to theſe parts, that in endeavouring to trace the courſe of the blood-veſſels in a muſcle, it would appear to be formed altogether by their ramifications; and in an attempt to follow the branches of its nerves, they would be found to be equal in proportion.

If a muſcle is pricked or irritated, it immediately contracts. This is called its irritable principle, and this irritability is to be conſidered as the characteriſtic of muſcular fibres, and may ſerve to prove their exiſtence in parts that are too minute to be examined by the eye. This power, which diſpoſes the muſcles to contract when ſtimulated, independent of the will, is ſuppoſed to be inherent in them; and is therefore named *vis inſita*. This property is not to be confounded with elaſticity, which the membranes and other parts of the body poſſeſs in a greater or leſs degree in common with the muſcles; nor with ſenſibility, for the heart, though the moſt irritable, ſeems to be the leaſt ſenſible of any of the muſcular parts of the body. After a muſcular fibre has contracted, it ſoon returns to a ſtate of relaxation, till it is excited afreſh, and then it contracts and relaxes again. We may likewiſe produce ſuch a contraction, by irritating the nerve leading to a muſcle, although the nerve itſelf is not affected. This principle is found to be greater in ſmall than in large, and in young than in old, animals.

In the voluntary muſcles theſe effects of contraction and relaxation of the fleſhy fibres are produced in obedience to the will, by what may be called the *vis nervoſa*, a property that is not to be confounded with the *vis inſita*. As the exiſtence of a *vis inſita* different from a *vis nervia*, was the doctrine taught by Doctor Haller in his *Elem. Phyſ.* but is at preſent called in queſtion by ſeveral, particularly Doctor Monro, we think it neceſſary to give a few objections, as ſtated in his Obſervations on the Nervous Syſtem:

"The chief experiment, (ſays the Doctor), which ſeems to have led Dr. Haller to this opinion, is the well-known one, that the heart and other muſcles, after being detached from the brain, continue to act ſpontaneouſly, or by ſtimuli may be roufed into action for a conſiderable length of time; but when it cannot be alledged, ſays Dr. Haller, that the nervous fluid is by the mind, or otherwiſe, impelled into the muſcle. That in this inſtance, we cannot comprehend by what power the nervous fluid or energy can be put in motion, muſt perhaps be granted: But has Dr. Haller given a better explanation of the manner in which his ſuppoſed vis inſita becomes active? If it be as difficult to point out the cauſe of the action of the vis inſita as that of the action of the vis nervea, the admiſſion of that new power, inſtead of relieving, would add to our perplexity. We ſhould then have admitted, that two cauſes of a different nature were capable of producing exactly the ſame effect; which is not in general agreeable to the laws of nature. We ſhould find other conſequences ariſe from ſuch an hypotheſis, which tend to weaken the credibility of it. For inſtance, if in a ſound animal the vis nervea alone produces the contraction of the muſcles, we will aſk what purpoſe the vis inſita ſerves? If both operate, are we to ſuppoſe that the vis nervea, impelled by the mind or living principle, gives the order, which the vis inſita executes, and that the nerves are the internuntii: and ſo admit two wiſe agents employed in every the moſt ſimple action? But inſtead of ſpeculating farther, let us learn the effect of experiments, and endeavour from theſe to draw plain concluſions.

"1. When I poured a ſolution of opium in water under the ſkin of the leg of a frog, the muſcles, to the ſurface of which it was applied, were very ſoon deprived of the power of contraction. In like manner, when I poured this ſolution into the cavity of the heart, by opening the vena cava, the heart was almoſt inſtantly deprived of its power of motion, whether the experiment was performed on it fixed in its place, or cut out of the body.

"2. I opened the thorax of a living frog; and then tied or cut its aorta, ſo as to put a ſtop to the circulation of its blood. I then opened the vena cava, and poured the ſolution of opium into the heart; and found, not only that this organ was inſtantly deprived of its powers of action, but that in a few minutes the moſt diſtant muſcles of the limbs were extremely weakened. Yet this weakneſs was not owing to the want of circulation, for the frog could jump about for more than an hour after the heart was cut out.

"In the firſt of theſe two experiments, we obſerve the ſuppoſed vis inſita deſtroyed by the opium; in the latter, the vis nervea; for it is evident that the limbs were affected by the ſympathy of the brain, and of the nervous ſyſtem in general, with the nerves of the heart.

"3. When the nerve of any muſcle is firſt divided by a tranſverſe ſection, and then burnt with a hot iron, or punctured with a needle, the muſcle in which it terminates contracts violently, exactly in the ſame manner as when the irritation is applied to the fibres of the muſcle. But when the hot iron, or needle, is confined to the nerve, Dr. Haller himſelf muſt have admitted, that the vis nervea, and not the vis inſita, was excited. But here I would aſk two queſtions. Firſt, Whether we do not as well underſtand how the vis nervea is excited when irritation is applied to the muſcle as when it is applied to the trunk of the nerve, the impelling power of the mind ſeeming to be equally wanting in both caſes? Secondly, If it appears that irritation applied to the trunk of a nerve excites the vis nervea, why ſhould we doubt that it can equally well excite it when applied to the ſmall and very ſenſible branches and terminations of the nerve in the muſcle?

"As, therefore, it appears that the ſuppoſed vis inſita is deſtroyed or excited by the ſame means as the vis nervea; nay, that when, by the application of opium to the heart of a frog, after the aorta is cut and the circulation interrupted, we have deſtroyed the vis inſita, the vis nervea is ſo much extinguiſhed, that the animal cannot act with the diſtant muſcles of the limb; and that theſe afterward grow very torpid, or loſe much of their ſuppoſed vis inſita; it ſeems clearly to follow, that there is no juſt ground for ſuppoſing that any other principle produces the contraction of a muſcle."

The *vis nervoſa*, or operation of the mind, if we may ſo call it, by which a muſcle is brought into contraction, is not inherent in the muſcle like the *vis inſita*, neither is it perpetual, like this latter property. After long continued or violent exerciſe, for example, the voluntary muſcles become painful, and at length incapable of further action; whereas the heart, and other involuntary muſcles, the motions of which depend ſolely on the *vis inſita*, continue through life in a conſtant ſtate of action, without any inconvenience or waſte of this inherent principle. The action of this vis nervoſa on the voluntary muſcles, conſtitutes what is called muſcular motion; a ſubject that has given riſe to a variety of hypotheſis, many of them ingenious, but none of them ſatisfactory.

Borelli and ſome others have undertaken to explain the cauſe of contraction, by ſuppoſing that every muſcular fibre forms as it were a chain of very minute bladders, while the nerves which are diſtributed through the muſcles, bring with them a ſupply of animal ſpirits, which at our will fill theſe bladders, and by increaſing their diameter in width, ſhorten them, and of courſe the whole fibre. Borelli ſuppoſes theſe bladders to be of a rhomboidal ſhape; Bernoullii on the other hand contends that they are oval. Our countryman, Cowper, fancied he had filled them with mercury: the cauſe of this miſtake was probably owing to the mercury's inſinuating itſelf into ſome of the lymphatic veſſels. The late ingenious Mr. Elliot undertook to account for the phenomena of muſcular motion on principles very different from thoſe juſt now mentioned. He ſuppoſed that a dephlogiſticated ſtate of the blood is requiſite for muſcular action, and that a communication of phlogiſton to the blood is a neceſſary effect of ſuch action. We know, that the muſcular fibre is ſhortened, and that the muſcle itſelf ſwells when in action; but how theſe phænomena are produced, we are unable to determine. We likewiſe know that the nerves are eſſential to muſcular motion; for upon dividing or making a ligature round the nerve leading to a muſcle, the latter becomes incapable of motion. A ligature made on the artery of a muſcle produces a ſimilar effect; a proof this, that a regular ſupply of blood is alſo equally neceſſary to muſcular motion. The cauſe of palſy is uſually not to be ſought for in the muſcle affected, but in the nerve leading to that muſcle, or in that part of the brain or ſpinal marrow from which the nerve derives its origin.

OF THE PARTICULAR MUSCLES.

As the enumeration and deſcription of the particular muſcles muſt be dry and unentertaining to the generality of readers, yet cannot be altogether omitted in a work of this nature, it appeared eligible to throw this part of the ſubject into the form of a table; in which the name, origin, inſertion, and principle uſe of each muſcle, will be found deſcribed in few words, and occaſionly its etymology, when it is of Greek derivation or difficult to be underſtood.

A TABLE

A TABLE of the MUSCLES,

ARRANGED ACCORDING TO THEIR SITUATION.

[*N.B.* This table does not include all the muſcles of the body; thoſe belonging to the eyes, internal ear, inteſtinum rectum, and the male and female organs of generation, being deſcribed in other parts of the work. The reader will be pleaſed to obſerve likewiſe, that although all the muſcles (a few only excepted) are in pairs, mention is here made only of the muſcles of one ſide.]

Art. 1. MUSCLES SITUATED UNDER THE INTEGUMENTS OF THE CRANIUM.

Name.	*Origin.*	*Inſertion.*	*Uſe.*
1. *Occipito frontalis.*	From the tranſverſe ridge of the os occipitis.	Into the ſkin of the eye-brows.	To pull the ſkin of the head backwards, and to raiſe the eye-brows and ſkin of the foreh[d].
2. *Corrugator ſupercilii.*	From above the joining of the os frontis, os naſi, and os maxillare.	Into the inner part of the occipito-frontalis.	To draw the eye-brows towards each other, and to wrinkle the forehead.

Art. 2. MUSCLES OF THE EYE-LIDS.

1. *Orbicularis Palpebrarum.*	From around the edge of the orbit.	Into the naſal proceſs of the os maxillare.	To ſhut the eye.
2. *Levator palpebræ ſuperioris.*	From the bottom of the orbit, near the optic foramen.	Into the cartilage of the upper eye-lid.	To open the eye.

Art. 3. MUSCLES OF THE EXTERNAL EAR.

1. *Attollens auriculam.*	From the tendon of the occipito frontalis near the os temporis.	Into the upper part of the ear.	To raiſe the ear.
2. *Anterior auriculæ.*	From near the back part of the zygoma.	Into an eminence behind the helix.	To raiſe this eminence, and to pull it forwards.
3. *Retrahentes* (s) *auriculæ.*	From the outer and back part of the root of the maſtoid proceſs.	Into the convex part of the concha.	To ſtretch the concha, and pull the ear backwards

Art. 4. MUSCLES OF THE CARTILAGES OF THE EAR.

1. *Tragicus*	From the outer and middle part of the concha, near the tragus.	Into the upper part of the tragus.	To depreſs the concha, & pull the point of the tragus a little outwards.
2. *Anti-tragicus.*	From the root of the inner part of the helix.	Into the upper part of the anti-tragus.	To dilate the mouth of the concha.
3. *Tranſverſus auriculæ.*	From the upper part of the concha.	Into the inner part of the helix.	To ſtretch the concha & ſcapha, & likewiſe to pull the parts it is connected with towards each other.
4. *Helicis major.*	From the upper, anterior, and acute part of the helix.	Into the cartilage of the helix, a little above the tragus.	To depreſs the upper part of the helix.
5. *Helicis minor.*	From the lower and fore part of the helix.	Into the helix, near the fiſſure in its cartilage.	To contract the fiſſure.

Art. 5. MUSCLES OF THE NOSE.

1. *Compreſſor* (t) *naſi.*	From the outer part of the root of the ala naſi.	Into the naſal proceſs of the os maxillare, and anterior extremity of the os naſi.	To ſtraighten the noſtrils, and likewiſe to corrugate the ſkin of the noſe.

Art. 6. MUSCLES OF THE MOUTH AND LIPS.

1. *Levator labii ſuperioris, alæque naſi.*	From the outer part of the orbitar proceſs of the os maxillare, and from the naſal proceſs of that bone, where it joins the os frontis.	Into the upper lip, and ala of the noſe.	To draw the upper lip and ſkin of the noſe upwards and outwards.
2. *Levator anguli oris.*	From the os maxillare ſuperius, between the orbitar foramen and the firſt dens molaris.	Into the orbicularis oris at the angle of the mouth	To raiſe the corner of the mouth.
3. *Zygomaticus major.*	From the os malæ, near the zygomatic ſuture.	Into the angle of the mouth.	To raiſe the angle of the mouth, and make the cheek prominent as in laughing.
4. *Zygomaticus minor.*	Immediately above the origin of the zygomatic major.	Into the angle of the mouth.	To raiſe the angle of the mouth obliquely outwards.
5. *Buccinator.*	From the alveoli of the dentes molares in the upper and lower jaws.	Into the angle of the mouth.	To contract the mouth, and draw the angle of it outwards and backwards.
6. *Depreſſor labii ſuperioris, alæque naſi.*	From the os maxill. ſuper. immediately above the gums of the dentes inciſores.	Into the root of the ala naſi and upper lip.	To draw the ala naſi and upper lip downwards.
7. *Depreſſor anguli oris.*	At the ſide of the chin from the lower edge of the maxilla inferior.	Into the angle of the mouth.	To draw the corner of the mouth downwards.
8. *Depreſſor labii inferioris.*	From the lower and anterior part of the maxilla inferior.	Into the under lip.	To draw the under lip downwards and ſomewhat outwards.
9. *Levator labii inferioris.*	From near the gums of the inciſores and caninus of the maxilla inferior.	Into the under lip & ſkin of the chin.	To raiſe the under lip and ſkin of the chin.
10. *Orbicularis Oris* (u).			To ſhut the mouth by conſtringing the lips.

Art. 7. MUSCLES OF THE LOWER JAW.

1. *Temporalis.*	From part of the os bregmatis and os frontis; ſquamous part of the os temporis; back part of the os malæ, and the temporal proceſs of the os ſphenoides (v).	Into the coronoid proceſs of the lower jaw.	To move the lower jaw upwards.
2. *Maſſeter* (w).	From the malar proceſs of the os maxillare, and the lower edges of the os malæ, and of the zygomatic proceſs of the os temporis.	Into the baſis of the coronoid proceſs, and that part of the jaw which ſupports that and the condyloid proceſs.	To raiſe and likewiſe to move the jaw a little forwards and backwards.
3. *Pterygoideus internus.*	From the inner ſurface of the outer wing of the pterygoid proceſs of the os ſphenoides, and from the proceſs of the os palati that helps to form the pterygoid foſſa.	Into the lower jaw on its inner ſide and near its angle.	To raiſe the lower jaw, and draw it a little to one ſide.
4. *Pterygoideus externus.*	From the external ala of the pterygoid proceſs, a ſmall part of the adjacent os maxillare, and a ridge in the temporal proceſs of the os ſphenoides.	Into the fore part of the condyloid proceſs of the lower jaw, and likewiſe of the capſular ligament.	To move the jaw forwards and to the oppoſite ſide (x); and at the ſame time to prevent the ligament of the joint from being pinched.

Art. 8. MUSCLES SITUATED AT THE FORE PART OF THE NECK.

1. *Latiſſimus colli* (y)	From the cellular membrane covering the pectoral, deltoid, and trapezius muſcles.	Into the ſide of the chin and integuments of the cheek.	To draw the cheeks and ſkin of the face downwards; and when the mouth is ſhut, to draw all that part of the ſkin to which it is connected below the lower jaw upwards.
2. *Maſtoideus* (z.)	From the upper part of the ſternum, and from the upper and fore part of the clavicle.	Into the maſtoid proceſs, and as far back as the lambdoidal ſuture.	To move the head to one ſide, or when both muſcles act, to bend it forwards.

(s) Theſe are three ſmall ſlender muſcles. The inferior one is ſometimes wanting.

(t) The noſe is affected by fibres of the occipito frontalis, and by ſeveral muſcles of the face; but this pair, the compreſſores, is the only one that is proper to it.

(u) This muſcle is in a great meaſure, if not wholly, formed by the buccinator, zygomatici, depreſſores, and other muſcles that move the lips. Its fibres ſurround the mouth like a ring.

(v) Some of its fibres likewiſe have their origin from a ſtrong faſcia that covers the muſcle and adheres to the bone round the whole circumference of its origin. When we remove this covering, we find the muſcle of a ſemicircular ſhape with its radiated fibres, converging and forming a ſtrong middle tendon.

(w) So called from its uſe in chewing, its derivation being from μασσαομαι *maſſaomai*, "to eat."

(x) This happens when the muſcle acts ſingly. When both act, the jaw is brought horizontally forwards.

(y) This broad and thin muſcular expanſion, which is ſituated immediately under the common integuments, is by Winſlow named *muſculus cutaneus*. Galen gave it the name of πλατυσμα μυωδες (*Platyſma-myoides*); the etymology of which is from πλατυσμος, *dilatatio*, and μυς, *muſculus*, and ειδος, *forma*.

(z) This, on account of its two origins, is by Albinus deſcribed as two diſtinct muſcles, which he names *ſterno-maſtoideus* and *cleido-maſtoideus*.

1. *Om-*

Art. 9. MUSCLES SITUATED BETWEEN THE TRUNK AND THE OS HYOIDES.

Name.	Origin.	Insertion.	Use.
1. *Omo-hyoideus* (A).	From the upper costa of the scapula near its niche; from part of a ligament that extends across this niche, and sometimes by a few fibres, from the coracoid process.	Into the basis of the os hyoides.	To draw the os hyoides in an oblique direction downwards.
2. *Sterno-hyoideus.*	From the cartilage of the first rib, the inner and upper part of the sternum, and a small part of the clavicle.	Into the basis of the os hyoides.	To draw the os hyoides downwards.
3. *Hyo-thyroideus.*	From part of the basis and horn of the os hyoides.	Into a rough oblique line at the side of the thyroid cartilage.	To raise the thyroid cartilage, or depress the os hyoides.
4. *Sterno-thyroideus.*	From between the cartilages of the 1st and 2d ribs, at the upper and inner part of the sternum.	Immediately under the hyo-thyroideus.	To pull the thyroid cartilage downwards.
5. *Crico-thyroideus.*	From the anterior part and side of the cricoid cartilage.	Into the lower part and inferior horn of the thyroid cartilage.	To pull the cricoid cartilage upwards and backwards, or the thyroid forwards and downwards.

Art. 10. MUSCLES SITUATED BETWEEN THE OS HYOIDES AND LOWER JAW.

1. *Digastricus* (B).	From a fossa at the root of the mastoid process, and likewise from the os hyoides.	Into the lower and anterior part of the chin.	To draw the lower jaw downwards
2. *Stylo-hyoideus* (C).	From the basis of the styloid process.	Into the side and fore part of the os hyoides near its base.	To draw the os hyoides obliquely upwards.
3. *Mylo-hyoideus* (D).	From the inside of the lower jaw, between the last dens molaris and the chin.	Into the basis of the os hyoides.	To move the os hyoides to either side, forwards or upwards.
4. *Geno-hyoideus* (E).	From the inside of the chin.	Into the base of the os hyoides.	To move the os hyoides forwards or upwards.
5. *Genio-glossus.*	From the inside of the chin.	Into the tongue and basis of the os hyoides.	To move the tongue in various directions.
6. *Hyo-glossus* (F.)	From the horn, basis, and appendix of the os hyoides.	Into the tongue laterally.	To draw the tongue downwards and inwards.
7. *Lingualis*	Laterally from the root of the tongue.	Into the extremity of the tongue.	To shorten the tongue, and draw it backwards.
8. *Stylo-glossus.*	From the styloid process, and sometimes also from a ligament that extends from thence to the angle of the lower jaw.	Into the side of the tongue from the root to near its tip.	To move the tongue backwards and to one side.
9. *Stylo-pharyngæus*	From the basis of the styloid process.	Into the side of the pharynx and posterior part of the thyroid cartilage.	To raise the thyroid cartilage and pharynx, and likewise to dilate the latter.
10. *Circumflexus palati*	From near the bony part of the Eustachian tube, and from the spinous process of the os sphenoides.	Into the semilunar edge of the os palati and the velum pendulum palati (G).	To dilate and draw the velum obliquely downwards.
11. *Levator palati.*	From the membranous part of the Eustachian tube, and the extremity of the os petrosum.	Into the velum pendulum palati.	To pull the velum backwards.

Art. 11. MUSCLES SITUATED ABOUT THE FAUCES.

Name.	Origin.	Insertion.	Use.
1. *Palato-pharyngæus*	From the lower and anterior part of the cartilaginous extremity of the Eustachian tube (H); the tendinous expansion of the circumflexus palati; and the velum pendulum palati near the basis and back part of the uvula.	Into the upper and posterior part of the thyroid cartilage.	To raise the pharynx and thyroid cartilage, or to pull the velum and uvula backwards and downwards.
2. *Constrictor isthmi faucium.*	From near the basis of the tongue laterally.	Into the velum pendulum palati, near the basis and fore part of the uvula.	To raise the tongue and draw the velum towards it (I.)
3. *Azygos uvulæ.*	From the end of the future that unites the ossa palati.	Into the extremity of the uvula.	To shorten the uvula, and bring it forwards and upwards.

Art. 12. MUSCLES AT THE BACK PART OF THE PHARYNX.

1. *Constrictor pharyngis superior.*	From the cuneiform process of the occipital bone; the pterygoid process of the os sphenoides, and from each jaw near the last dens molaris (K).	Into the middle of the pharynx.	To move the pharynx upwards and forwards, and to compress its upper part.
2. *Constrictor pharyngis medius* (L).	From the horn and appendix of the os hyoides, and from the ligament that unites it with the thyroid cartilage.	Into the middle of the processus cuneiformis of the occipital bone, about its middle and before the great foramen.	To draw the os hyoides and pharynx upwards, and to compress the latter.
3. *Constrictor pharyngis inferior* (M).	From the cricoid and thyroid cartilages.	Into the middle of the pharynx.	To compress part of the pharynx.

Art. 13. MUSCLES ABOUT THE GLOTTIS.

1 *Crico-arytænideus lateralis.*	From the side of the cricoid cartilage.	Into the basis of the arytænoid cartilage laterally.	To open the glottis.
2 *Crico-arytænoideus posticus.*	From the cricoid cartilage posteriorly.	Into the basis of the arytænoid cartilage posteriorly.	To open the glottis.
3. *Arytæ-noideus obliquus.*	From the basis of one of the arytænoid cartilages.	Near the extremity of the other arytænoid cartilage.	To draw the parts it is connected with towards each other.
4. *Arytæ-noideus transversus*	From one of the arytænoid cartilages laterally.	Into the other arytænoid cartilage laterally.	To shut the glottis.
5. *Thyreo-arytænoideus.*	From the posterior and under part of the thyroid cartilage.	Into the arytænoid cartilage.	To draw the arytænoid cartilage forwards.
6. *Arytæno-epiglottideus*	From the upper part of the arytænoid cartilage laterally.	Into the side of the epiglottis.	To move the epiglottis outwards.
7. *Thyreo-epiglottideus*	From the thyroid cartilage.	Into the side of the epiglottis.	To pull the epiglottis obliquely downwards (N).

Art. 14. MUSCLES AT THE FORE PART OF THE NECK, CLOSE TO THE VERTEBRÆ.

1. *Rectus capitis internus major.*	From the anterior extremities of the tranverse processes of the five lowermost cervical vertebræ.	Into the fore part of the cuneiform process of the os occipitis.	To bend the head forwards.
2. *Rectus capitis internus minor.*	From the anterior and upper part of the first cervical vertebra.	Near the basis of the condyloid process of the os occipitis.	To assist the last described muscle.
3. *Rectus capitis lateralis.*	From the anterior and upper part of the tranverse pro-	Into the os occipitis, opposite to the stylo-mastoid	To move the head to one side.

(A) As this muscle does not always arise from the coracoid process, it seems to have been improperly named *scapulæ hyoideus* by Douglas and Albinus. Winslow calls it *omo-hyoideus*, on account of its general origin from the scapula.

(B) From δὶς and κάρα (*twice*), because it has two fleshy bellies with a middle tendon. This tendon passes through the stylo-hyoideus.

(C) In some subjects we meet with another muscle, which from its having nearly the same origin, insertion, and use as this, has been named *hyo-stylo-æus* after.

(D) So named from its arising near the dentes molares (*mylæ*), and its being inserted into the os hyoides.

(E) From γένυς, *genius*, "the chin."

(F) From ὑοειδὲς, *hyoeides*, and γλῶσσα, *glossa*, "the tongue."

(G) This muscle in its course forms a round tendon, which, after passing over a kind of hook formed by the inner plate of the pterygoid process of the sphenoid bone, expands into a tendinous membrane.

(H) The few fibres that arise from the Eustachian tube are described as a distinct muscle by Albinus, under the name of *pharyngo-staphylæus*. They serve to dilate the mouth of the tube.

(I) This muscle, and the palato-pharyngæus, likewise serve to close the passage into the fauces, and to carry the food into the pharynx.

(K) The three orders of fibres here mentioned, with a few others derived from the tongue, have given occasion to Douglas to describe them as four distinct muscles, under the names of *cephalo-pharyngæus*, *myo-pharyngæus*, *thyro-pharyngæus*, and *chondro-pharyngæus*.

(L) Douglas makes two muscles of this, the *ceratopharyngæus* and *basilo-pharyngæus*.

(M) The *crico-pharyngæus* and *thyro-pharyngæus* of Douglas.

(N) When either this or the preceding muscle acts with its fellow, the epiglottis is drawn directly downwards upon the glottis.

ANATOMY.

Name.	Origin.	Insertion.	Use.
	cess of the first cervical vertebra.	foramen.	
4. *Longus colli.*	Within the thorax, laterally from the bodies of the three uppermost dorsal vertebræ; from the basis and fore part of the transverse processes of the first and second dorsal vertebræ, and of the last cervical vertebræ; and lastly, from the anterior extremities of the transverse processes of the 6th, 5th, 4th, and 3d cervical vertebræ.	Into the second cervical vertebra anteriorly.	To pull the neck to one side (o).

Art. 15. MUSCLES AT THE FORE PART OF THE ABDOMEN.

1. *Obliquus externus.*	From the lower edges of the eight inferior ribs, near their cartilages.	Into the linea alba (p), ossa pubis (q), and spine of the ilium (r).	To compress and support the viscera, assist in evacuating the feces and urine, draw down the ribs, and bend the trunk forwards, or obliquely to one side.
2. *Obliquus internus.*	From the spinous process of the three lowermost lumbar vertebræ, the back part of the os sacrum, the spine of the ilium, and back part of Fallopius's ligament (s.)	Into the cartilages of all the false ribs, linea alba (s), and fore part of the pubis.	To assist the obliquus externus.
3. *Transversalis.*	From the cartilages of the seven inferior ribs; the transverse processes of the last dorsal, and four upper lumbar vertebræ; the inner part of Fallopius's ligament and the spine of the ilium.	Into the linea alba and cartilago ensiformis.	To compress the abdominal viscera.
4. *Rectus abdominis.*	From the upper edge of the pubis and the symphysis pubis.	Into the cartilages of the 5th, 6th, and 7th ribs, and to the edge of the cartilago ensiformis (u).	To compress the fore part of the abdomen, and to bend the trunk forwards.
5. *Pyramidalis* (v).	From the anterior and upper part of the pubis.	Into the linea alba and inner edge of the rectus, commonly about two inches above the pubis.	To assist the lower portion of the rectus.

Name.	Origin.	Insertion.	Use.
Art. 16. MUSCLES AT THE FORE PART OF THE THORAX.			
1. *Pectoralis Major.*	From the cartilaginous ends of the 5th and 6th ribs; the sternum, and anterior part of the clavicle.	Into the upper and inner part of the os humeri (w).	To draw the arm forwards, or obliquely forwards.
2. *Subclavius.*	From the cartilage of the first rib.	Into the under surface of the clavicle.	To move the clavicle forwards and downwards, and to assist in raising the first rib
3. *Pectoralis minor* (x).	From the upper edges of the 3d, 4th, and 5th ribs.	Into the coracoid process of the scapula.	To move the scapula forwards and downwards, or to elevate the ribs.
4. *Serratus Magnus.*	From the eight superior ribs.	Into the basis of the scapula.	To bring the scapula forwards.
Art. 17. MUSCLES THAT CONCUR IN FORMING THE THORAX.			
1. *Diaphragma* (y)			
2. *Levatores costarum.*	From the transverse processes of the last cervical, and the eleven upper dorsal vertebræ.	Into the upper side of each rib, near its tuberosity	To move the ribs upwards and outwards.
3. *Intercostales externi*	From the lower edge of each upper rib.	Into the superior edge of each lower rib.	To elevate the ribs.
4. *Intercostales interni* (z).			
5. *Sternocostales* (a).	From the cartilago ensiformis, and lower and middle part of the sternum.	Into the cartilages of the 2d, 3d, 4th, 5th, and 6th ribs.	To depress the cartilages of the ribs.
Art. 18. MUSCLES AT THE BACK PART OF THE NECK AND TRUNK.			
1. *Trapezius (c), or cucullaris.*	From the middle of the os occipitis, and the spinous processes of the two inferior cervical, and of all the dorsal vertebræ (d).	Into the posterior half of the clavicle, part of the acromion, and the spine of the scapula.	To move the scapula.
2. *Rhomboidus* (e).	From the spinous processes of the three lowermost cervical, and of all the dorsal vertebræ.	Into the basis of the scapula.	To move the scapula upwards and backwards.
3. *Latissimus dorsi.*	From part of the spine of the os ilium, the spinous processes of the os sacrum and lumbar vertebræ, and of six or eight of the dorsal vertebræ; also from the 4 inferior false ribs near their cartilages.	Into the os humeri, at the inner edge of the groove for lodging the long head of the biceps muscle.	To draw the os humeri downwards and backwards, and to roll it upon its axis.

(o) When both muscles act, the neck is drawn directly forwards.

(p) The linea alba is that tendonous expansion which reaches from the cartilago ensiformis to the os pubis. It is formed by the interlacement of the tendonous fibres of the oblique and transverse muscles, and on this account some anatomists have considered these as three digastric muscles.

(q) A little above the pubis the tendonous fibres of this muscle separate from each other, so as to form an opening called the *ring* of the obliquus externus, and commonly, though improperly, the ring of the abdominal muscles, there being no such aperture either in the transversalis or obliquus internus. This ring in the male subject affords a passage to the spermatic vessels, and in the female to the round ligament of the uterus.

(r) From the anterior and upper spinous process of the ilium, this muscle is stretched tendonous to the os pubis, and thus forms what is called by some *Fallopius's*, and by others *Poupart's ligament*. The blood vessels pass under it to the thigh.

(s) The tendon formed by the upper part of this muscle in its way to the linea alba is divided into two layers. The posterior layer runs under, and the anterior one over, the rectus muscle.

(t) From this part it detaches some fibres which extend downwards upon the spermatic chord, and form what is described as the cremaster muscle.

(u) The fibres of the rectus are generally divided by three tendonous intersections. The two upper thirds of this muscle passing between the tendonous layers of the obliquus internus, are inclosed as it were in a sheath; but at its lower part we find it immediately contiguous to the peritonæum, the inferior portion of the tendon of the transversalis passing over the rectus, and adhering to the anterior layer of the obliquus internus.

(v) This muscle is sometimes wanting.

(w) The fibres of this muscle pass towards the axilla in a folding manner, and with those of the latissimus dorsi form the arm-pit.

(x) This and some other muscles derive their name of *serratus*, from their arising by a number of tendinous or fleshy digitations, resembling the teeth of a saw (*serra*).

(y) For a description of the diaphragm, see Part IV. Sect. IV.

(z) The origin, insertion, and use of the internal intercostals, are similar to those of the external. The reader, however, will be pleased to observe, that the intercostales externi occupy the spaces between the ribs only from the spine to their cartilages; from thence to the sternum, there being only a thin membrane, which is spread over the intercostales interni; and that the latter, on the contrary, extend only from the sternum to the angles of each rib. The fibres of the external muscles run obliquely forwards; those of the internal obliquely backwards. This difference in the direction of their fibres induced Galen to suppose that they were intended for different uses; that the external intercostals, for instance, serve to elevate, and the internal ones to depress the ribs. Fallopius seems to have been the first who ventured to dispute the truth of this doctrine, which has since been revived by Boyle, and more lately still by Hamberger, whose theoretical arguments on this subject have been clearly refuted by the experiments of Haller.

(a) These consist of four, and sometimes five distinct muscles on each side. Vesalius, and after him Douglas and Albinus, confound them as forming a single muscle, which, on account of its shape, they name *serratus*. Verheyen, Winslow, and Haller, more properly describe them as so many separate muscles, which, on account of their origin and insertion, they name *sterno-costales*.

(b) So named by Riolanus, from *trapezium*, on account of its quadrilateral shape. Columbus and others give it the name of *cucullaris*, from its resemblance to a monk's hood.

(c) The tendonous fibres of this muscle, united with those of its fellow in the nape of the neck, form what is called the *ligamentum cervicis*.

(d) This muscle consists of two distinct portions, which are described as separate muscles by Albinus, under the names of *rhomboideus minor* and *rhomboideus major*.

Name.	Origin.	Insertion.	Uſe.
4. *Serratus inferior poſticus.*	From the ſpinous proceſſes of the two lowermoſt dorſal, and of three of the lumbar vertebræ.	Into the lower edges of the three or four lowermoſt ribs near their cartilages.	To draw the ribs outwards, downwards, and backwards.
5. *Levator ſcapulæ.*	From the tranſverſe proceſſes of the four uppermoſt vertebræ colli.	Into the upper angle of the ſcapula.	To move the ſcapula forwards and upwards.
6. *Serratus ſuperior Poſticus.*	From the lower part of the ligamentum colli, the ſpinous proceſs of the lowermoſt cervical vertebræ, and of the two ſuperior dorſal vertebræ.	Into the 2d, 3d, and 4th ribs.	To expand the thorax.
7. *Splenius* (F).	From the ſpinous proceſſes of the four or five uppermoſt vertebræ of the back, and of the lowermoſt cervical vertebræ.	Into the tranſverſe proceſſes of the two firſt cervical vertebræ, the upper and back part of the maſtoid proceſs, and a ridge on the os occipitis.	To move the head backwards.
8. *Complexus* (G).	From the tranſverſe proceſſes of the four or five uppermoſt dorſal, and of the ſix lowermoſt cervical vertebræ.	Into the os occipitis.	To draw the head backwards.
9. *Trachelo maſtoideus* (H).	From the tranſverſe proceſſes of the firſt dorſal vertebra, and four or five of the lowermoſt cervical vertebræ.	Into the maſtoid proceſs.	To draw the head backwards.
10. *Rectus capitis poſticus major.*	From the ſpinous proceſs of the ſecond cervical vertebra.	Into the os occipitis.	To extend the head and draw it backwards.
11. *Rectus capitis poſticus minor.*	From the firſt vertebra of the neck.	Into the os occipitis.	To aſſiſt the rectus major.
12 *Obliquus ſuperior capitis.*	From the tranſverſe proceſs of the firſt cervical vertebra.	Into the os occipitis.	To draw the head backwards.
13 *Obliquus inferior capitis.*	From the ſpinous proceſs of the ſecond cervical vertebra.	Into the tranſverſe proceſs of the firſt cervical vertebra.	To draw the face towards the ſhoulder, and to move the firſt vertebra upon the ſecond.
14. *Sacro-lumbalis* (I).	From the back part of the os ſacrum, ſpine of the ilium, ſpinous proceſſes, and roots of the tranſverſe proceſſes of the vertebræ of the loins.	Into the lower edge of each rib.	To draw the ribs downwards, move the body upon its axis, aſſiſt in erecting the trunk, and turn the neck backwards, or to one ſide.
15. *Longiſſimus dorſi* (K)	The ſame as that of the ſacro-lumbalis.	Into the tranſverſe proceſſes of the dorſal vertebræ.	To ſtretch the vertebræ of the back, and keep the trunk erect.
16. *Spinalis dorſi.*	From the ſpinous proceſſes of the uppermoſt lumbar and lowermoſt dorſal vertebræ.	Into the ſpinous proceſſes of the nine ſuperior dorſal vertebræ.	To extend the vertebræ.
17 *Semi-ſpinalis dorſi.*	From the tranſverſe proceſſes of the 7th, 8th, 9th, and 10th vertebræ of the back.	Into the ſpinous proceſſes of the four uppermoſt dorſal, and lowermoſt of the cervical vertebræ.	To draw the ribs outwards, downwards, and backwards.
18. *Multifidus Spinæ* (L).	From the os ſacrum, ilium, oblique and tranſverſe proceſſes of the lumbar vertebræ, tranſverſe proceſſes of the dorſal, and four of the cervical vertebræ.	Into the ſpinous proceſſes of the lumbar, dorſal, and ſix of the cervical vertebræ.	To extend the back and draw it backwards, or to one ſide.
19 *Semi ſpinalis colli.*	From the tranſverſe proceſſes of the five or ſix uppermoſt dorſal vertebræ.	Into the ſpinous proceſſes of the 2d, 3d, 4th, 5th, and 6th cervical vertebræ.	To ſtretch the neck obliquely backwards.
20. *Scalenus* (M).	From the tranſverſe proceſſes of the five inferior cervical vertebræ.	Into the upper and outer part of the firſt and ſecond ribs.	To move the neck forwards, or to one ſide.
21. *Interſpinales* (N)	From the upper part of each of the ſpinous proceſſes of the ſix inferior cervical vertebræ.	Into the under part of each of the ſpinous proceſſes of the vertebræ above.	To draw the ſpinous proceſſes inwards each other.
22. *Inter-tranſverſales* (O)	From the upper part of each of the tranſverſe proceſſes of the vertebræ.	Into the under part of each of the tranſverſe proceſſes of the vertebræ above.	To draw the tranſverſe proceſſes towards each other.

Art. 19. MUSCLES WITHIN THE CAVITY OF THE ABDOMEN, OR THE ANTERIOR AND LATERAL PARTS OF THE SPINE.

1. *Pſoas parvus* (P)	From the ſides and tranſverſe proceſſes of the uppermoſt lumbar vertebra, and ſometimes of the lowermoſt dorſal vertebra.	Into the brim of the pelvis, at the junction of the os pubis with the ilium.	To bend the loins forwards.
2. *Pſoas magnus.*	From the bodies and tranſverſe proceſſes of the laſt dorſal, and all the lumbar vertebræ.	Into the os femoris, a little below the trochanter minor.	To bend the thigh forwards.
3. *Iliacus internus.*	From the inner lip, hollow part, and edge of the os ilium.	In common with the pſoas magnus.	To aſſiſt the pſoas magnus.
4. *Quadratus lumborum* (Q).	From the poſterior part of the ſpine of the ilium.	Into the tranſverſe proceſſes of the four uppermoſt lumbar vertebræ, the inferior edge of the laſt rib, and the ſide of the lowermoſt dorſal vertebra.	To ſupport the ſpine, or to draw it to one ſide.
5 *Coccygæus*	From the poſterior and inner edge of the ſpine of the iſchium.	Into the lower part of the os ſacrum, and almoſt the whole length of the os coccygis latterally.	To draw the os coccygis forwards and inwards (R).

Art. 20. MUSCLES ON THE SCAPULA AND UPPER PART OF THE OS HUMERI.

1. *Deltoides* (S)	From the clavicle, proceſſus acromion, and ſpine of the ſcapula.	Into the anterior and middle part of the os humeri.	To raiſe the arm.

(F) According to ſome writers, this muſcle has gotten its name from its reſemblance to the ſpleen; others derive it from *ſplenium ſplint.*

(G) So named on account of its complicated ſtructure.

(H) So named from its origin from the neck (τραχηλος) and its inſertion into the maſtoid proceſs.

(I) Several thin faſciculi of fleſhy fibres ariſe from the lower ribs, and terminate in the inner ſide of this muſcle. Steno names them *muſculi ad ſacro lumbalem acceſſorii.* The ſacro lumbalis likewiſe ſends off a fleſhy ſlip from its upper part, which by Douglas and Albinus is deſcribed as a diſtinct muſcle, under the name of *cervicalis deſcendens.* Morgagni has very properly conſidered it as a part of the ſacro-lumbalis.

(K) At the upper part of this muſcle a broad thin layer of fleſhy fibres is found croſſing, and intimately adhering to it. This portion, which is deſcribed by Albinus under the name of *tranſverſalis cervicis*, may very properly be conſidered as an appendage to the longiſſimus dorſi. It ariſes from the tranſverſe proceſſes of the five or ſix ſuperior dorſal vertebræ, and is inſerted into the tranſverſe proceſſes of the ſix inferior cervical vertebræ. By means of this appendage the longiſſimus dorſi may ſerve to move the neck to one ſide, or obliquely backwards.

(L) Anatomiſts in general have unneceſſarily multiplied the muſcles of the ſpine. Albinus has the merit of having introduced greater ſimplicity into this part of myology. Under the name of *multifidus ſpinæ*, he has very properly included thoſe portions of muſcular fleſh intermixed with tendonous fibres, ſituated cloſe to the back part of the ſpine, and which are deſcribed by Douglas under the names of *tranſverſales colli, dorſi, & lumborum.*

(M) The ancients gave it this name from its reſemblance to an irregular triangle (σκαληνος). It conſiſts of three fleſhy portions. The anterior one affords a paſſage to the axillary artery, and between this and the middle portion we find the nerves going to the upper extremities. The middle is in part covered by the poſterior portion, which is the longeſt and thinneſt of the three.

(N) In the generality of anatomical books we find theſe muſcles divided into *inter ſpinales cervicis, dorſi*, and *lumborum*, but we do not find any ſuch muſcles either in the loins or back.

(O) Theſe muſcles are to be found only in the neck and loins; what have been deſcribed as the *inter-tranſverſales dorſi* being rather ſmall tendons than muſcles.

(P) This and the following pair of muſcles derive their name of *pſoas* from ψοα, *lumbus*, on account of their ſituation at the anterior part of the loins.

(Q) So called from its ſhape, which is that of an irregular ſquare.

(R) Some of the fibres of this muſcle are united with thoſe of the levator ani, ſo that it aſſiſts in cloſing the lower part of the pelvis.

(S) So named from its ſuppoſed reſemblance to the Greek Δ reverſed,

Name.	Origin.	Insertion.	Use.
2 *Supraspinatus.*	From the basis, spine, and upper costa of the scapula.	Into a large tuberosity at the head of the os humeri.	To raise the arm.
3. *Infraspinatus.*	From the basis and spine of the scapula.	Into the upper and middle part of the tuberosity.	To roll the os humeri outwards.
4. *Teres minor* (t).	From the inferior costa of the scapula.	Into the lower part of the tuberosity.	To assist the infraspinatus.
5. *Teres major.*	From the inferior angle, and inferior costa of the scapula.	Into the ridge at the inner side of the groove formed for the long head of the biceps.	To assist in the rotatory motion of the arm.
6. *Subscapularis.*	From the basis, superior and inferior costæ of the scapula.	Into the upper part of a small tuberosity at the head of the os humeri.	To roll the arm inwards.
7. *Coracobrachialis* (u).	From the coracoid process of the scapula.	Into the middle and inner side of the os humeri.	To roll the arm forwards and upwards.

Art. 21. MUSCLES ON THE OS HUMERI.

1 *Biceps flexor cubiti.*	By two heads, one from the coracoid process, and the other or long head, from the upper and outer edge of the glenoid cavity of the scapula;	Into the tuberosity at the upper end of the radius;	To bend the forearm.
2 *Brachiæus internus.*	From the os humeri, below, and at each side of the tendon of the deltoides.	Into a small tuberosity at the fore part of the coronoid process of the ulna.	To assist in bending the fore-arm.
3 *Triceps extensor cubiti.*	By three heads; the first, from the inferior costa of the scapula; the second, from the upper and outer part of the os humeri; and the third, from the back part of that bone.	Into the upper and outer part of the olecranon.	To extend the fore-arm.

Art. 22. MUSCLES ON THE FORE ARM.

1. *Supinator longus.*	From the outer ridge and anterior surface of the os humeri, a little above its outer condyle.	Into the radius near its styloid process.	To assist in turning the palm of the hand upwards
2. *Extensor carpi radialis longus.*	Immediately below the origin of the supinator longus.	Into the upper part of the metacarpal bone of the fore-finger.	To extend the wrist.
3. *Extensor carpi radialis brevis.*	From the outer and lower part of the outer condyle of the os humeri, and the upper part of the radius	Into the upper part of the metacarpal bone of the middle finger.	To assist the extensor longus.
4. *Extensor digitorum communis.*	From the outer condyle of the os humeri.	Into the back part of all the bones of the four fingers.	To extend the fingers.
5. *Extensor minimi digiti.*	From the outer condyle of the os humeri.	Into the bones of the little finger.	To extend the little finger.
6. *Extensor carpi ulnaris.*	From the outer condyle of the os humeri.	Into the metacarpal bone of the little finger.	To assist in extending the wrist.
7. *Anconæus* (v).	From the outer condyle of the os humeri.	Into the outer edge of the ulna.	To extend the fore-arm.
8. *Flexor carpi ulnaris.*	From the inner condyle of the os humeri, and anterior edge of the olecranon (w).	Into the os pisiforme.	To assist in bending the hand.
9. *Palmaris longus.*	From the inner condyle of the os humeri.	Into the internal annular ligament, and aponeurosis palmaris (x).	To bend the hand
10. *Flexor carpi radialis.*	From the inner condyle of the os humeri.	Into the metacarpal bone of the fore finger.	To bend the hand
11 *Pronator radii teres.*	From the outer condyle of the os humeri, and coronoid process of the ulna.	Into the anterior and convex edge of the radius, near its middle.	To roll the hand inwards.
12. *Flexor sublimis perforatus* (y)	From the inner condyle of the os humeri, inner edge of the coronoid process of the ulna, and upper and anterior part of the radius.	Into the second bone of each finger.	To bend the second joint of the fingers.
13 *Supinator radii brevis*	From the outer condyle of the os humeri, and posterior surface and outer edge of the ulna.	Into the anterior, inner, and upper part of the radius	To roll the radius outwards.
14 *Abductor pollicis longus.*	From the middle and back part of the ulna, interosseous ligament, and radius.	By two tendons into the os trapezium, and first bone of the thumb	To stretch the first bone of the thumb outwards.
15 *Extensor minor pollicis.*	From the back part of the ulna, and interosseous ligament and radius.	Into the convex part of the second bone of the thumb	To extend the second bone of the thumb obliquely outwards.
16 *Extensor major pollicis.*	From the back of the ulna and interosseous ligament.	Into the third and last bone of the thumb.	To stretch the thumb obliquely backwards.
17 *Indicator*	From the middle of the ulna.	Into the metacarpal bone of the fore-finger.	To extend the fore-finger.
18. *Flexor profundus perforans.*	From the upper and fore part of the ulna, and interosseous ligament.	Into the fore part of the last bone of each of the fingers.	To bend the last joint of the fingers
19. *Flexor longus pollicis.*	From the upper and fore part of the radius	Into the last joint of the thumb.	To bend the last joint of the thumb
20 *Pronator radii quadratus.*	From the inner and lower part of the ulna.	Into the radius, opposite to its styloid.	To roll the radius inwards, and of course to assist in the pronation of the hand

Art. 23. MUSCLES OF THE HAND.

1. *Lumbricales* (z).	From the tendons of the perforans.	Into the tendons of the extensor digitorum communis	To bend the first, and to extend the two last joints of the fingers (a).
2. *Abductor brevis pollicis.*	From the fore part of the internal annular ligament, os scaphoides, and one of the tendons of the abductor longus pollicis.	Into the outer side of the second bone of the thumb near its root.	To move the thumb from the fingers.
3. *Opponens pollicis.*	From the inner and anterior part of the internal annular ligament, and from the os scaphoides.	Into the first bone of the thumb.	To move the thumb inwards, and to turn it upon its axis.
4. *Flexor brevis pollicis.*	From the os trapezoides, internal annular ligament, os magnum and os unciforme	Into the ossa sesamoidea and second bone of the thumb.	To bend the second joint of the thumb.
5. *Adductor pollicis.*	From the metacarpal bone of the middle finger.	Into the basis of the second bone of the thumb.	To move the thumb towards the fingers.
6. *Abductor indicis.*	From the inner side of the first bone of the thumb, and from the os trapezium.	Into the first bone of the fore finger posteriorly.	To move the fore finger towards the thumb.
7. *Palmaris brevis.*	From the internal annular ligament, and aponeurosis palmaris.	Into the os pisiforme, and the skin covering the abductor minimi digiti.	To contract the palm of the hand.
8. *Abductor minimi digiti.*	From the internal annular ligament and os pisiforme.	Into the side of the first bone of the little finger.	To draw the little finger from the rest.
9. *Flexor parvus minimi digiti.*	From the os unciforme and internal annular ligament.	Into the first bone of the little finger	To bend the little finger.
10 *Adductor metacarpi minimi digiti*	From the os unciforme and internal annular ligament.	Into the metacarpal bone of the little finger.	To move that bone towards the rest.

(t) This and the following pair are called *teres*, from their being of a long and round shape.

(u) This muscle affords a passage to the musculo-cutaneous nerve.

(v) So called from *ulna, cubitus*.

(w) Between the two origins of this muscle we find the ulnor-nerve going to the fore arm.

(x) The aponeurosis palmaris is a tendonous membrane that extends over the palm of the hand. Some anatomists have supposed it to be a production of the tendon of this muscle, but without sufficient grounds; for in some subjects we find the palmaris longus inserted wholly into the annular ligament, so as to be perfectly distinct from this aponeurosis: and it now and then happens, that no palmaris longus is to be found, whereas this expansion is never deficient.

(y) This muscle is named *perforatus*, on account of the four tendons in which it terminates, being perforated by those of another muscle, the perforans.

(z) So named from their being shaped somewhat like the lumbricus or earth-worm.

(a) Fallopius was the first who remarked the two opposite ufes of this muscle. Their extending power is owing to their connection with the extenfor communis.

Name.	Origin.	Insertion.	Uſe.
11 *Interoſſei interni.*	Situated between the metacarpal bones.	Into the roots of the fingers.	To extend the fingers and move them towards the thumb (B).
10 *Interoſſei externi.*	Situated between the metacarpal bones on the back of the hand.	Into the roots of the fingers.	To extend the fingers; but the firſt draws the middle finger inwards, the ſecond draws it outwards, and the third draws the ring finger inwards.

Art 24. MUSCLES AT THE BACK PART OF THE PELVIS, AND UPPER PART OF THE THIGH.

1. *Glutæus (C) maximus.*	From the ſpine of the ilium, poſterior ſacro-iſchiatic ligaments, os ſacrum, and os coccygis.	Into the upper part of the *linea aſpera* of the os femoris.	To extend the thigh and draw it outwards.
2. *Glutæus medius.*	From the ſpine and ſuperior ſurface of the ilium.	Into the outer and back part of the great trochanter of the os femoris.	To draw the thigh outwards and a little backwards, and when it is bended, to roll it.
3 *Glutæus minimus.*	From the outer ſurface of the ilium and the border of its great niche.	Into the upper and anterior part of the great trochanter.	To aſſiſt the former.
4. *Pyriformis (D).*	From the anterior part of the os ſacrum.	Into a cavity at the root of the trochanter major.	To roll the thigh outwards.
5. *Gemini (E)*	By two portions, one from the outer ſurface of the ſpine of the iſchium; the other from the tuberoſity of the iſchium and poſterior ſacro-iſchiatic ligament.	Into the ſame cavity as the pyriformis.	To roll the thigh outwards, and likewiſe to confine the tendon of the obturator internus, when the latter is in action.
6 *Obturator internus.*	From the ſuperior half of the inner border of the foramen thyroideum.	Into the ſame cavity with the former.	To roll the thigh outwards.
7 *Quadratus (F) femoris*	From the tuberoſity of the iſchium.	Into a ridge between the trochanter major and trochanter minor.	To move the thigh outwards.

Art 25. MUSCLES ON THE THIGH (G).

1. *Biceps flexor cruris.*	By two heads; one from the tuberoſity of the iſchium, the other from the linea aſpera near the inſertion of the glutæus maximus.	Into the upper and back part of the fibula (H).	To bend the leg.
2. *Semi-tendinoſus.*	From the tuberoſity of the iſchium.	Into the upper and inner part of the tibia.	To bend and draw the leg inwards.
3 *Semi-membranoſus* (I)	From the tuberoſity of the iſchium.	Into the upper & back part of the head of the tibia.	To bend the leg.
4 *Tenſor vaginæ femoris.*	From the ſuperior and anterior ſpinous proceſs of the ilium.	Into the inner ſide of the faſcia lata, which covers the outſide of the thigh.	To ſtretch the faſcia.
5. *Sartorius*	From the ſuperior and anterior ſpinous proceſs of the ilium.	Into the upper and inner part of the tibia.	To bend the leg inwards (K).
6. *Rectus.*	By two tendons; one from the anterior and inferior ſpinous proceſs of the ilium; the other from the poſterior edge of the cotyloid cavity.	Into the upper and fore part of the patella.	To extend the leg
7. *Gracilis.*	From the fore-part of the iſchium and pubis.	Into the upper and inner part of the tibia.	To bend the leg.
8. *Vaſtus externus* (L).	From the anterior and lower part of the great trochanter, and the outer edge of the linea aſpera.	To the upper and outer part of the patella.	To extend the leg
9. *Vaſtus internus.*	From the inner edge of the linea aſpera, beginning between the fore-part of the os femoris and the root of the leſſer trochanter.	Into the upper and inner part of the patella.	To extend the leg
10 *Cruræus* (M).	From the outer and anterior part of the leſſer trochanter	Into the upper part of the patella.	To extend the leg
11. *Pectinalis.*	From the anterior edge of the os pubis, or pectinis, as it is ſometimes called.	Into the upper and fore-part of the linea aſpera.	To draw the thigh inwards, upwards and to roll it a little outwards.
12. *Adductor longus femoris* (N)	From the upper and fore part of the os pubis	Near the middle and back part of the linea aſpera.	To draw the thigh inwards, upwards, and to roll it a little outwards.
13. *Adductor brevis femoris.*	From the fore part of the ramus of the os pubis.	Into the inner and upper part of the linea aſpera.	
14. *Adductor magnus femoris.*	From the lower and fore part of the ramus of the os pubis.	Into the whole length of the linea aſpera	
15 *Obturator externus*	From part of the obturator ligament, and the inner half of the circumference of the foramen thyroideum.	Into the os femoris near the root of the great trochanter.	To move the thigh outwards in an oblique direction, and likewiſe to bend and draw it inwards.

Art. 26. MUSCLES ON THE LEG.

1 *Gaſtrocnemius* (O) *externus.*	By a heads; 1 from the inner condyle, the oth[r] from the out[r] condyle of the os femoris.	By a great round tendon, common to this and the following muſcle.	To extend the foot.
2 *Gaſtrocnemius* (P) *internus.*	By two heads; one from the back part of the head of the fibula, the other from the upper and back part of the tibia.	By a large tendon (the *tendo achillis*) common to this & the former muſcle, into the lower and back part of the os calcis.	To extend the foot.
3 *Plantaris* (Q)	From the upper and poſterior part of the outer condyle of the os femoris.	Into the inſide of the back part of the os calcis.	To aſſiſt in extending the foot.
4. *Popliteus* (R).	From the outer condyle of the thigh.	Into the upper & inner part of the tibia.	To aſſiſt in bending the leg and rolling it inwards.
5. *Flexor longus digitorum pedis* (S).	From the upper and inner part of the tibia.	By four tendons, which, after paſſing through the perforations in thoſe of the flexor digitorum brevis, are inſerted into the laſt bone of all the toes, except the great toe.	To bend the laſt joint of the toe.

(B) The third interoſſeus internus (for there are four of the externi and three of the interni) differs from the reſt in drawing the middle finger from the thumb.

(C) From γλουτος, *nates* (D) So named from its pear-like ſhape.

(E) The two portions of this muſcle having been deſcribed as two diſtinct muſcles by ſome anatomiſts, have occaſioned it to be named *gemini*. The tendon of the obturator internus runs between theſe two portions

(F) This muſcle is not of the ſquare ſhape its name would ſeem to indicate.

(G) The muſcles of the leg and thigh are covered by a broad tendonous membrane called *faſcia lata*, that ſurrounds them in the manner of a ſheath. It is ſent off from the tendons of the glutæi and other muſcles, and dipping down between the muſcles it covers, adheres to the linea aſpera, and ſpreading over the joint of the knee, gradually diſappears on the leg. It is thickeſt on the inſide of the thigh.

(H) The tendon of this muſcle forms the *outer ham-ſtring*.

(I) So named on account of its origin, which is by a broad flat tendon three inches long.

(K) Spigelius was the firſt who gave this the name of *ſartorius*, or the taylor's muſcle, from its uſe in croſſing the legs.

(L) The vaſtus externus, vaſtus internus, and cruræus, are ſo intimately connected with each other, that ſome anatomiſts have been induced to conſider them as a *triceps*, or ſingle muſcle with three heads.

(M) Under the cruræus we ſometimes meet with two ſmall muſcles, to which Albinus has given the name of *ſub-cruræi*. They terminate on each ſide of the patella, and prevent the capſular ligament from being pinched. When they are wanting, which is very often the caſe, ſome of the fibres of the cruræus are found adhering to the capſula.

(N) This and the two following muſcles have been uſually, but improperly, conſidered as forming a ſingle muſcle with three heads, and on that account named *triceps femoris*.

(O) Γαστροκνημια, *ſura*, "the calf of the leg."

(P) This muſcle is by ſome anatomiſts named *ſolæus*, on account of its being ſhaped like the ſole-fiſh.

(Q) This muſcle has gotten the name of *plantaris*, from its being ſuppoſed to furniſh the aponeuroſis that covers the ſole of the foot; but it does not in the leaſt contribute to the formation of that tendonous expanſion.

(R) So called on account of its ſituation at the ham (*poples*).

(S) This muſcle, about the midſle of the foot, unites with a fleſhy maſs, which, from its having firſt been deſcribed by Sylvius, is uſually called *maſſa carnea* JACOBI SYLVII.

Front and Back Views of the third and fourth Layer of Muscles.

See the System. Part 2. Sect. 2.

Fig. 2.

The Table represents the Third Layer of Muscles on the Posterior part of the Body.

Fig. 1.

The Table represents the Third Layer of Muscles on the Anterior part of the Body.

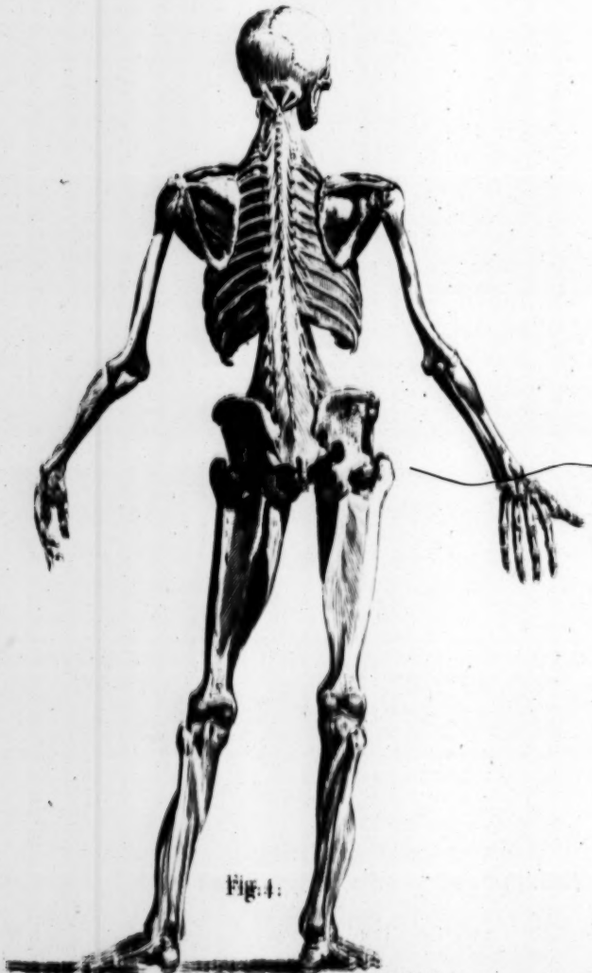


Fig. 4.

The Table represents the Fourth Layer of Muscles on the Posterior part of the Body.

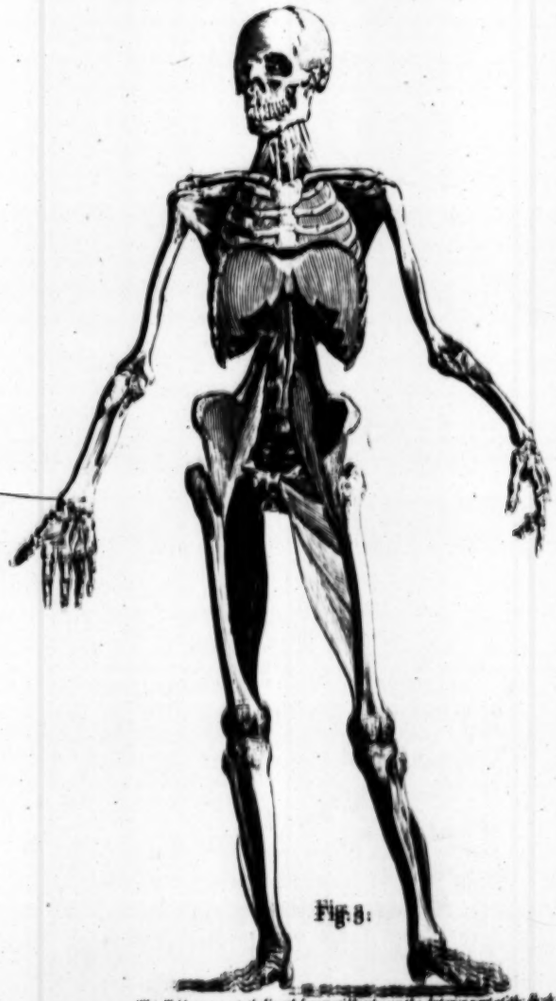


Fig. 3.

The Table represents the Fourth Layer of Muscles on the Anterior part of the Body.

Muscles; See System of Anatomy, Part 2. Section 2.

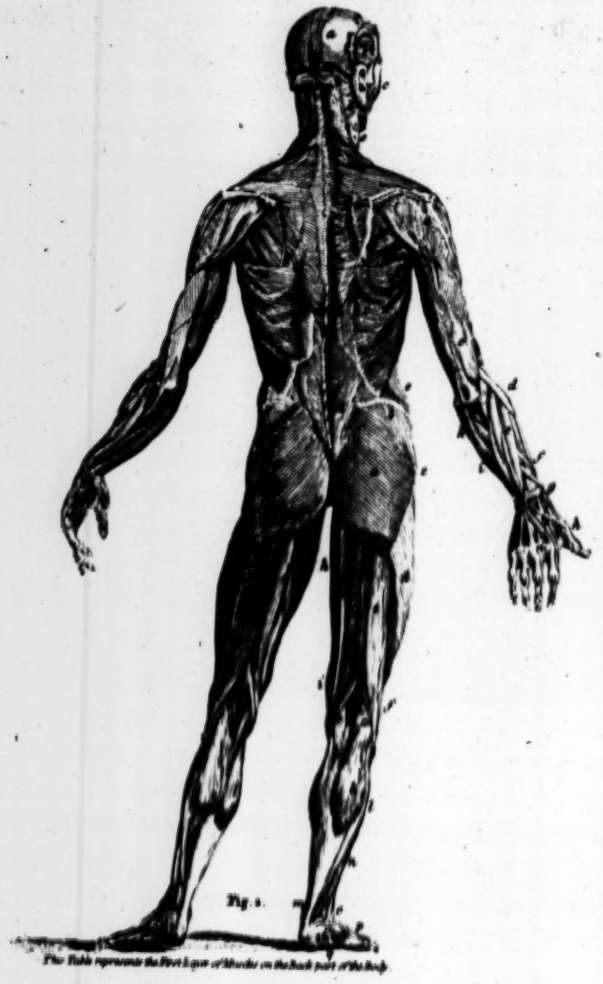


Fig. 2.

This Table represents the First Layer of Muscles on the Back part of the Body.

Fig. 1.

This Table represents the First Layer of Muscles on the Anterior part of the Body.

Fig. 4.

This Table represents the Second Layer of Muscles on the Back part of the Body.

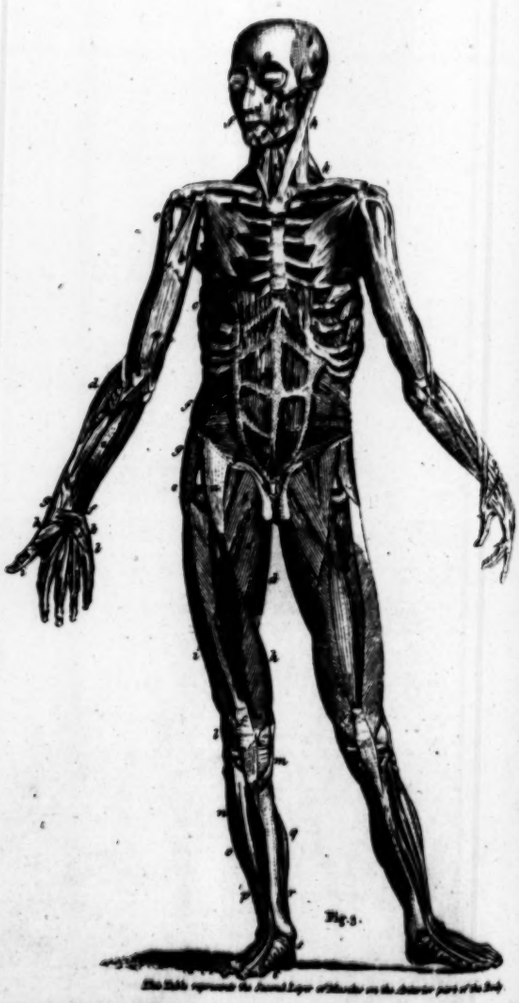


Fig. 3.

This Table represents the Second Layer of Muscles on the Anterior part of the Body.

Grainger Fecit.

Engraved for Hall's Encyclopædia, & Printed for C. Cooke No. 17, Paternoster Row.

Name.	Origin.	Insertion.	Use.
6. *Flexor longus pollicis pedis.*	From the back part, and a little below the head of the fibula.	Into the laſt bone of the great toe.	To bend the great toe.
7. *Tibialis poſticus.*	From the back part and outer edge of the tibia, & likewiſe from the interoſſeous ligament and adjacent part of the fibula.	Into the inner and upper part of the os naviculare and ſide of the os cuneiforme medium.	To move the foot inwards.
8. *Peroneus longus.*	From the outer ſide of the head of the tibia, and alſo from the upper, anterior, and outer part of the *perone* or fibula, to which it adheres for a conſiderable way down.	Into the metatarſal bone of the great toe.	To move the foot outwards.
9. *Peroneus brevis.*	From the outer and fore-part of the fibula.	Into the metatarſal bone of the little toe.	To aſſiſt the laſt deſcribed muſcle.
10 *Extenſor longus digitorum pedis.*	From the upper, outer, and fore part of the tibia, interoſſeous ligament, and inner edge of the fibula.	By four tendons into the firſt joint of the ſmaller toes.	To extend the toes.
11. *Peroneus tertius.*	From the fore-part of the lower half of the fibula, and from the interoſſeous ligament.	Into the metatarſal bone of the little toe.	To bend the foot.
12. *Tibialis anticus.*	From the upper and fore-part of the tibia.	Into the os cuneiforme internum.	To bend the foot.
13. *Extenſor proprius pollicis pedis.*	From the upper and fore part of the tibia.	Into the convex ſurface of the bones of the great toe.	To extend the great toe.

Art. 27. MUSCLES ON THE FOOT.

1. *Extenſor brevis digitorum pedis.*	From the upper and anterior part of the os calcis.	By 4 tendons; 1 of which joins the tendon of the externus longus pollicis and the other 3 the tendons of the extenſor digitorum longus.	To extend the toes.
2. *Flexor brevis digitorum pedis.*	From the lower part of the os calcis.	By four tendons, which, after affording a paſſage to thoſe of the flexor longus are inſerted into the 2d phalanx of each of the ſmall toes.	To bend the ſecond joint of the toes.
3. *Abductor pollicis pedis.*	From the inner and lower part of the os calcis.	Into the firſt joint of the great toe.	To move the great toe from the other toes.
4. *Abductor minimi digiti.*	From the outer tubercle of the os calcis, the root of the metatarſal bone of the little toe, and alſo from the aponeuroſis plantaris.	Into the outer ſide of the firſt joint of the little toe.	To draw the little toe outwards.
5. *Lumbricales pedes.*	From the tendons of the flexor longus digitorum pedis.	Into the tendinous expanſion at the upper part of the toes.	To draw the toes inwards.
6. *Flexor brevis pollicis pedis.*	From the inferior & anterior part of the os calcis, and alſo from the inferior part of the os cuneiforme externum.	By two tendons into the firſt joint of the great toe.	To bend the firſt joint of the great toe.
7. *Adductor pollicis pedis*	From near the roots of the metatarſal bones of the 2d, 3d, and 4th toes.	Into the outer os ſeſamoideum, or firſt joint of the great toe.	To draw the great toe nearer to the reſt, & alſo to bend it.
8. *Tranſverſales pedis.*	From the outer and under part of the anterior end of the metatarſal bone of the little toe.	Into the inner os ſeſamoideum, and anterior end of the metatarſal bone of the great toe.	To contract the foot.
9. *Flexor brevis minimi digiti pedis.*	From the baſis of the metatarſal bone of the little toe.	Into the firſt joint of the little toe.	To bend the little toe.
10 *Interoſſei pedis interni* (t.)	Situated between the metatarſal bones.		
Interoſſei pedis externi (u.)			

(t) The interoſſei interni are three in number; their uſe is to draw the ſmaller toes towards the great toe.

EXPLANATION OF PLATE II.

Figure I. repreſents the firſt layer of muſcles ſituated on the anterior part of the whole body, immediately under the common teguments, and tendinous faſciæ.

HEAD AND NECK.

a, The anterior fleſhy belly of the occipito-frontalis ſituated on the os frontis. Above *a*, the tendinous aponeuroſis of the occipito-frontalis, covering the upper part of the parietal bones. *b*, Attollens aurem. Under it, the tendinous aponeuroſis covering the temporal muſcle. Anterior auris between *c* and the ear. *c*, Orbicularis palbebrarum. Its tendon is ſeen at the inner canthus, fixed to the naſal proceſs of the ſuperior maxillary bone. Levator labii ſuperioris alæque naſi: is ſeen divided into two portions running down along the ſide of the noſe, and on the out ſide of it the levator anguli oris. Next this, the zygomaticus minor. Further outwards, zygomaticus major. On the ala and tip of the noſe, the compreſſor naris. *d*, Depreſſor anguli oris. And beneath it a portion of the depreſſor labii inferioris. *e*, Obicularis oris. *f*, Platyſma-myoides. Behind *f*, the ſterno-cleido-maſtoidæus is ſeen through the platyſma-myoides.

TRUNK.

a, Pectoralis major. The upper part of it is covered by the origin of the platyſma-myoides. *b*, Serratus magnus. The other portions reſemble this. *c*, Latiſſimus dorſi. *d*, Obliquus externus deſcendens. *e*, Linea ſemilunaris. *f*, Linea alba. Below *f*, umbilicus. Between *e* and *f*, the rectus abdominis; and, at the inferior part of the linea alba, oppoſite to *g*, the pyramydales appear through the tendons of the oblique muſcles. *g*, Ring of the external oblique muſcle; with the ſpermatic chord, paſſing through it, and covered by the cremaſter muſcle.

SUPERIOR EXTREMITY.

a, Deltoides. Above the clavicle, a portion of the trapezius is ſeen. *b*, Biceps flexor cubiti. At the bending of the arm are ſeen its tendon going towards the radius, and the part from which the tendinous aponeuroſis that covers the fore-arm, cut off. On the inſide of the biceps, part of the triceps extenſor cubiti, and, on the outſide, part of the brachialis internus. *c*, Supinator radii longus. *d*, Pronator teres. *e*, Palmaris longus. *f*, Palmaris brevis. On the palm of the hand, the aponeuroſis palmaris is ſeen extended from the annular ligament at the wriſt to the roots of the metacarpal bones of the four fingers. *g*, Flexor carpi radialis. *h*, Part of the flexor ſublimus perforatus. *i*, Inſertion of the flexor carpi ulnaris. *k*, Abductor pollicis.

INFERIOR EXTREMITY.

a, Tenſor vaginæ femoris, the vagina or tendinous faſcia being cut off. On the outſide of it, a portion of the glutæus maximus. *b*, Part of the iliacus internus. On the inſide of it, between *b* and *c*, part of the pſoas magnus. *c*, Pectinalis. *d*, Triceps longus. *e*, Gracilis. *f*, Sartorius. *g*, Rectus cruris. Its tendon is ſeen inſerted into the patella, from which a ſtrong tendon is ſent to be fixed to the tubercle of the tibia. *h*, Vaſtus externus. *i*, Vaſtus internus. *k*, Tibialis anticus. *l*, Peronæus longus. On the outſide of it, a portion of the ſolæus. *m*, Extenſor longus digitorum pedis, with the peronæus tertius, and extenſor proprius pollicis pedis. *n*, Gaſtrocnemius externus, ſeu Gemellus. *o*, Solæus. *p*, Ligamentum tarſi annulare. *q*, Abductor pollicis pedis.

Figure II. repreſents a back view of the muſcles, which are immediately ſituated below the common integuments.

HEAD AND NECK.

a, Part of the occipito frontalis muſcle, with its aponeuroſis. *b*, Attollens aurem. *c*, Anterior auris. *d*, Retrahentes auris.

TRUNK.

a, Trapezius, ſeu cucularis. *b*, Its tendinous joining with its fellow in the nape of the neck, which is called ligamentum nuchæ, ſeu colli. *c*, The fleſhy belly of the latiſſimus dorſi. *d*, The tendon of the latiſſimus dorſi, which ariſes in common with the ſerratus poſticus inferior. *e*, Part of the obliquus externus abdominis.

SUPERIOR EXTREMITY.

a, Deltoides. *b*, Infra ſpinatus, with a portion of the teres minor and major below it. *c*, Triceps extenſor cubiti. Its tendon is ſeen inſerted into the head of the ulna, called olecranon; and on the inſide of it, the anconæus. *d*, Extenſor carpi radialis longior, covered by a portion of the ſupinator radii longus; and under it, a portion of the extenſor carpi radialis brevior. *e*, Extenſor digitorum communis manus, which ſplits into four tendons, that paſs, with the indicator, under the ligamentum carpi annulare externum, at the extremities of the metacarpal bones, under ligaments proper to themſelves, and are loſt in a broad tendon, which covers the back of the four fingers. *f*, Extenſor oſſis metacarpi pollicis manus. *g*, Extenſor primi internodii pollicis manus. *h*, Extenſor ſecundi internodii pollicis manus. *i*, Extenſor carpi ulnaris. *k*, Part of the flexor carpi ulnaris. Under it, part of the flexor profundus perforatus

(u) The interoſſei externi are four in number; the firſt ſerves to move the fore toe towards the great toe; the reſt move the toes outwards. All the interoſſei aſſiſt in extending the toes.

And on the inſide, part of the flexor ſublimus perforatus, which are more diſtinctly ſeen on the right fore-arm. Likewiſe, on the right hand, are ſeen part of the abductor pollicis manus, abductor minimi digiti manus, and the aponeuroſis palmaris.

INFERIOR EXTREMITY.

a, Glutæus maximus. *b*, Part of the glutæus medius. *c*, Part of the tenſor vaginæ femoris. *d*, Vaſtus externus. *e*, The long head of the biceps flexor cruris. And beneath it, *f*, Part of the ſhort head. *g*, Semitendinoſus. And beneath it, on each ſide, a portion of the ſemimembranoſus is ſeen. *h*, Gracilis. On the outſide of it, a portion of the adductor magnus is ſeen. *i*, A ſmall part of the vaſtus internus. *k*, Gaſtrocnemius externus, ſeu gemellus. And within its outer head, a portion of the plantaris. *l*, Solæus ſeu gaſtrocnemius internus. *m*, Tendo-achillis, with the plantaris. *n*, Peronæus longus. *o*, Peronæus brevis, between it and the tendo-achillis, a portion of the flexor longus digitorum pedis. *p*, Tendons of the extenſor longus digitorum pedis, with the peronæus tertius paſſing under the ligamentum tarſi annulare; and the flexor brevis digitorum pedis is ſeen beneath them. *q*, Abductor minimi digiti pedis, and above it the tendons of the peronæus longus and brevis, paſſing under proper ligaments of their own.

Figure III. Repreſents the ſecond layer of muſcles on the anterior part of the whole body.

HEAD AND NECK.

a, Corrugator ſupercilii. *b*, Temporalis. *c*, Maſſeter. *d*, Levator anguli oris. *e*, Buccinator. *f*, Orbicularis oris. Oppoſite to the right ala naſi, the portion of this muſcle which Albinus names Naſalis labii ſuperioris. *g*, Depreſſor labii inferioris. *h*, Sterno-cleido-maſtoidæus, which is ſeen below, ariſing from the ſternum and clavicle, by two heads. *i*, Sterno-hyoidæus. On the outſide of it, the omo-hyoidæus. Further out, a portion of the hyo-thyroidæus. *k*, Levator ſcapulæ.

TRUNK.

a, Subclavius. *b*, Pectoralis minor. *c*, Serratus magnus. *d*, Rectus, abdominis, divided into ſeveral fleſhy portions by its tendinous interſections. *e*, Pyramidalis. *f*, Obliquus aſcendens internus. *g*, Spermatic cord, with the origin of the cremaſter muſcle.

SUPERIOR EXTREMITY.

a, Biceps flexor cubiti. *b*, Short head of the biceps. Beneath the upper part of it, a portion of the coraco-brachialis. Beneath the under part, a portion of the brachialis internus. *c*, Long head of the biceps. At the bending of the arm, the tendon of the biceps, and the place where the tendinous aponeuroſis was cut from it, are ſeen. *d*, Extenſor carpi radialis longior. Beneath it a portion of the extenſor carpi radialis brevior. *e*, Flexor ſublimus perforatus. *f*, Inſertion of the extenſor carpi ulnaris. *g*, Extenſors of the thumb. *h*, Opponens pollicis. On the inſide of it, a portion of the flexor pollicis brevis. *i*, Tendon of the flexor longus pollicis manus, after paſſing through the flexor brevis pollicis manus. *k*, Abductor minimi digiti manus. *l*, Flexor parvus minimi digiti manus. *m*, Ligamentum carpi annulare.

INFERIOR EXTREMITY.

a, Iliacus internus. Between *a* and *b*, part of the pſoas magnus. *b*, Pectinalis. *c*, Triceps longus. *d*, Gracilis. *e*, Rectus cut off near its origin. *f*, Tendon of the rectus cruris cut off above the patella, from which a ſtrong tendon is ſent to be inſerted into the tubercle of the tibia. *g*, Portion of the glutæus medius. On the inſide of it, part of the glutæus minimus. *h*, Vaſtus internus. *i*, Vaſtus externus. *k*, Cruræus. *l*, Inſertion of the biceps flexor cruris into the fibula. *m*, Tendons of the gracilis and ſemitendinouſus inſerted into the tibia. *n*, Solæus. *o*, Peronæus longus. *p*, Extenſor longus digitorum, with the peronæus tertius on the outſide, and extenſor pollicis proprius on the inſide. *q*, Solæus. *r*, Flexor longus digitorum. *ſ*, Tendons of the tibialis poſticus and flexor longus digitorum pedis. *t*, Flexor brevis digitorum pedis.

Figure IV. repreſents the ſecond layer of the muſcles on the poſterior part of the body.

HEAD AND NECK.

a, Temporalis; its tendon is ſeen paſſing below the zygoma. *b*, Maſſeter. *c*, Splenius capitis et colli. *d*, Portion of the complexus. *e*, Levator ſcapulæ, ſeu muſculus patientiæ.

TRUNK.

a, Rhomboides major. *b*, Rhomboides minor. And immediately above it the upper edge of the ſerratus poſticus ſuperior is ſeen. *c*, The ſerratus poſticus ſuperior on the right ſide. *d*, Serratus poſticus inferior. *e*, Part of the ſpinalis dorſi. *f*, Part of the longiſſimus dorſi. *g*, Part of the ſacrolumbalis. *h*, Serratus magnus. *i*, The broad tendon, by which the latiſſimus dorſi begins, and from which the tendon of the ſerratus poſticus inferior is inſeparable. *k*, Part of the obliquus internus aſcendens abdominis. *l*, The ſphincter ani, fixed to the point of the os coccygis; at the ſide of which the coccygæus, a portion of the levator ani is ſeen, and lower down, oppoſite to *l*, part of the tranſverſalis penis.

SUPERIOR EXTREMITY.

a, Supra ſpinatus. *b*, Infra ſpinatus. *c*, Teres minor. *d*, Teres major. *e*, Triceps extenſor cubiti. *f*, Its head, called longus. *g*, The brevis. And, *h*, a ſmall portion of the third head, named brachialis externus. *i*, The tendon of the triceps, inſerted into the olecranon. *k*, Part of the brachialis internus. *l*, Anconæus, which ſeems to be continued from that part of the brachialis externus immediately above it. *m*, Extenſor carpi radialis longior; and beneath it the brevior; both are ſeen at the wriſt, inſerted into the metacarpal bones of the fore and middle fingers. *n*, Flexor carpi ulnaris. *o*, Part of the ſupinator radii brevis. *p*, Extenſor oſſis metacarpi pollicis manus. *q*, Extenſor primi internodii pollicis manus. *r*, Extenſor ſecundi internodii pollicis manus. *ſ*, Indicator, inſerted into the root of the firſt joint of the fore-finger. *t*, One of the three external interoſſei manus. The other two are diſtinctly ſeen without letters. *u*, One of the tendons of the extenſors of the fingers cut; and the ſame is ſeen in each of the other three fingers, joining with the tendons and aponeuroſis of the interoſſei and lumbricales, and ſpread upon the back of the fingers.

N. B. On the right hand, part of the flexors of the fingers, the abductor pollicis, and minimi digiti, are ſeen.

INFERIOR EXTREMITY.

a, Glutæus medius. *b*, Pyriformis. *c*, The two muſcles called Gemini, between which the tendon of the obturator internus paſſes over the tuberoſity of the os iſchium; and its fleſhy belly is ſeen within the pelvis, partly covered the coccygæus and levator ani. *d*, Quadratus femoris. *e*, Vaſtus externus. *f*, *f*, Parts of the triceps magnus. *g*, Long head of the triceps flexor cruris; and beneath it part of the ſhort head is ſeen. *h*, Semitendinoſus, and beneath it parts of the ſemimembranoſus are ſeen on each ſide of it. *i*, Gracilis. *k*, A ſmall portion of the vaſtus internus. *l*, Poplitæus. *m*, The fleſhy belly of the plantaris; and its long ſlender tendon is ſeen paſſing over the inſide of the ſolæus. *n*, Solæus. *o*, The place where the tendon of the gemellus was cut off; but the fleſh of the ſolæus runs further down. *p*, Tendo-achillis, with the plantaris. *q*, Peronæus longus, paſſing at the outer angle to the ſole of the foot; beneath it, the peronæus brevis to the root of the metatarſal bone of the little toe; and between it and the tendo-achillis, a portion of the flexor longus digitorum pedis. *r*, Tendons of the extenſor longus digitorum pedis, with the peronæus tertius; and beneath theſe, the extenſor brevis digitorum pedis. *ſ*, Flexor brevis minimi digiti pedis.

EXPLANATION OF PLATE III.

Figure I. repreſents the third layer of muſcles, with ſome of the ligaments, cartilages, and naked bones on the anterior part of the whole body.

a, Depreſſor labii ſuperioris alæque naſi. *b*, Orbicularis oris; after moſt of the muſcles, which are fixed to it, and aſſiſt to form it, have been taken away. *c*, Buccinator. Above *c* part of the peterygoidæus externus is ſeen paſſing behind the coronoid proceſs of the lower jaw. *d*, Levator labii inferioris. *e*, Sterno-thyroidæus. Immediately above, and ſeemingly the continuation of it, the Hyo-thyroidæus. *f*, Scalenus medius. Contiguous to it, on the inſide, Scalenus anticus. Above it, a portion of the Trachelo-maſtoidæus. Between the ſcalenus anticus, and ſterno-thyroidæus, and hyo-thyroidæus, the rectus capitis anterius major, and longus colli.

TRUNK.

a, Third row of external intercoſtal muſcles. The reſt appear in the ſame manner between the other ribs. *b*, Third row of internal intercoſtal muſcles. The reſt appear between the other ribs. *c*, Tranſverſalis abdominis. *d*, The place from which the inferior part of the tendon of the tranſverſalis, that paſſes before the rectus and pyramidalis muſcles, is cut off. Between theſe portions of each ſide, the peritonæum is laid bare, and the ligaments of the bladder which were formerly the umbilical arteries and urachus. Between this portion and the os pubis, the ſpermatic cord is ſeen cut. *e*, The inferior edge of the upper part of the tendon of the tranſverſalis, which paſſes behind the rectus, and immediately adheres to the peritonæum. *f*, The anterior lamella of the internal oblique, which joined the tendon of the external to paſs over the rectus. Between *f* and *g*, the poſterior lamella of the internal oblique, joining with the tendon of the tranſverſalis, to paſs behind the rectus. *g*, The place at the linea alba, from which the tendon of the external oblique, and interior lamella of the internal, were cut off. At *g*, Umbilicus.

SUPERIOR EXTREMITY.

a, Subſcapularis. *b*, Teres minor. *c*, Coraco-brachialis. The part from which the ſhort head of the biceps flexor cubiti was cut off from it, is ſeen at its upper end. *d*, Brachialis internus. *e*, Brachialis externus, or third head of the triceps. *f*, Extenſor carpi radialis longior, and with it the extenſor carpi radialis brevior. Both theſe are diſtinctly ſeen in the right hand. Between the tendon of the brachialis internus, and extenſor radialis, the ſupinator radii brevis is ſeen. *g*, Flexor longus pollicis manus, with the fleſhy portion of it, which ariſes from the internal condyle of the os humeri. *h*, Flexor profundus perforans, which ſplits into four tendons, which paſs under the ligamentum carpi annulare. *i*, Pronator quadratus. *k*, Adductor minimi digiti manus. *l*, One of the lumbricales. The other three appear in the ſame manner, along the tendons of the flexor profundus. Behind theſe, the internal interoſſei are ſeen.

INFE-

INFERIOR EXTREMITY.

a, Glutæus minimus. *b*, Iliacus internus. On the inside of it, between *b* and *c*, the psoas magnus. *c*, Obturator externus. *d*, Adductor brevis femoris. *e*, Adductor magnus femoris. *f*, Gracilis, which is seen inserted into the inside of the head of the tibia. *g*, The short head of the biceps flexor cruris. *h*, Peronæus longus. *i*, Peronæus brevis. Between these two peronæi and the tibia, the tibialis posticus is seen. *k*, Tendon of the tibialis posticus, covering the tendon of the flexor longus digitorum pedis. *l*, Extensor brevis digitorum pedis.

Figure II. represents the third layer of muscles on the posterior part of the body, with some of the ligaments and naked bones.

HEAD AND NECK.

a, Part of the buccinator. *b*, Complexus. *c*, Trachelo-mastoidæus; on the outside of it the transversalis colli. *d*, Scalenus medius. *e*, Scalenus posticus.

TRUNK.

a, Spinalis dorsi; and beneath it the multifidus spinæ. *b*, Longissimus dorsi, which sends off a fleshy slip to the trachelo-mastoidæus. *c*, Sacro-lumbalis, with the cervicalis descendens sent off from it along the side of the neck, and outside of the transversalis colli. *d*, Semispinalis dorsi. *e*, Transversalis abdominis.

N. B. The spaces between the spinous processes of the vertebræ have muscular fasciculi between them, particularly those of the neck, and are named interspinales colli, dorsi, and lumborum, but those of the back seem to be tendinous and ligamentous.

SUPERIOR EXTREMITY.

a, Teres major. *b*, Part of the coraco-brachialis. *c*, Part of the brachialis internus. *d*, The third head of the triceps extensor cubiti, called brachialis externus, after the longus and brevis have been cut off. *e*, Extensor radialis longior. *f*, Extensor radialis brevior. *g*, Part of the flexor profundus perforans. *h*, Supinator radii brevis. *i*, Part of the adductor pollicis manus. *k*, One of the three external interossei; the other two may be easily distinguished without letters. *l*, Tendons of the extensors of the fingers joined with those of the lumbricales and interossei, which form a tendinous expansion on the back of the four fingers.

N. B. on the right hand, part of the flexors of the fingers and thumb; part of the adductor pollicis, and the whole of the adductor minimi digiti, are seen.

INFERIOR EXTREMITY.

a, Glutæus minimus. *b*, Obturator internus, its fleshy belly is seen within the pelvis. Beneath *b*, the tendon of the obturator externus. *c*, Semimembranosus. *d*, The short head of the biceps flexor cruris. *e*, Triceps magnus. *f*, Gracilis. In the ham, the origins of the two heads of the gastrocnemius externus and plantaris, are seen. *g*, Poplitæus. *h*, Tibialis posticus. *i*, Flexor longus digitorum pedis. *k*, Flexor pollicis longus. *l*, Peronæus longus, running down to be inserted into the metatarsal bone of the little toe. Beneath it, the peronæus brevis, passing to the sole of the foot. *m*, Extensor brevis digitorum pedis. *n*, Part of the flexor longus digitorum pedis.

Figure III. represents a posterior view of the most deep seated muscles.

HEAD AND NECK.

a, Rectus capitis minor. *b*, Rectus capitis major. *c*, Obliquus superior capitis. *d*, Obliquus inferior capitis. *e*, Interspinales colli. *f*, Scaleni musculi. *g*, Intertransversales colli.

TRUNK.

h, Levitores costarum. *i*, Intercostales externi. *k*, Intercostales interni. *l*, Intertransversales dorsi. *m*, Interspinales dorsi. *n*, Interspinales lumborum. *o*, Intertransversales lumborum. *p*, Quadratus lumborum.

INFERIOR EXTREMITY.

q, Obturator externus. *r*, Adductores magni femorum. *s*, Tibialis posticus. *t*, Peroneus brevis. *u*, Interossei.

SUPERIOR EXTREMITY.

a, Subscapularis. *b*, Supinator brevis. *c*, Pronator quadratus. *d*, Interossei. *e*, Flexor pollicis manus.

Figure IV. represents an anterior view of the most deep seated muscles.

HEAD AND NECK.

a, Pteregoideus internus. *b*, Longus colli. *c*, Scaleni. *d*, Intertransversales colli. *e*, Intercostales.

TRUNK.

f, Diaphragma. *g*, Quadratus lumborum. *h*, Psoas parvus. *i*, Psoas magnus. *k* Iliacus internus.

INFERIOR EXTREMITY.

l, Triceps adductor femoris. *m*, Tibialis posticus. *n*, Peroneus brevis. *o*, Interossei pedis.

SUPERIOR EXTREMITY.

p, Subscapularis. *q*, Supinator brevis. *r*, Pronator quadratus. *s*, Flexor pollicis manus. *t*, Adductor pollicis manus. *u*, Lumbricales. *v*, Interossei manus.

EXPLANATION OF PLATE IV.

Figure III. represents the diaphragm seen within the abdomen, where it forms a considerable concavity.

A A, Its superior radiated portion. B B, Its two cruræ or inferior portion. C, Centrum tendinosum. D, Opening by which the inferior vena cava passes to the heart. E, The slit through which the œsophagus passes to the stomach. F, The aorta and thoracic duct passing into the thorax between its two cruræ.

Figure IV. shews the pteregoid and some other internal muscles. A, Pteregoideus externus. B, Pteregoideus internus. C, Lower jaw. D, Occiput. E, Cervical vertebræ.

Figure V. shews the posterior muscles of the pharynx. A, Os occipitis. B, Œsophagus. C, Intermediate muscles.

Figures VI. VII. VIII. shew the posterior part of the pharynx in different views, after the removal of some of the muscles.

Figures IX, X, XI, XII. exhibit a posterior view of the pharynx and larynx, after the removal of all the posterior muscles of the pharynx.

Figures XIII, XIV, XV, XVI, XVII. exhibit the three laminæ of muscles which are found in the sole of the foot, as well as the tendons of the flexor muscles of the toes, which are situated on the leg, to give a more clear view of the muscles on this part of the body, than can be seen in the whole figures. *Fig.* 13. The tendons and muscles on the sole of the foot, immediately under the integuments. *Fig.* 14. The first order of muscles after removing the tendinous expansion. *Fig.* 15. The second order of muscles. *Fig.* 16. The third order of muscles removed, which shew the tendons of the flexors. *Fig.* 17. The fourth order of muscles removed, shewing the tendons of the tibialis posticus, &c.

PART III.

OF THE ABDOMEN, OR LOWER BELLY.

THE abdomen, or lower belly, extends from the lower extremity of the sternum, or the hollow, usually called the pit of the stomach, and more properly *scrobiculus cordis*, to the lower part of the trunk.

It is distinguished into three divisions called *regions*; of these the upper one, which is called the *epigastric region*, begins immediately under the sternum, and extends to within two fingers breadth of the navel, where the middle or *umbilical region* begins, and reaches to the same distance below the navel. The third, which is called the *hypogastric*, includes the rest of the abdomen, as far as the os pubis. Each of these regions is subdivided into three others; two of which compose the sides and the other the middle part of each region. The middle part of the upper region is called *epigastrium*, and its two sides *hypochondria*. The middle part of the next region is the umbilical region, properly so called, and its two sides are the flanks, or iliac regions. Lastly, the middle part of the lower region retains the name of hypogastrium, and its sides are called inguina or groins. The back part of the abdomen bears the name of lumbar region.

These are the divisions of the lower belly, which are necessary to be held in remembrance, as they frequently occur in surgical and anatomical writing. We shall now proceed to examine the contents of the abdomen; and after having pointed out the names and arrangement of the several viscera contained in it, describe each of them separately.

After having removed the skin, adipose membrane, and abdominal muscles, we discover the peritonæum or membrane that envelopes all the viscera of the lower belly. This being opened, the first part that presents itself is the omentum or caul, floating on the surface of the intestines, which are likewise seen every where loose and moist, and making a great number of circumvolutions through the whole cavity of the abdomen. The stomach is placed in the epigastrium, and under the stomach is the pancreas. The liver fills the right hypochondrium, and the spleen is situated in the left. The kidneys are seen about the middle of the lumbar region, and the urinary bladder and parts of generation are seated in the lower division of the belly.

SECT I. *Of the Peritonæum.*

The peritonæum is a strong simple membrane, by which all the viscera of the abdomen are surrounded; and in some measure supported. Many anatomical writers, particularly Winslow, have described it as being composed of two distinct membranous laminæ; but their description seems to be erroneous. What perhaps appeared to be a second lamina, being found to be simply a cellular coat, which sends off productions to the blood-vessels passing out of the abdominal cavity. The aorta and vena cava likewise derive a covering from the same membrane, which seems to be a part of the cellular membrane we have already described. The peritonæum, by its productions and reduplications, envelopes the greatest part of the abdominal viscera. It is soft and capable of considerable extension; and is kept smooth and moist by a vapour, which is constantly exhaling from its inner surface, and is returned again into the circulation by the absorbents. This moisture not only contributes to the softness of the peritonæum, but prevents the attrition and other ill effects which would otherwise probably be occasioned, by the motion of the viscera upon each other. When this fluid is supplied in too great a quantity, or the absorbents become incapable of carrying it off, it accumulates, and

and conſtitutes an aſcites or dropſy of the belly; and when by any means the exhalation is diſcontinued, the peritonæum thickens, becomes diſeaſed, and the viſcera are ſometimes found adhering to each other. The peritonæum is not a very vaſcular membrane. In a ſound ſtate it ſeems to be endued with little or no feeling, and the nerves that paſs through it appear to belong to the abdominal muſcles.

SECT. II. *Of the Omentum.*

The omentum, epiploon, or cawl, is a double membrane, produced from the peritonæum. It is interlarded with fat, and adheres to the ſtomach, ſpleen, duodenum, and colon; from thence hanging down looſe and floating on the ſurface of the inteſtines. Its ſize is different in different ſubjects. In ſome it deſcends as low as the pelvis, and it is commonly longer at the left ſide than the right. This part, the ſituation of which we have juſt now deſcribed, was the only one known to the ancients under the name of *epiploon* but at preſent we diſtinguiſh three omenta, viz. *omentum magnum colico gaſtricum*, *omentum parvum hepatico gaſtricum*, and *omentum colicum*. They all agree in being formed of two very delicate laminæ, ſeparated by a thin layer of cellular membrane.

The omentum magnum colico gaſtricum, of which we have already ſpoken, derives its arteries from the ſplenic and hepatic. Its veins terminate in the vena portæ. Its nerves, which are very few, come from the ſplenic and hepatic plexus.

The omentum parvum hepatico gaſtricum, abounds leſs with fat than the great epiploon. It begins at the upper part of the duodenum, extends along the leſſer curvature of the ſtomach as far as the œſophagus, and terminates about the neck of the gall-bladder, and behind the left ligament of the liver, ſo that it covers the leſſer lobe; near the beginning of which we may obſerve a ſmall opening, firſt deſcribed by Winſlow, through which the whole pouch may eaſily be diſtended with air (x). The veſſels of the omentum parvum are derived chiefly from the coronary ſtomachic arteries and veins.

The omentum colicum begins at the fore part of the cœcum and right ſide of the colon. It appears as a hollow conical appendage to theſe inteſtines, and uſually terminates at the back of the omentum magnum. It ſeems to be nothing more than a membranous coat of the cœcum and colon, aſſuming a conical ſhape when diſtended with air.

The uſes of the omentum are not yet ſatisfactorily determined. Perhaps by its ſoftneſs and looſeneſs it may ſerve to prevent thoſe adheſions of the abdominal viſcera, which have been found to take place when the fat of the omentum has been much waſted. Some authors have ſuppoſed that it aſſiſts in the preparation of bile; but this idea is founded merely on conjecture.

SECT. III. *Of the Stomach.*

The ſtomach is a membranous and muſcular bag, in ſhape not unlike a bagpipe, lying acroſs the upper part of the abdomen, and inclining rather more to the left than the right ſide. It has two orifices, one of which receives the end of the œſophagus, and is called the *cardia*, and ſometimes the left and upper orifice of the ſtomach; though its ſituation is not much higher than the other, which is ſtyled the right and inferior orifice, and more commonly the *pylorus*; both theſe openings are more elevated than the body of the ſtomach.

The aliment paſſes down the œſophagus into the ſtomach through the cardia, and after having undergone the neceſſary digeſtion, paſſes out at the pylorus where the inteſtinal canal commences.

The ſtomach is compoſed of four tunics or coats, which are ſo intimately connected together that it requires no little dexterity in the anatomiſt to demonſtrate them. The exterior one is membranous, being derived from the peritonæum.---The ſecond is a muſcular tunic, compoſed of fleſhy fibres which are in the greateſt number about the two orifices.---The third is called the nervous coat, and within this is the villous or velvet-like coat which compoſes the inſide of the ſtomach. The two laſt coats being more extenſive than the two firſt, form the folds, which are obſerved every where in the cavity of this viſcus, and more particularly about the pylorus; where they ſeem to impede the too haſty excluſion of the aliment, making a conſiderable plait, called *valvula pylori*. The inner coat is conſtantly moiſtened by a mucus, which approaches to the nature of the ſaliva, and is called the gaſtric juice; this liquor has been ſuppoſed to be ſecreted by certain minute glands (y) ſeated in the nervous tunic, whoſe excretory ducts open on the ſurface of the villous coat.

The arteries of the ſtomach called the gaſtric arteries are principally derived from the cæliac; ſome of its veins paſs to the ſplenic, and others to the vena portæ; and its nerves are chiefly from the eighth pair or par vagum. The account given of the tunics of the ſtomach may be applied to the whole alimentary canal; for both the œſophagus and inteſtines are, like this viſcus, compoſed of four coats. Before we deſcribe the courſe of the aliment and the uſes of the ſtomach, it will be neceſſary to ſpeak of other parts which aſſiſt in the proceſs of digeſtion.

SECT. IV. *Of the Oeſophagus.*

The œſophagus or gullet is a membranous and muſcular canal, extending from the bottom of the mouth to the upper orifice of the ſtomach---Its upper part, where the aliment is recieved is ſhaped ſomewhat like a funnel, and is called the *pharynx*. From hence it runs down cloſe to the bodies of the vertebræ as far as the diaphragm, in which there is an opening through which it paſſes, and then terminates in the ſtomach about the eleventh or twelfth vertebra of the back.

The œſophagus is plentifully ſupplied with arteries from the external carotid, bronchial, and ſuperior intercoſtal arteries; its veins empty themſelves into the vena azygos, internal jugular, and mammary veins, &c. Its nerves are derived chiefly from the eighth pair. We likewiſe meet with a mucus in the œſophagus, which every where lubricates its inner ſurface, and tends to aſſiſt in deglutition.---This mucus ſeems to be ſecreted by very minute glands, like the mucus in other parts of the alimentary canal.

SECT. V. *Of the Inteſtines.*

The inteſtines form a canal, which is uſually ſix times longer than the body to which it belongs. This canal extends from the pylorus or inferior orifice of the ſtomach, to the anus. It will be eaſily underſtood, that a part of ſuch great length muſt neceſſarily make many circumvolutions, to be confined with ſo many other viſcera within the cavity of the lower belly.

Although the inteſtines are in fact, as we have obſerved, only one long and extenſive canal, yet different parts have been diſtinguiſhed by different names. The inteſtines are firſt diſtinguiſhed into two parts, one of which begins at the ſtomach, and is called the *thin* or *ſmall inteſtines*, from the ſmall ſize of the canal, when compared with the other part, which is called the *large inteſtines*, and includes the lower portion of the canal down to the anus. Each of theſe parts has its ſubdiviſions. -- The ſmall inteſtines being diſtinguiſhed into *duodenum jejunum*, and *ilium*, and the larger portion into cœcum, colon, and rectum. The ſmall inteſtines fill the middle and fore parts of the belly, while the large inteſtines fill the ſides and both the upper and lower parts of the cavity.

The *duodenum*, which is the firſt of the ſmall inteſtines, is ſo called, becauſe it is about 12 inches long. It begins at the pylorus and terminates in the jejunum, which is a part of the canal obſerved to be uſually more empty than the other inteſtines.---This appearance gives it its name, and likewiſe ſerves to point out where it begins.

The next diviſion is the *ilium*, which of itſelf exceeds the united length of the duodenum and jejunum, and has received its name from its numerous circumvolutions. The large circumvolution of the ilium covers the firſt of the large inteſtines called the *cæcum* (x), which ſeems properly to belong to the colon, being a kind of pouch of about four fingers in width, and nearly of the ſame length, having exteriorly a little appendix; called *appendix cæci*.

The *cæcum* is placed in the cavity of the os ilium on the right ſide, and terminates in the colon, which is the largeſt of all the inteſtines. This inteſtine aſcends by the right kidney to which it is attached, paſſes under the hollow part of the liver, and the bottom of the ſtomach to the ſpleen, to which it is likewiſe ſecured, as it is alſo to the left kidney; and from thence paſſes down towards the os ſacrum, where, from its ſtraight courſe, the canal begins to take the name of *rectum*. There are three ligamentous bands extending thro' the whole length of the colon, which by being ſhorter than its two inner coats, ſerve to increaſe the plaits on the inner ſurface of this gut.

The *anus*, which terminates the inteſtinum rectum, is furniſhed with three muſcles; one of theſe is compoſed of circular fibres, and from its uſe in ſhutting the paſſage of the anus is called *ſphincter ani*. The other two are the *levatores ani*, ſo called becauſe they elevate the anus after dejection. When theſe, by palſy, or any other diſeaſe, loſe the power of contracting, the anus prolapſes; and when the ſphincter is affected by ſimilar cauſes, the fæces are voided involuntarily.

It has been already obſerved, that the inteſtinal canal is compoſed of four tunics; but it remains to be remarked, that here, as in the ſtomach, the two inner tunics being more extenſive than the other two, form the plaits which are to be ſeen in the inner ſurface of the inteſtines, and are called *valvulæ conniventes*.

(x) This membranous bag, though exceedingly thin and tranſparent, is found capable of ſupporting mercury, thrown into it by the ſame channel.

(y) Heiſter, ſpeaking of theſe glands, very properly ſays, "in *porcis* facile, in *homine* raro obſervantur;" for although many anatomical writers have deſcribed their appearance and figure, yet they do not ſeem to have been hiterto ſatisfactorily demonſtrated in the human ſtomach; and the gaſtric juice is now more generally believed to be derived from the exhalant arteries of the ſtomach.

(x) Anatomiſts have differed with reſpect to this diviſion of the inteſtines.---The method here followed is now generally adopted; but there are authors who allow the name of *cæcum* only to the little appendix, which has likewiſe been called the *vermiform appendix*, from its reſemblance to a worm in ſize and length.

Some

Some authors have conſidered theſe plaits as tending to retard the motion of the fæces, in order to afford more time for the ſeparation of the chyle: but there are others who attribute to them a different uſe: they contend, that theſe valves, by being naturally inclined downwards, cannot impede the deſcent of the fæces, but that they are intended to prevent their return upwards. They are probably deſtined for both theſe uſes; for although theſe folds incline to their lower ſide, yet the inequalities they occaſion in the canal, are ſufficient to retard in ſome meaſure the progreſſive motion of the fæces, and to afford a greater ſurface for the abſorption of chyle, and their natural poſition ſeems to oppoſe itſelf to the return of the aliment.

Beſides theſe *valvulæ conniventes*, there is one more conſiderable than the reſt, called the *valve of the colon*; which is found at that part of the canal where the inteſtinum ileum is joined to the colon. This valve permits the alimentary pulp to paſs downwards, and ſerves to prevent its return upwards: and it is by this valve, that glyſters are prevented from paſſing into the ſmall inteſtines (y).

Of the little vermiform appendix of the cœcum, it will be ſufficient to ſay, that its uſes have never yet been aſcertained. In birds we meet with two of theſe appendices.

The inteſtines are lubricated by a conſtant ſupply of mucus, which is probably ſecreted by very minute follicles (z). This mucus promotes the deſcent of the alimentary pulp, and in ſome meaſure defends the inner ſurface of the inteſtines from the irritation to which it would, perhaps, otherwiſe be continually expoſed from the aliment; and which, when in a certain degree, excites a painful diſorder called *colic*, a name given to the diſeaſe, becauſe its moſt uſual ſeat is in the inteſtinum colon. The inteſtines are likewiſe frequently diſtended with air, and this diſtenſion ſometimes occaſions pain, and conſtitutes the flatulent colic.

The arteries of the inteſtines are continuations of the meſenteric arteries, which are derived in two conſiderable branches from the aorta.---The redundant blood is carried back into the vena portarum.

In the rectum the veins are called *hemorrhoidal*, and are there diſtinguiſhed into internal and external: the firſt are branches of the inferior meſenteric vein, but the latter paſs into other veins. Sometimes theſe veins are diſtended with blood from obſtructions, from weakneſs of their coats, or from other cauſes, and what we call the *hæmorrhoids* takes place. In this diſeaſe they are ſometimes ruptured; and the diſcharge of blood which conſequently follows, has probably occaſioned them to be called *hæmorrhoidal veins*. The nerves of the inteſtines are derived from the eighth pair.

Sect. VI. *Of the Meſentery.*

The name of the *meſentery* implies its ſituation amidſt the inteſtines. It is in fact a part of the peritonæum, being a reduplication (a). of that membrane from each ſide of the lumbar vertebræ, to which it is firmly attached, ſo that it is formed of two laminæ, connected to each other by cellular membrane.

The inteſtines, in their different circumvolutions, form a great number of arches, and the meſentery accompanies them through all theſe turns; but by being attached only to the hollow part of each arch, it is found to have only a third of the extent of the inteſtines. That part of this membrane which accompanies the ſmall inteſtines is the *meſentery*, properly ſo called; but thoſe parts of it which are attached to the colon and rectum are diſtinguiſhed by the names of *meſo-colon* and *meſo-rectum*.

There are many conglobate glands diſperſed through this double membrane, through which the lacteals and lymphatics paſs in their way to the thoracic duct. The blood veſſels of the meſentery were deſcribed in ſpeaking of the inteſtines. This membrane, by its attachment to the vertebræ, ſerves to keep the inteſtines in their natural ſituation. The idea uſually formed of the colic called *miſerere*, is perfectly erroneous: it being impoſſible that the inteſtines can be twiſted, as many ſuppoſe they are, in that diſeaſe, their attachment to the meſentery effectually preventing ſuch an accident---but a diſarrangement ſometimes takes place in the inteſtinal canal itſelf, which is productive of diſagreeable and ſometimes fatal conſequences.---This is by an introſuſpection of the inteſtine, an idea of which may be eaſily formed, by taking the finger of a glove, and involving one part of it within the other.

If inflammation takes place, the ſtricture in this caſe is increaſed, and the periſtaltic motion of the inteſtines (by which is meant the progreſſive motion of the fæces downwards) is inverted, and what is called the *iliac paſſion* takes place. The ſame effects may be occaſioned by a deſcent of the inteſtine, or of the omentum either with it or by itſelf, and thus conſtituting what is called an *hernia* or *rupture*; a term by which in general is meant the falling down or protruſion of any part of the inteſtine, or omentum, which ought naturally to be contained within the cavity of the belly.

To convey an idea of the manner in which ſuch a deſcent takes place, it will be neceſſary to obſerve, that the lower edge of the tendon of the muſculus obliquus externus, is ſtretched from the fore-part of the os ilium or haunch-bone of the os pubis, and conſtitutes what is called *Poupart's* or *Fallopius's ligament*, forming an opening, through which paſs the great crural artery and vein. Near the os pubis the ſame tendinous fibres are ſeparated from each other, and form an opening on each ſide, called the *abdominal ring*, through which the ſpermatic veſſels paſs in men, and the ligamenta uteri in women. In conſequence of violent efforts, or perhaps of natural cauſes, the inteſtines are found ſometimes to paſs through theſe openings; but the peritonæum which incloſes them when in their natural cavity, ſtill continues to ſurround them even in their deſcent. This membrane does not become torn or lacerated by the violence, as might be eaſily imagined; but its dilatability enables it to paſs out with the viſcus, which it incloſes as it were in a bag, and thus forms what is called the *hernial ſac*.

If the hernia be under Poupart's ligament, it is called *femoral*; if in the groin, *inguinal* (b); and *ſcrotal*, if in the ſcrotum. Different names are likewiſe given to the hernia as the contents of the ſac differ, whether of omentum only, or inteſtine, or both:---but theſe definitions more properly belong to the province of ſurgery.

Sect. VII. *Of the Pancreas.*

The pancreas is a conglomerate gland, placed behind the bottom of the ſtomach, towards the firſt vertebra of the loins; ſhaped like a dog's tongue, with its point ſtretched out towards the ſpleen, and its other end extending towards the duodenum. It is about eight fingers breadth in length, two or three in width, and one in thickneſs.

This viſcus, which is of a yelloviſh colour, ſomewhat inclined to red, is covered with a membrane which it derives from the peritoneum. Its arteries, which are rather numerous than large, are derived chiefly from the ſplenic and hepatic, and its veins paſs into the veins of the ſame name.---Its nerves are derived from the intercoſtal.

The many little glands of which it has been obſerved the pancreas is compoſed, all ſerve to ſecrete a liquor called the *pancreatic juice*, which in its colour, conſiſtence, and other properties, does not ſeem to differ from the ſaliva. Each of theſe glands ſends out a little excretory duct, which uniting with others, help to form larger ducts; and all theſe at laſt terminate in one common excretory duct (firſt diſcovered by Virtſungus in 1642), which runs through the middle of the gland, and is now uſually called *ductus pancreaticus Virtſungi*. This canal opens into the inteſtinum duodenum, ſometimes by the ſame orifice with the biliary duct, and ſometimes by a diſtinct opening. The liquor it diſcharges being of a mild and inſipid nature, ſerves to dilute the alimentary pulp, and to incorporate it more eaſily with the bile.

Sect. VIII. *Of the Liver.*

The liver is a viſcus of conſiderable ſize, and of a reddiſh colour; convex ſuperiorly and anteriorly where it is placed under the ribs and diaphragm, and of an equal ſurface poſteriorly. It is chiefly ſituated in the right hypochondrium, and under the falſe ribs; but it likewiſe extends into the epigaſtric region, where it borders upon the ſtomach. It is covered by a production of the peritoneum, which ſerves to attach it by three of its reduplications to the falſe ribs. Theſe reduplications are called *ligaments*, though very different in their texture from what are called by the ſame name in other parts of the body. The umbilical cord, too, which in the fœtus is pervious, gradually becomes a ſimple ligament after birth; and by paſſing to the liver, ſerves likewiſe to ſecure it in its ſituation.

At the poſterior part of this organ where the umbilical veſſels enter, it is found divided into two lobes. Of theſe, the

(y) This is not invariably the caſe, for the contents of a clyſter have been found not only to reach the ſmall inteſtines, but to be voided at the mouth. Such inſtances, however, are not common.

(z) Some writers have diſtinguiſhed theſe glands into miliary, lenticular, &c.---Brunner and Peyer were the firſt anatomiſts who deſcribed the glands of the inteſtines, and their deſcriptions were chiefly taken from animals, theſe glandular appearances not ſeeming to have been hitherto ſatisfactorily pointed out in the human ſubject.---It is now pretty generally believed, that the mucus which every where lubricates the alimentary canal, is exhaled from the minute ends of arteries; and that theſe extremities firſt open into a hollow veſicle, from whence the depoſited juice of ſeveral branches flows out through one common orifice.

(a) He who only reads of the reduplication of membranes, will perhaps not eaſily underſtand how the peritonæum and pleura are reflected over the viſcera in their ſeveral cavities; for one of theſe ſerves the ſame purpoſes in the thorax that the other does in the abdomen. This diſpoſition, for the diſcovery of which we are indebted to modern anatomiſts, conſtitutes a curious part of anatomical knowledge: but the ſtudent, unaided by experience, and aſſiſted only by what the limits of this work would permit us to ſay on the occaſion, would probably imbibe only confuſed ideas of the matter; and it will perfectly anſwer the preſent purpoſe, if he conſiders the meſentery as a membrane attached by one of its ſides to the lumbar vertebræ, and by the other to the inteſtines.

(b) The hernia congenita will be conſidered with the male organs of generation, with which it is intimately connected.

largeſt is placed in the right hypocondrium; the other, which covers part of the ſtomach, is called the *little lobe*. All the veſſels which go to the liver paſs in at the fiſſure we have mentioned; and the production of the peritoneum, which inveſts the liver, was deſcribed by Gliſſon, an Engliſh anatomiſt, as accompanying them in their paſſage, and ſurrounding them like a globe: hence this production has been commonly known by the name of *capſula of Gliſſon:* but it appears to be chiefly a continuation of the cellular membrane which covers the vena porta ventralis.

The liver was conſidered by the ancients as an organ deſtined to prepare and perfect the blood; but later diſcoveries have proved, that this opinion was wrong, and that the liver is a glandular ſubſtance formed for the ſecretion of the bile.

The blood is conveyed to the liver by the hepatic artery and the vena portæ. This is contrary to the mode of circulation in other parts, where veins only ſerve to carry off the redundant blood: but in this viſcus the hepatic artery, which is derived from the cæliac, is principally deſtined for its nouriſhment; and the vena porta, which is formed by the union of the veins from moſt of the abdominal viſcera, furniſhes the blood from which the bile is chiefly to be ſeparated: ſo that theſe two ſeries of veſſels ſerve very diſtinct purpoſes. The vena porta, as it is ramified through the liver, performs the office both of a vein and an artery; for like the former it returns the blood from the extremities of arteries, while as the latter it prepares it for ſecretion.

The nerves of the liver are branches of the intercoſtal and par vagum. The bile, after being ſeparated from the maſs of blood, in a manner of which mention will be made in another place, is conveyed out of this organ by very minute excretory ducts, called *pori biliarii*; theſe uniting together like the excretory ducts in the pancreas, gradually form larger ones, which at length terminate in a conſiderable channel called *ductus hepaticus*.

Sect. IX. *Of the Gall-bladder.*

The gall-bladder is a little membranous bag, ſhaped like a pear, and attached to the poſterior and almoſt inferior part of the great lobe of the liver. It has two tunics; of which the exterior one is a production of the peritonæum. The interior, or villous coat, is ſupplied with a mucus that defends it from the acrimony of the bile. Theſe two coverings are intimately connected by means of the cellular membrane, which from its firm gliſtening appearance has generally been ſpoken of as a muſcular tunic.

The gall-bladder is ſupplied with blood-veſſels from the hepatic arteries. Theſe branches are called the *cyſtic arteries*, and the cyſtic veins carry back the blood. Its nerves are derived from the ſame origin as thoſe of the liver. The neck of the gall-bladder is continued in the form of a canal called *ductus cyſticus*, which ſoon unites with the ductus hepaticus we deſcribed as the excretory duct of the liver; and forming one common canal, takes the name of *ductus choledochus communis*, through which both the cyſtic and hepatic bile are diſcharged into the duodenum. This canal opens into the inteſtine in an oblique direction, firſt paſſing through the exterior tunic, and then piercing the other coats after running between each of them a very little way. This œconomy ſerves two uſeful purpoſes;—to promote the diſcharge of bile, and to prevent its return.

The bile may be defined to be a natural liquid ſoap, ſomewhat unctuous and bitter, and of a yellowiſh colour, which mixes with water, oil, and vinous ſpirits, and is capable of diſſolving reſinous ſubſtances. From ſome late experiments made by M. Cadet, it appears to be formed of an animal oil, combined with the alkaline baſe of ſea-ſalt, a ſalt of the nature of milk and a calcareous earth which is ſlightly ferruginous. See the Syſtem of Chymistry, Part V. Chap V.

Its definition ſeems ſufficiently to point out the uſes for which it is intended (c). It blends the alimentary maſs, by dividing and attenuating it; corrects the too great diſpoſition to aceſcency, which the aliment acquires in the ſtomach; and, finally, by its acrimony, tends to excite the periſtaltic motion of the inteſtines.

After what has been ſaid, it will be conceived that there are two ſorts of bile; one of which is derived immediately from the liver through the hepatic duct, and the other from the gall-bladder. Theſe two biles, however, do not eſſentially differ from each other. The hepatic bile indeed is milder, and more liquid than the cyſtic, which is conſtantly thicker and yellower; and by being bitterer, ſeems to poſſeſs greater activity than the other.

Every body know the ſource of the hepatic bile, that it is ſecreted from the maſs of blood by the liver; but the origin of the cyſtic bile has occaſioned no little controverſy amongſt anatomical writers. There are ſome who contend, that it is ſeparated in the ſubſtance of the liver, from whence it paſſes into the gall-bladder through particular veſſels. In deer, and in ſome other quadrupeds, as well as in ſeveral birds and fiſhes, there is an evident communication, by means of particular veſſels, between the liver and the gall-bladder. Bianchi, Winſlow, and others, have aſſerted the exiſtence of ſuch veſſels in the human ſubject, and named them *hepaticyſtic ducts*; but it is certain that no ſuch ducts exiſt.—In obſtructions of the cyſtic duct, the gall-bladder has been found ſhrivelled and empty; ſo that we may conſider the gall-bladder as a reſervoir of hepatic bile; and that it is an eſtabliſhed fact, that the whole of the bile contained in the gall-bladder is derived from the liver; that it paſſes from the hepatic to the cyſtic duct, and from that to the gall-bladder. The difference in the colour, conſiſtence, and taſte of the bile, is merely the conſequence of ſtagnation and abſorption. When the ſtomach is diſtended with aliment, this reſervoir undergoes a certain degree of compreſſion, and the bile paſſes out into the inteſtinal canal; and in the efforts to vomit, the gall-bladder ſeems to be conſtantly affected, and at ſuch times diſcharges itſelf of its contents.

Sometimes the bile concretes in the gall-bladder, ſo as to form what are called *gall-ſtones* (d). When theſe concretions paſs into the cyſtic duct, they ſometimes occaſion exquiſite pain, by diſtending the canal in their way to the duodenum; and by lodging in the ductus choledochus communis, and obſtructing the courſe of the bile, this fluid will be abſorbed, and by being carried back into the circulation occaſion a temporary jaundice.

Sect. X. *Of the Spleen.*

The ſpleen is a ſoft and ſpongy viſcus, of a bluiſh colour, and about five or ſix fingers breadth in length, and three in width, ſituated in the left hypochondrium, between the ſtomach and the falſe ribs. That ſide of it which is placed on the ſide of the ribs is convex; and the other, which is turned towards the ſtomach, is concave. The ſplenic artery, which is a branch from the cæliac, ſupplies this viſcus with blood, and a vein of the ſame name carries it back into the vena portæ.

Its nerves are derived from a particular plexus called the *ſplenic*, which is formed by branches of the intercoſtal nerve, and by the eighth pair, or par vagum. The ancients, who ſuppoſed two ſorts of bile, conſidered the ſpleen as the receptacle of what they called *atra bilis*. Havers, who wrote profeſſedly on the bones, determined its uſe to be that of ſecreting the ſynovia; and the late Mr. Hewſon imagined, that it concurred with the thymus and lymphatic glands of the body in forming the red globules of the blood. All theſe opinions ſeem to be equally fanciful. The want of an excretory duct has occaſioned the real uſe of this viſcus to be ſtill doubtful. Perhaps the blood undergoes ſome change in it, which may aſſiſt in the preparation of the bile. This is the opinion of the generality of modern phyſiologiſts; and the great quantity of blood with which it is ſupplied, together with the courſe of its veins into the vena portæ, ſeem to render this notion probable.

Sect. XI. *Of the Glandulæ Renales, Kidneys, and Ureters.*

The glandulæ renales, which were by the ancients ſuppoſed to ſecrete the atra bilis, and by them named *capſulæ atrabiliares*, are two flat bodies of an irregular figure, one on each ſide between the kidney and the aorta.

In the fœtus they are as large as the kidneys: but they do not increaſe afterwards in proportion to thoſe parts; and in adults and old people they are generally found ſhrivelled, and much waſted. They have their arteries and veins. Their arteries uſually ariſe from the ſplenic or the emulgent, and ſometimes from the aorta; and their veins go to the neighbouring veins, or to the vena cava. Their nerves are branches of the intercoſtal. The uſe of theſe parts is not yet perfectly known. In the fœtus the ſecretion of urine muſt be in a very ſmall quantity, and a part of the blood may perhaps then paſs through theſe channels, which in the adult is carried to the kidneys to ſupply the matter of urine.

The kidneys are two in number, ſituated one on the right and the other on the left ſide in the lumbar region, between the laſt falſe rib and the os ilium, by the ſides of the vertebræ. Each kidney in its figure reſembles a ſort of bean, which from its ſhape is called *kidney-bean*. The concave part of each kidney is turned towards the aorta and vena cava aſcendens. They are ſurrounded by a good deal of fat, and receive a coat from the peritonæum; and when this is removed, a very fine membrane is found inveſting their ſubſtance and the veſſels which ramify through them. Each kidney has a conſiderable artery and vein, which are called the *emulgent*. The artery is a branch from the aorta, and the vein paſſes into the vena cava. Their nerves, which every where accompany the blood-veſſels, ariſe from a conſiderable plexus, which is derived from the intercoſtal. In each kidney, which in the adult is of a pretty firm texture, there are three ſubſtances to be diſtinguiſhed (e). The

(c) The ancients, who were not acquainted with the real uſe of the liver, conſidered the bile as an excrementitious and uſeleſs fluid.

(d) Theſe concretions ſometimes remain in the gall-bladder without cauſing any uneaſineſs. Dr. Heberden relates, that a gall-ſtone weighing two drams was found in the gall-bladder of the late Lord Bath, though he had never complained of the jaundice, nor of any diſorder which he could attribute to that cauſe. *Med. Tranſ.* Vol. ii.

(e) The kidneys in the fœtus are diſtinctly lobulated; but in the adult they become perfectly firm, ſmooth, and regular.

outer-

outer part is glandular or cortical, beyond this is the vascular or tubular substance, and the inner part is papillary or membranous.

It is in the cortical part of the kidney that the secretion is carried on; the urine being here received from the minute extremities of the capillary arteries, is conveyed out of this cortical substance by an infinite number of very small cylindrical canals or excretory vessels, which constitute the tubular part. These tubes, as they approach the inner substance of the kidney, gradually unite together; and thus forming larger canals, at length terminate in ten or twelve little protuberances called *papillæ*, the orifices of which may be seen without the assistance of glasses. These papillæ open into a small cavity or reservoir called the *pelvis of the kidney*, and formed by a distinct membranous bag which embraces the papillæ. From this pelvis the urine is conveyed through a membranous canal which passes out from the hollow side of the kidney, a little below the blood vessels, and is called *ureter*.

The ureters are each about as large as a common writing-pen. They are somewhat curved in their course from the kidneys, like the letter *ſ*, and at length terminate in the posterior and almost inferior part of the bladder, at some distance from each other. They pass into the bladder in the same manner as the ductus choledochus communis passes into the intestinum duodenum, not by a direct passage, but by an oblique course between the two coats; so that the discharge of urine into the bladder is promoted, whilst its return is prevented. Nor does this mode of structure prevent the passage of fluids only from the bladder into the ureters, but likewise air:—for air thrown into the bladder inflates it, and it continues to be distended if a ligature is passed round its neck; which seems to prove sufficiently that it cannot pass into the ureters.

Sect. XII. *Of the Urinary Bladder.*

The urinary bladder is a membranous and muscular bag of an oblong roundish shape, situated in the pelvis, between the os pubis and intestinum rectum in men, and between the os pubis and uterus in women. Its upper and widest part is usually called the *bottom*, its narrower part the *neck* of the bladder; the former only is covered by the peritonæum.

The bladder is formed of three coats, connected together by means of cellular membranes. The external or peritonæal, is only a partial one, covering the upper and back part of the bladder. The middle or muscular coat, is composed of irritable, and of course muscular fibres, which are mostly collected around the neck of the bladder, but not so as to form a distinct muscle or sphincter, as the generality of anatomists have hitherto supposed. The inner coat, though much smoother, has been said to resemble the villous tunic of the intestines, and like that is provided with a mucus, which defends it against the acrimony of the urine.

It will be easily conceived from what has been said, that the kidneys are two glandular bodies through which a saline and excrementitious fluid called *urine* is constantly filtering from the mass of blood.

While only a small quantity of urine is collected in the bladder, it excites no kind of uneasiness; but when a greater quantity is accumulated, so that the bladder is distended in a certain degree, it excites in us a certain sensation, which brings on as it were a voluntary contraction of the bladder to promote its discharge. But this contraction is not effected by the muscular fibres of the bladder alone: for all the abdominal muscles contract in obedience to our will, and press downwards all the viscera of the lower belly; and these powers being united, at length overcome the resistance of the fibres surrounding the neck of the bladder, which dilates and affords a passage to the urine through the urethra. The frequency of this evacuation depends on the quantity of urine secreted; on the degree of acrimony it possesses; on the size of the bladder, and on its degree of sensibility.

The urine varies much in its colour and contents. These varieties depend on age, sex, climate, diet, and other circumstances. In infants it is generally a clear watery fluid, without smell or taste. As we advance in life, it acquires more colour and smell, and becomes more impregnated with salts. In old people it becomes still more acrid and fetid. In a healthy state it is nearly of a straw colour. After being kept for some time, it deposits a tartarous matter, which is found to be composed chiefly of earth and salt, and soon incrusts the sides of the vessel in which it is contained. While this separation is taking place, appearances like minute fibres or threads of a whitish colour, may be seen in the middle of the urine, and an oily scum observed floating on its surface. So that the most common appearances of the urine are sufficient to ascertain that it is a watery substance, impregnated with earthy, saline, and oily particles.

The urine is not always voided of the same colour and consistence, for these are found to depend on the proportion of its watery part to that of its other constituent principles. Its colour and degree of fluidity seem to depend on the quantity of saline and inflammable particles contained in it: so that an increased proportion of those parts will constantly give the urine a higher colour, and add to the quantity of sediment. The variety in the appearance of the urine depends on the nature and quantity of solid and fluid aliment we take in; and it is likewise occasioned by the different state of the urinary vessels, by which we mean the channels through which it is separated from the blood, and conveyed through the pelvis into the ureters. The causes of calculous concretions in the urinary passages are to be looked for in the natural constitution of the body, mode of life, &c.

It having been observed, that after drinking any light wine or spa water, it very soon passed off by urine, it has been supposed by some, that the urine is not altogether conveyed to the bladder by the ordinary course of circulation, but that there must certainly exist some other shorter means of communication, perhaps by certain vessels between the stomach and the bladder, or by a retrograde motion in the lymphatics. But it is certain, that if we open the belly of a dog, press out the urine from the bladder, pass a ligature round the emulgent arteries, and then sow up the abdomen, and give him even the most diuretic liquor to drink, the stomach and other channels will be distended with it, but not a drop of urine will be found to have passed into the bladder; or the same thing happens when a ligature is thrown round the two ureters. This experiment then seems to be a sufficient proof, that all the urine we evacuate is conveyed to the kidneys through the emulgent arteries, in the manner we have described.---It is true, that wine and other liquors promote a speedy evacuation of urine: but the discharge seems to be merely the effect of the stimulus they occasion; by which the bladder and urinary parts are solicited to a more copious discharge of the urine, which was before in the body, and not immediately of that which was last drank; and this increased discharge, if the supply is kept up, will continue; nor will this appear wonderful, if we consider the great capacity of the vessels that go to the kidneys; the constant supply of fresh blood that is essential to health; and the rapidity with which it is incessantly circulated through the heart to all parts of the body.

Sect. XIII. *Of Digestion.*

We are now proceeding to speak of *digestion*, which seems to be introduced in this place with propriety, after a description of the abdominal viscera, the greater part of which contribute to this function. By *digestion* is to be understood, the changes the aliment undergoes for the formation of chyle:---these changes are effected in the mouth, stomach, and small intestines. The mouth, of which every body has a general knowledge, is the cavity between the two jaws, formed anteriorly and laterally by the lips, teeth, and cheeks, and terminating posteriorly in the throat. The lips and cheeks are made up of fat and muscles covered by the cuticle, which is continued over the whole inner surface of the mouth, like a fine and delicate membrane. Beside this membrane, the inside of the mouth is furnished with a spongy and very vascular substance called the *gums*, by means of which the teeth are secured in their sockets. A similar substance covers the roof of the mouth, and forms what is called the *velum pendulum palati*, which is fixed to the extremity of the arch formed by the ossa maxillaria and ossa palati, and terminates in a soft, small, and conical body, named *uvula*; which appears, as it were, suspended from the middle of the arch over the basis of the tongue.

The velum pendulum palati performs the office of valve between the cavity of the mouth and the pharynx, being moved by several muscles (f).

The tongue is composed of several muscles (g) which enable it to perform a variety of motions for the articulation of the voice; for the purposes of mastication; and for conveying the aliment into the pharynx. Its upper part is covered with papillæ, which constitute the organ of taste, and are easily to be distinguished; it is covered by the same membrane that lines the inside of the mouth, and which makes at its inferior part towards its basis a reduplication called *frænum*.

Posteriorly, under the velum palati, and at the basis of the tongue, is the pharynx; which is the beginning of the œsophagus, stretched out every way, so as to resemble the top of a funnel, through which the aliment passes into the stomach.

The mouth has a communication with the nostrils at its posterior and upper part; with the ears, by the Eustachian tubes; with the lungs, by means of the larynx; and with the stomach, by means of the œsophagus.

The pharynx is constantly moistened by a fluid, secreted by two considerable glands called the *tonsils*, one on each side of the velum palati. These glands, from their supposed resemblance to almonds, have likewise been called *amygdalus*.

The mouth is moistened by a considerable quantity of saliva. This fluid is derived from the *parotid glands*; a name which by its etymology points out their situation to be near the ears. They are two in number, one on each side under the os malæ: and they are of the conglomerate kind; being formed of many

(f) These are the circumflexus palati, levator palati mollis, palato pharyngæus constrictor isthmi faucium, and axygos uvulæ, See Table of Muscles in this System, Art. 13.

(g) These are the genio-glossus, hyo-glossus lingualis, and styloglossus. See Table of Muscles, Art. 10.

ſmaller glands, each of which ſends out a very ſmall excretory duct, which unites with the reſt, to form one common channel, that runs over the cheek, and piercing the buccinator muſcle, opens into the mouth on each ſide, by an orifice into which a briſtle may be eaſily introduced.---Beſides theſe, the maxillary glands, which are placed near the inner ſurface of the angle of the lower jaw on each ſide; the ſublingual glands, which are ſituated at the root of the tongue; the glands of the palate, which are ſeated in the velum palati; and thoſe of the cheeks, lips, &c. together with many other leſs conſiderable ones,---pour the ſaliva into the mouth through their ſeveral excretory ducts.

The ſaliva, like all the other humours of the body, is found to be different in different people: but in general, it is a limpid and inſipid fluid, without ſmell in healthy ſubjects; and theſe properties would ſeem to prove, that it contains very few ſaline or inflammable particles. The uſes of the ſaliva ſeem to be to moiſten and lubricate the mouth, and to aſſiſt in reducing the aliment into a ſoft pulp before it is conveyed into the ſtomach.

The variety of functions which are conſtantly performed by the living body, muſt neceſſarily occaſion a continual waſte and diſſipation of its ſeveral parts. A great quantity is every day thrown off by the inſenſible perſpiration and other diſcharges; and were not theſe loſſes conſtantly recruited by a freſh ſupply of chyle, the body would ſoon effect its own diſſolution. But nature has very wiſely favoured us with organs fitted to produce ſuch a ſupply; and has at the ſame time endued us with the ſenſations of hunger and thirſt, that our attention may not be diverted from the neceſſary buſineſs of nutrition. The ſenſation of hunger is univerſally known; but it would perhaps be difficult to deſcribe it perfectly in words. It may, however, be defined to be a certain uneaſy ſenſation in the ſtomach, which induces us to wiſh for ſolid food; and which likewiſe ſerves to point out the proper quantity, and time for taking it. In deſcribing the ſtomach, mention was made of the gaſtric juice, as every where lubricating its inner coat. This humour mixes itſelf with the aliment in the ſtomach, and helps to prepare it for its paſſage into the inteſtines; but when the ſtomach is perfectly empty, this ſame fluid irritates the coats of the ſtomach itſelf, and produces the ſenſation of hunger.

A certain proportion of liquid aliment is required to aſſiſt in the proceſs of digeſtion, and to afford that moiſture to the body, of which there is ſuch a conſtant diſſipation.---Thirſt induces us to take this neceſſary ſupply of drink; and the ſeat of this ſenſation is in the tongue, fauces, and œſophagus, which from their great ſenſibility are required to be kept moiſt, for though the fauces are naturally moiſtened by the mucus and ſalival juices; yet the blood, when deprived of its watery part or rendered acrimonious by any natural cauſes, never fails particularly to effect theſe parts, and the whole alimentary canal, and to occaſion thirſt.---This is the common effect of fevers and of hard labour, by both which too much of the watery part of the blood is diſſipated.

It has been obſerved, that the aliment undergoes ſome preparation in the mouth before it paſſes into the ſtomach; and this preparation is the effect of maſtication. In treating of the upper and lower jaws, mention was made of the number and arrangement of the teeth. The upper jaw was deſcribed as being immoveable; but the lower jaw was ſpoken of as being capable of elevation and depreſſion, and of a grinding motion. The aliment, when firſt carried into the mouth, is preſſed between the teeth of the two jaws by a very ſtrong and frequent motion of the lower jaw; and the tongue and the cheeks aſſiſting in this proceſs, continue to replace the food between the teeth till it is perfectly divided, and reduced to the conſiſtence of pulp. The inciſores and canini divide it firſt into ſmaller pieces, but it is between the ſurfaces of the dentes molares by the grinding motion of the jaw that the maſtication is completed.

During this proceſs, the ſalival glands being gently compreſſed by the contraction of the muſcles that move the lower jaw, pour out their ſaliva: this helps to divide and break down the food, which at length becomes a kind of pulp, and is then carried over the baſis of the tongue into the fauces. But to effect this paſſage into the œſophagus, it is neceſſary that the other openings which were mentioned as having a communication with the mouth as well as the pharynx, ſhould be cloſed; that none of the aliment, whether ſolid or liquid, may paſs into them, whilſt the pharynx alone is dilated to receive it:---And ſuch a diſpoſition actually takes place in a manner we will endeavour to deſcribe.

The trachea arteria, or windpipe, through which the air is conveyed to the lungs, is placed before the œſophagus.---In the act of ſwallowing; therefore, if the *larynx* (for ſo the upper part of the trachea is called) is not cloſed, the aliment will paſs into it in its way to the œſophagus. But this is prevented by a ſmall and very elaſtic cartilage, called *epiglottis*, which is attached only to the fore-part of the larynx; ſo that the food in its paſſage to the œſophagus preſſes down this cartilage, which then covers the glottis or opening of the larynx; and at the ſame time the velum palati being capable of ſome degree of motion, is drawn backwards by its muſcles, and cloſes the openings into the noſe and the Euſtachian tubes.---This, however, is not all. The larynx, which being compoſed of cartilaginous rings, cannot fail in its ordinary ſtate to compreſs the membranous canal of the œſophagus, is in the act of deglutition carried forwards and upwards by muſcles deſtined for that purpoſe; and conſequently drawing the fore-part of the pharynx with it, that opening is fully dilated. When the aliment has reached the pharynx, its deſcent is promoted by its own proper weight, and by the muſcular fibres of the œſophagus, which continue to contract from above downwards, until the aliment has reached the ſtomach. That theſe fibres have no inconſiderable ſhare in deglutition, any perſon may experience, by ſwallowing with his head downwards, when the deſcent of the aliment cannot poſſibly be effected by its weight.

It is neceſſary that the noſtrils and the lungs ſhould communicate with the mouth, for the purpoſes of ſpeech and reſpiration: but if the moſt minute part of our food happens to be introduced into the trachea, it never fails to produce a violent cough, and ſometimes the moſt alarming ſymptoms. This is liable to happen when we laugh or ſpeak in the act of deglutition: the food is then ſaid to have paſſed the wrong way, and indeed this is not improperly expreſſed: for death would ſoon follow, if the quantity of aliment introduced into the trachea ſhould be ſufficient to obſtruct the reſpiration only during a very ſhort time; or the irritable particles of food ſhould not ſoon be thrown up again by means of the cough, which in theſe caſes very ſeaſonably increaſes in porportion to the degree of irritation.

If the velum palati did not cloſe the paſſage to the noſtrils, deglutition would be performed with difficulty, and perhaps not at all; for the aliment would return through the noſe, as is ſometimes the caſe in drinking. Children, from a deficiency of this velum palati, have been ſeen to die a few hours after birth; and they who from diſeaſe or any other cauſes have not this part perfect, ſwallow with difficulty.

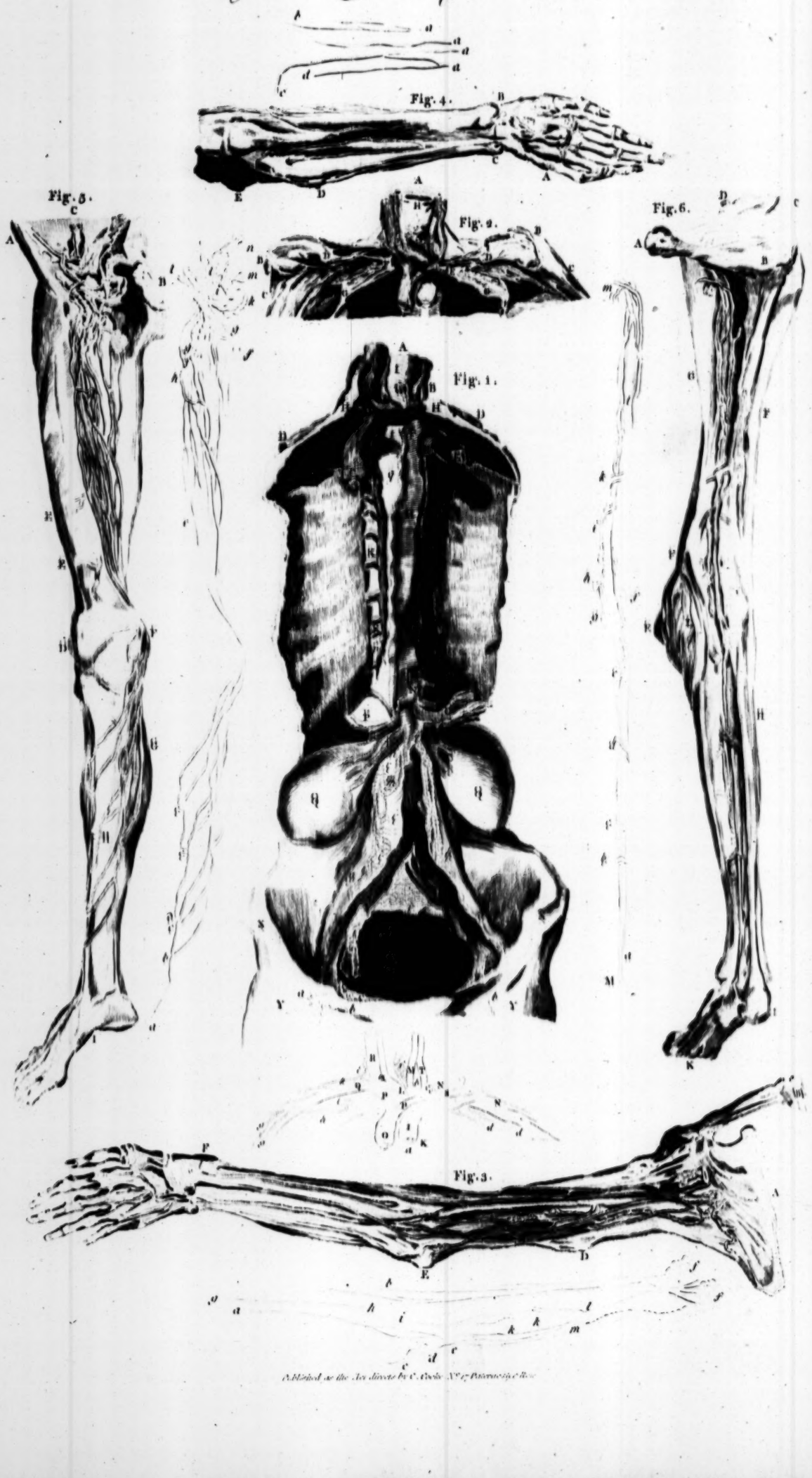
The aliment, after having been ſufficiently divided by the action of the teeth, and attenuated by the ſaliva, is received into the ſtomach, where it is deſtined to undergo a more conſiderable change. The properties of the aliment not being much altered at its firſt entrance into the ſtomach, and before it is thoroughly blended with the gaſtric juice, is capable of irritating the inner coat of the ſtomach to a certain degree, and occaſions a contraction of its two orifices---In this membranous bag, ſurrounded by the abdominal viſcera, and with a certain degree of natural heat, the aliment undergoes a conſtant agitation by means of the abdominal muſcles and of the diaphragm, and likewiſe by a certain contraction or expanſion of the muſcular fibres of the ſtomach itſelf. By this motion, every part of the food is expoſed to the action of the gaſtric juice, which gradually divides and attenuates it, and prepares it for its paſſage into the inteſtines.

Some obſervations lately publiſhed by Mr. Hunter in the Philoſophical Tranſactions, tend to throw conſiderable light on the principles of digeſtion. There are few dead bodies in which the ſtomach, at its great end, is not found to be in ſome degree digeſted (H). Animals, or parts of animals, poſſeſſed of the living principle, when taken into the ſtomach, are not in the leaſt affected by the action of that viſcus; but the moment they loſe the living principle, they become ſubject to its digeſtive powers. This ſeems to be the caſe with the ſtomach, which is enabled to reſiſt the action of its juices in the living body: but when deprived of the living principle, it is then no longer able to reſiſt the powers of that menſtruum, which it had itſelf formed for the digeſtion of its contents; the proceſs of digeſtion appearing to be continued after death. This is confirmed by what happens in the ſtomachs of fiſhes: They frequently ſwallow, without maſtication, fiſh which are larger than the digeſting parts of their ſtomach can contain; and in ſuch caſes, that part which is taken into the ſtomach is more or leſs diſſolved, while that part which remains in the œſophagus is perfectly ſound; and here, as well as in the human body, the

(H) The Abbe Spallanzani, who has lately written upon digeſtion, finds, from a variety of experiments, made upon quadrupeds, birds, and fiſhes, that digeſtion goes on for ſome time after death, though far leſs conſiderable than in living animals; but heat is neceſſary in many animals, or at leaſt promotes it in a much greater degree. He found alſo, that when the ſtomach was cut out of the body, it had ſomewhat of the power of digeſtion, though this was trifling when compared with that which took place when the ſtomach was left in the body. In not one of the animals was the great curvature of the ſtomach diſſolved, or much eroded after death. There was often a little eroſion, eſpecially in different fiſhes; in which, when he had cleared the ſtomach of its contents, the internal coat was wanting. In other animals there was only a ſlight excoriation; and the injury in all of them was at the inferior part, or great curvature. The coats of the ſtomach ſuffer leſs after death than fleſh, or part of the ſtomach of ſimilar animals put into it: The author aſſigns as a reaſon for this, that theſe bodies are inveſted on all ſides by the gaſtric fluid, whereas it only acts on the internal ſurface of the ſtomach.

digeſting

Absorbent Vessels the System of Anatomy Part II Sect. 3rd



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digesting part of the ſtomach is often reduced to the ſame ſtate as the digeſted part of the food. Theſe appearances tend to prove, that digeſtion is not effected by a mechanical power, by contractions of the ſtomach, or by heat; but by a fluid ſecreted in the coats of the ſtomach, which is poured into its cavity, and there animalizes the food, or aſſimilates it to the nature of blood.

From ſome late experiments by M. Sage, it appears, that inflammable air has the property of deſtroying and diſſolving the animal texture: And as we ſwallow with the ſubſtances which ſerve us for food a great quantity of atmoſpherical air, M. Sage thinks it poſſible, that dephlogiſticated, which is its principle, may be converted in the ſtomach into inflammable air, or may modify into inflammable air a portion of the oily ſubſtance which is the principle of aliments. In this caſe, would not the inflammable air (he aſked), by diſſolving our food, facilitate its converſion into chyle?

Be this as it may, the food, after having remained one, two, or three hours in the ſtomach, is converted into a greyiſh pulp, which is uſually called *chymus*, a word of Greek etymology, ſignifying *juice*, and ſome few milky or chylous particles begin to appear.—But the term of its reſidence in this bag is proportioned to the nature of the aliment, and to the ſtate of the ſtomach and its juices. The thinner and more perfectly digeſted parts of the food paſs by a little at a time into the duodenum, through the pylorus, the fibres of which relax to afford it a paſſage; and the groſſer and leſs digeſted particles remain in the ſtomach till they acquire a ſufficient fluidity to paſs into the inteſtines, where the nature of the *chymus* is perfectly changed. The bile and pancreatic juice which flow into the duodenum, and the mucus, which is every where diſtilled from the ſurface of the inteſtines, mix themſelves with the alimentary pulp, which they ſtill further attenuate and diſſolve, and into which they ſeem to infuſe new properties.

Two matters very different from each other in their nature and deſtination, are the reſult of this combination.—One of theſe, which is compoſed of the liquid parts of the aliment, and of ſome of its more ſolid particles, extremely divided and mixed with the juices we have deſcribed, conſtitutes a very mild, ſweet, and whitiſh fluid, reſembling milk, and diſtinguiſhed by the name of *chyle*. This fluid is abſorbed by the lacteal veins, which convey it into the circulation, where, by being aſſimilated into the nature of blood, it affords that ſupply of nutrition, which the continual waſte of the body is found to require. The other, is the remains of the elementary maſs deprived of all its nutritious particles, and containing only ſuch parts as were rejected by the abſorbing mouths of the lacteals. This groſſer part, called the *fæces*, paſſes on through the courſe of the inteſtines, to be voided at the anus, as will be explained hereafter; for this proceſs in the œconomy cannot be well underſtood till the motion of reſpiration has been explained. But the ſtructure of the inteſtines is a ſubject which may be properly deſcribed in this place, and deſerves to be attended to.

It has been already obſerved, that the inteſtinal canal is five or ſix times as long as the body, and that it forms many circumvolutions in the cavity of the abdomen, which it traverſes from the right to the left, and again from the left to the right; in one place deſcending, and in another extending itſelf upwards. It was noticed likewiſe, that the inner coat of the inteſtines, by being more capacious than their exterior tunics, formed a multitude of plaits placed at a certain diſtance from each other, and called *valvulæ conniventes*. Now this diſpoſition will be found to afford a farther proof of that divine wiſdom, which the anatomiſt and phyſiologiſt cannot fail to diſcover in all their purſuits.—For if the inteſtinal canal was much ſhorter than it naturally is; if inſtead of the preſent circumvolutions it paſſed in a direct courſe from the ſtomach; and if its inner ſurface was ſmooth and deſtitute of valves; the aliment would conſequently paſs with great rapidity to the anus, and ſufficient time would be wanting to aſſimilate the chyle, and for the neceſſary abſorption of it into the lacteals: ſo that the body would be deprived of the ſupply of nutrition, which is ſo eſſential to life and health; but the length and circumvolutions of the inteſtines, the inequality of their internal ſurface, and the courſe of the aliment through them, all concur to perfect the ſeparation of the chyle from the fæces, and to afford the neceſſary nouriſhment to the body.

EXPLANATION OF PLATE V. *On the Viſcera.*

Figure III. repreſents the body laid open to ſhew the thoracic and abdominal viſcera in ſitu, nothing being removed but the omentum.

A, Larynx. B. The internal jugular vein. C, The termination of the thoracic duct at the angle, between the left ſubclavian and jugular veins. D, The ſubclavian vein. E, Cava deſcendens. F, The right auricle of the heart. G, The right ventricle. H, Part of the left ventricle. I, Aorta aſcendens. K, Arteria pulmonalis. L, The right lobe of the lungs, part of which is cut off to ſhew the great blood-veſſels. M, The left lobe of the lungs. N, The diaphragm. O, The liver. P, The ligamentum rotundum. Q, The gall-bladder. R, The ſtomach preſſed by the liver towards the left ſide. S, The ſmall guts. T, The ſpleen.

Figure IV. repreſents an internal view of the body below the diaphragm, with the inteſtines removed to ſhew the remaining viſcera, and the thoracic duct.

AA, The under ſide of the liver. B, Ligamentum rotundum. C, The gall-bladder. D, The pancreas. E, The ſpleen. FF, The kidneys. GG, The emulgent veins. H, The thoracic duct. I, Aorta deſcendens. K, Vena cava aſcendens. LL, Spermatic plexus, going over Poupart's ligament to the teſticles. M, A probe under the ſpermatic veſſels, and the arteria meſenterica inferior, and over the ureters. N, The ureter. O, Inferior meſenteric artery. PP, Ureters going down to the bladder. Q, The iliac veſſels. R, Sigmoid flexor of the colon going down to form the rectum. S, The rectum inteſtinum. TT, The anterior ſpine of the os ileum. UU, The iliac artery and vein going under Poupart's ligament to the thigh. X, The bladder of urine. Y, Oſſa pubis.

Figure V. repreſents a view of the heart in ſitu.

In this preparation the heart and its veſſels are filled with what is called injection, (a compound of bees wax and tallow coloured with vermillion, king's yellow, or any other pigment) to ſhew the different diameters of the cavities of the heart and veſſels. The heart, therefore, and its veſſels, appear in the print larger than they ever can in the natural ſtate in the living body; becauſe, in the living body they are only half full; alſo to obtain this view, the pericardium is removed, the cellular membrane and air veſicles of the lungs diſſected off to ſhew more clearly the exit of the large blood veſſels from the heart, &c.

A, The right auricle. B, The right ventricle. C, a portion of the left ventricle ſeen. D, The right coronary artery, and vein; theſe are the veſſels with their correſponding ones on the other ſide, which ſupply the ſubſtance of the heart with blood. E, The apex of the heart; it is this point which we feel pulſating between the 5th and 6th ribs of the left ſide in violent exertions. F, Aorta aſcendens. G, G, The right and left carotid arteries. H, H, The two ſubclavian arteries. I, Aorta deſcendens. 1, 2, 3, 4, &c. Small arteries going off to the intervertebral ſpaces. K, Vena cava deſcendens. L, L, The right and left ſubclavian veins. M, M, The right and left jugular veins.

Figure VI. ſhews the ſtomach, with the omentum hanging before the inteſtines. A, Cardia, or upper orifice. B, Pylorus, or lower orifice. C, Valvula pylori. D, Leſſer curvature. E, Greater curvature, to which the omentum is attached. F, Anterior ſide of the ſtomach.

Figure VII. ſhews the veins of the inteſtines and other abdominal viſcera, uniting to form the vena portæ, which is ramified through the liver. A, A, A, Extreme branches of the meſenteric vein. B, The great meſenteric vein about to enter the liver. C, C, C, Its extreme branches forming the vena portæ.

SECT. XIV. OF THE COURSE OF THE CHYLE AND OF THE LYMPHATIC AND ABSORBENT SYSTEM.

An infinite number of very minute veſſels, called the *lacteal veins*, ariſe like net-work from the inner ſurface of the inteſtines, (but principally from the *jejunum* and *ileum*), which are deſtined to imbibe the nutritious fluid or chyle. Theſe veſſels, which were diſcovered by Aſellius in 1622 (1), paſs obliquely through the coats of the inteſtines, and running along the meſentery, unite as they advance, and form larger branches, all of which paſs through the meſenteric or conglobate glands, which are very numerous in the human ſubject. As they run between the inteſtines and theſe glands, they are ſtyled *venæ lacteæ primi generis*: but after leaving theſe glands, they are found to be leſs numerous, and being increaſed in ſize, are then called *venæ lacteæ ſecundi generis*, which go to depoſit their contents in the *thoracic duct*, through which the chyle is conveyed into the blood. This *thoracic duct* begins about the lower part of the firſt vertebra lumborum, from whence it paſſes up by the ſide of the aorta, between that and the vena azygos, cloſe to the vertebræ, being covered by the pleura. Sometimes it is found divided into two branches; but they uſually unite again into one canal, which opens into the left ſubclavian vein, after

(1) We are informed by Galen, that the lacteals had been ſeen in kids by Eraſiſtratus, who conſidered them as arteries carrying a milky fluid; but from the remote time in which he lived, they do not ſeem to have been noticed till they were diſcovered in a living dog by Aſellius, who denominated them *lacteals*, and conſidered them as ſerving to convey the chyle from the inteſtines to the liver; for before the diſcovery of the thoracic duct, the uſe of the live was univerſally ſuppoſed to be that of converting the chyle into blood. But the diſcovery of the thoracic duct by Pecquet, not long after, corrected this error. Pecquet very candidly confeſſes, that his diſcovery accidentally aroſe from his obſerving a white fluid, mixed with the blood, flowing out of the vena cava, after he had cut off the heart of a living dog: which he ſuſpected to be chyle, and afterwards traced to its ſource from the thoracic duct: This duct had been ſeen near an hundred years before in a horſe by Euſtachius, who ſpeaks of it as a vein of a particular ſtructure, but without knowing any thing of its termination or uſe.

having run a little way in an oblique courſe between its coats. The ſubclavian vein communicates with the vena cava, which paſſes to the right auricle of the heart. The lower part of this duct being usually larger than any other part of it, has been named *receptaculum chyli*, or *Pecquet's receptacle*, in honour of the anatomiſt who firſt diſcovered it in 1651. In ſome quadrupeds, in turtle, and in fiſh, this enlargement is more conſpicuous in proportion to the ſize of the duct, than it usually is in the human ſubject, where it is not commonly found large enough to merit the name of *receptaculum*.

Opportunities of obſerving the lacteals in the human ſubject do not often occur; but they may be eaſily demonſtrated in a dog or any other quadruped that is killed two or three hours after feeding upon milk, for then they appear filled with white chyle. But theſe *lacteals* which we have deſcribed, as paſſing from the inteſtines through the meſentery to the thoracic duct, compoſe only a part of a ſyſtem of veſſels which perform the office of *abſorption*, and which conſtitute with their common trunk the thoracic duct, and the conglobate glands that are diſperſed through the body, what may be ſtyled the *lympathic ſyſtem*. So that what is ſaid of the ſtructure of one of theſe ſeries of veſſels may very properly be applied to that of the other.

The *lymphatic veins* (K) are minute pellucid tubes, which, like the lacteals, direct their courſe towards the centre of the body, where they pour a colourleſs fluid into the thoracic duct. The lympathics from all the lower parts of the body gradually unite as they approach this duct, into which they enter by three or four very large trunks, that ſeem to form the lower extremity of this canal, or *receptaculum chyli*, which may be conſidered as the great trunk of the lymphatic ſyſtem. The lacteals open into it near the ſame place; and the lymphatics, from a large ſhare of the upper parts of the body, pour their lymph into different parts of this duct as it runs upwards, to terminate in the left ſubclavian vein. The lymphatics from the right ſide of the neck, thorax, and right arm, &c. terminate in the right ſubclavian vein.

As the lymphatics commonly lie cloſe to the large blood-veſſels, a ligature paſſed round the crural artery in a living animal, by including the lympatics, will occaſion a diſtenſion of theſe veſſels below the ligature, ſo as to demonſtrate them with eaſe; and a ligature paſſed round the thoracic duct, inſtantly after killing an animal, will, by ſtopping the courſe of its contents into the ſubclavian vein, diſtend not only the lacteals, but alſo the lymphatics in the abdomen and lower extremities, with their natural fluids (L). The coats of theſe veſſels are too thin to be ſeparated from each other; but the mercury they are capable of ſuſtaining, proves them to be very ſtrong; and their great power of contraction, after undergoing conſiderable diſtenſion, together with the irritability with which Baron Haller found them to be endued, ſeems to render it probable, that, like the blood-veſſels, they have a muſcular coat. The lymphatics are nouriſhed after the ſame manner as all the other parts of the body. For even the moſt minute of theſe veſſels are probably ſupplied with ſtill more minute arteries and veins. This ſeems to be proved by the inflammation of which they are ſuſceptible, and the painful ſwellings which ſometimes takes place in lymphatic veſſels, prove that they have nerves as well as blood-veſſels. Both the lacteals, lymphatics and thoracic duct, are furniſhed with valves, which are much more common in theſe veſſels than in the red veins. Theſe valves are uſually in pairs, and ſerve to promote the courſe of the chyle and lymph towards the thoracic duct, and to prevent its return. Mention has been made of the glands, through which the lacteals paſs in their courſe through the meſentery; and it is to be obſerved, that the lymphatics paſs through ſimilar glands in their way to the thoracic duct. Theſe glands are all of the conglobate kind, but the changes which the chyle and lymph undergo in their paſſage through them, have not yet been aſcertained.

The *lymphatic veſſels* begin from ſurfaces and cavities in all parts of the body as *abſorbents*. This is a fact now univerſally allowed: but how the fluids they abſorb are poured into thoſe cavities, is a ſubject of controverſy. The contents of the abdomen, for inſtance, were deſcribed as being conſtantly moiſtened by a very thin watery fluid. The ſame thing takes place in the pericardium, pleura, and all the other cavities of the body, and this watery fluid is the *lymph*. But whether it is exhaled into thoſe cavities through the minute ends of arteries, or tranſuded through their coats, are the points in diſpute. We cannot here be permitted to relate the many ingenious arguments that have been advanced in favour of each of theſe opinions; nor is it perhaps of conſequence to our preſent purpoſe to enter into the diſpute. It will be ſufficient if the reader can form an idea of what the lymph is, and of the manner in which it is abſorbed.

The *lymph*, from its tranſparency and want of colour, ſhould ſeem to be nothing but water; and hence the firſt diſcoverers of theſe veſſels ſtyled them *aqueous*; but experiments prove, that the lymph of an healthy animal coagulates by being expoſed to the air, or a certain degree of heat, and likewiſe by being ſuffered to reſt; ſeeming to agree in this property with that part of the blood called the *coagulable lymph*.---This property of the lymph leads to determine its uſe, in moiſtening and lubricating the ſeveral cavities of the body in which it is found; and for which, by its gelatinous principle, it ſeems to be much better calculated than a pure and watery fluid would be, for ſuch it has been ſuppoſed to be by ſome anatomiſts.

The mouths of the *lymphatics* and *lacteals*, by acting as capillary tubes, ſeem to abſorb the *lymph* and *chyle* ſomewhat in the ſame manner as a capillary tube of glaſs, when put into a baſon of water, is enabled to attract the water into it to a certain height: but it is probable that they likewiſe poſſeſs a living power, which aſſiſts in performing this office. In the human body the *lymph*, or the *chyle*, is probably conveyed upon this principle, as far as the firſt pair of valves, which ſeem to be placed not far from the orifice of the abſorbing veſſel, whether *lymphatic* or *lacteal*; and the fluid will then be propelled forwards, by a continuation of the abſorption at the orifice. But this does not ſeem to be the only inducement to its progreſs towards the thoracic duct; theſe veſſels have probably a muſcular coat, which may ſerve to preſs the fluid forwards from one pair of valves to another; and as the large lymphatic veſſels and the thoracic duct are placed cloſe to the large arteries, which have a conſiderable pulſation, it is reaſonable to ſuppoſe, that they derive ſome advantages from this ſituation.

EXPLANATION OF THE PLATES ON THE ABSORBENTS AND LYMPHATICS.

Whoever carefully views the Abſorbent Syſtem, muſt be convinced, that as it explains and points out the cure of many diſeaſes, it deſerves the attention of the practitioners of the healing art. And as it is ſo generally diffuſed through the animal kingdom, it ſtrongly claims the regard of thoſe who wiſh to enquire philoſophically into the animal œconomy. We have therefore introduced a figure formed from an idea of the late Dr. William Hunter, who, for the better explanation of this Syſtem, ſuppoſed a figure to be tranſparent in order to ſhew the courſe and diſtribution of the abſorbent veſſels in a connected point of view. We have alſo added ſix repreſentations from Haller's treatiſe on the lymphatics, of which we have given copious deſcriptions.

EXPLANATION OF PLATE VI.

This ſubject was taken from M. de Pile's Anatomy for Painters, but conſiderably improved by Mr. Edward Blake; and the abſorbents were added to it by Dr. Roberts, from the deſcriptions and repreſentations given by public lecturers and profeſſors in town, and from foreign writers on the ſubject, particularly from Monſieur Maſcagni in Italy, who has given plates of them, and ſhewn them on every ſurface and cavity of the human body, and that they are equally numerous with the veins. Mr. John Hunter has proved their exiſtence even in the ſubſtance of bone itſelf. See his treatiſe on the Animal Œconomy.

The deſign of this figure muſt be very eaſily underſtood by any perſon who has ever viewed a vaſcular ſubject, or read the deſcription of the blood-veſſels in the human body. The abſorbents are obſerved to have a peculiar affection to arteries, and their great trunks always accompany thoſe of arteries, and the larger the artery is, the larger are the abſorbents, increaſing in diameter as the artery increaſes. They obtain the ſame name with the arteries they accompany, only when they come towards the ſurface of the body, they then leave the ſmaller ramifications of arteries, and attend the larger trunks of veins, and there again they receive their name from the neareſt vein, ſo that the reader has only to look back to the deſcription of the blood-veſſels, in this ſyſtem, to have a pretty clear idea of their ſize and ſituation.

In this figure we have ſuppoſed the parietes of the thorax and abdomen to be cut away, in order to ſee the abſorbents upon the viſcera with greater preciſion, and the better to ſhew their variety and ſtructure: they ſeem to admit of very little change all over the body, excepting upon the lungs and liver. Upon the lungs they take the reticular form of the air veſicles, and

(K) The arteries in their courſe through the body becoming gradually too minute to admit the red globules of the blood, have been ſtyled *capillary* or *lymphatic arteries*. The veſſels which are here deſcribed as conſtituting the lymphatic ſyſtem, were at firſt ſuppoſed to be continued from thoſe arteries, and to convey back the lymph, either into the red veins, or the thoracic duct; the office of abſorption having been attributed to the *red veins*. But we now that the *lymphatic veins* are not continuations of the *lymphatic arteries*, but that they conſtitute the *abſorbent ſyſtem*. There are ſtill, however, ſome very reſpectable names among the anatomiſts of the preſent age, who contend, that the red veins are likewiſe as abſorbents:---but it ſeems to have been clearly proved, that the red veins do abſorb no where but in the cavernous cells of the penis, the erection of which is occaſioned by a diſtenſion of thoſe cells with arterial blood.

(L) In the dead body they may be eaſily demonſtrated by opening the artery ramifying through any viſcus, as in the ſpleen, for inſtance, and then throwing in air; by which the lymphatics will be diſtended. One of them may then be punctured, and mercury introduced into it through a blow-pipe.

appear

appear hexagonal, pentagonal, &c. according to the shape of the vehicle they accompany. Upon the liver they appear like a tight ball prodigiously knotted; this appearance of knots are valves, which for the size of the absorbent, are closer together and more numerous than any where else in the body, are represented in the figure.

The absorbents, like the blood vessels, are infinitely minute in their ramifications, and like them, the smaller branches go into larger and larger, until you come to the main trunk, which is called *Receptaculum Chyli*, or thoracic duct; so that supposing a tree dug out of the ground with its roots carefully laved, it is only taking a view of this tree with its roots, body and branches, to have a very full idea of the system at large. The upper extremities, head and arms, &c. resemble the branches, the lower extremities, the roots, and the *Receptaculum Chyli*, the body of the tree.

The *Receptaculum Chyli* is represented in the plate, arising from the loins in the middle of the body, running up its whole length, and terminating in the angle of the left jugular, and subclavian veins. The black knobs among the absorbents, are representations of glands, and the large vessel in the middle, is the artery of the limb it belongs to. The same view is given here, as in the plate, to keep up the connection in the System.

EXPLANATION of PLATE VII.

Figure I. exhibits the trunk of the human subject, prepared to shew the lymphatic vessels and the ductus thoracicus. A, the neck. B B, The two jugular veins. C, The vena cava superior. D D D D, The subclavian veins. E, The beginning of the aorta pulled to the left side by means of a ligature, in order to shew the thoracic duct behind it. F, The branches arising from the curvature of the aorta. G G, The two carotid arteries. H H, The first ribs. I I, The trachea. K K, The spine. L L, The vena azygos. M M, The descending aorta. N, The cæliac artery dividing into three branches. O, The superior mesenteric artery. P, The right crus diaphragmatis. Q Q, The two kidneys. R, The right emulgent artery. S S, The external iliac arteries. g, d, The musculi psoæ. T, The internal iliac artery. U, The cavity of the pelvis. X X, The spine of the os ilium. Y Y, The groins. *a*, A lymphatic gland in the groin, into which lymphatic vessels from the lower extremities are seen to enter. *b b*, The lymphatic vessels of the lower extremities passing under Poupart's ligament. *c c*, A plexus of the lymphatic vessels lying on each side of the pelvis. *d*, The psoas muscle, with lymphatic vessels lying upon its inside. *e*, A plexus of lymphatics, which having passed over the brim of the pelvis at (*c*), having entered the cavity of the pelvis, and received the lymphatic vessels belonging to the viscera contained in that cavity, next ascends, and passes behind the iliac artery to (*g*). *f*, Some lymphatic vessels of the left side passing over the upper part of the os sacrum, to meet those of the right side. *g*, The right psoas, with a large plexus of lymphatics lying on its inside. *h h*, The plexus lying on each side of the spine. *i i i*, Spaces occupied by the lymphatic glands. *k*, The trunk of the lacteals lying on the under side of the superior mesenteric artery. *l*, The same dividing into two branches, one of which passes on each side of the aorta; that of the right side being seen to enter the thoracic duct at (*m*). *m*, The thoracic duct beginning from the large lymphatics. *n*, The duct passing under the lower part of the crus diaphragmatis and under the right emulgent artery. *o*, The thoracic duct penetrating the thorax. *p*, Some lymphatic vessels joining that duct in the thorax. *q*, The thoracic duct passing under the curvature of the aorta, to get to the left subclavian vein; the aorta being drawn aside to shew the duct. *r*, A plexus of lymphatic vessels passing upon the trachea from the thyroid gland to the thoracic duct.

Figure II. represents the upper part of the trunk taken from a higher point of view, in order to shew the termination of the thoracic duct more perfectly, and also the trunks of the absorbent vessels of the head and upper extremities. A, The neck. B B, The two shoulders with the pectoral muscles turned over them. C C, The arms. D D, The cut ends of the clavicles. E E, The extremities of the two first ribs. F F, The subclavian muscles. G G, The ribs. H, The trachea. I, The aorta ascendens. K, The aorta descendens. L, The trunk of the carotid, and subclavian artery of the right side. M, The left carotid. N N, The left subclavian artery. O, The cava superior. P, The trunks of the subclavian and jugular veins. Q, The right subclavian vein. R, The right jugular vein. S, The left subclavian vein. T, The left jugular. *a*, The thoracic duct passing on the right side of the descending aorta (K) behind the ascending aorta (I), and behind the lower part of the left carotid artery (M), and then appearing at (*b*). *b*, The upper part of the thoracic duct, lying between the left carotid, and the left jugular vein, and passing behind that vein downwards, and outwards towards the angle between the left jugular and the left subclavian. *c*, The extremity of the thoracic duct, entering the angle between the left jugular and the left subclavian vein. *d d*, Two of the trunks of the lymphatics of the left arm lying upon the outside of the cheft, and passing under the subclavian muscle F (*on the figure*) and the subclavian vein S, the clavicle it is being removed, and its cut extremity seen at D, upon the figure. *e*, A trunk formed by the lymphatics of the upper extremity, which trunk joins the extremity of the thoracic duct (*c*), and enters the angle between the left jugular and the left subclavian vein. *f*, Lymphatics from the thyroid gland running upon the trachea, and passing under the aorta to get to the thoracic duct, just where that duct enters the veins. *g g*, A trunk of the lymphatics of the right arm, lying on the outside of the right brachial artery. *h*, A branch of this trunk making a net-work on the outside of the thorax just under the clavicle. *i*, That net-work passing under the right subclavian vein (Q) and under the subclavian muscle F, (on the figure) the clavicle itself being removed. *k*, The common trunk both of that plexus and of all the other lymphatics of the upper extremity of the right side, which trunk lies between the right subclavian artery and vein, and passes into the angle between the right jugular and the right subclavian. *l*, The trunk of the lymphatics of the right side of the neck, lying on the outside of the right jugular vein, and passing into the angle between that vein and the subclavian of the same side. *m*, One of the lymphatics of the right side of the thyroid gland going under the right jugular vein.

Figure III. exhibits a fore view of the upper extremity. This representation being made from a dried preparation, the muscles therefore appear very small. It has a peculiarity in the ulnar artery, running over the muscles instead of under them. A, The scapula. B, The clavicle. C, The extremity of the brachial artery. D, The muscles lying on the inside of the arm. E, The inner condyle of the os humeri. F, The lower extremity of the radius.

On the Out-Lines to Fig. 3.

a, A lymphatic vessel which lies in the cellular membrane immediately under the skin, and passes up on the inside of the arm to the axillary glands. b, Superficial lymphatic vessels passing over the muscles from the back of the fore arm, and likewise over the biceps to the glands in the axilla. *c*, A superficial lymphatic from the back of the fore arm. d, A gland through which it passes. e, The lymphatics from the anterior and the posterior part of the fore arm uniting. f f, Lymphatic glands in the axilla. g, A deeper seated lymphatic vessel, lying close to the radial artery, which it accompanies all the way to (h). h, The deep seated lymphatic vessel passing under the interosseous and ulnar arteries, and appearing again on the arm at (i) i, The deep seated lymphatic vessel lying close to the brachial artery. k k, Two small lymphatic glands through which it passes. l, The same vessels now become much larger, and passing under a branch of the artery and some cellular membrane, and appearing at (m). m, The trunk of the deep seated lymphatic vessels passing upwards to the axilla, where it enters the glands, f f. f f, Three axillary glands, which are common both to the superficial and the deep seated lymphatic vessels.

Figure IV. exhibits a back view of the fore arm and hand. The preparation from which this view was taken having been previously dried, the muscles appear very slender. A, The hand. B, The lower extremity of the radius. C, The lower extremity of the ulna. D, The muscles on the back of the fore arm turned aside to exhibit a deep seated lymphatic vessel, which perforates the interosseous ligament to get to the fore part. E, The olecranon.

On the Out-Lines to Fig. 4

a a a, Lymphatics appearing on the back part of the fore arm immediately under the skin. b, Some of the lymphatics, bending over the upper extremity of the radius to get to the fore part of the arm. c, A lymphatic passing over the ulna, immediately under the olecranon, and under the inner condyle of the os humeri, to get to the fore part of the arm. d, A lymphatic which has penetrated the muscles, perforates the interosseous ligament, and gets to the fore part of the arm near the radial artery.

Figure V. exhibits the more superficial lymphatic vessels of the lower extremity. A, The spine of the os ilium. B, The os pubis. C, The iliac artery. D, The knee. E E, F, Branches of the crural artery. G, The musculus gastrocnemius. H, The tibia. I, The tendon of the musculus tibialis anticus.

On the Out-Lines to Fig. 5.

a, A lymphatic vessel belonging to the top of the foot. b, Its first division into branches. c c, c, Other divisions of the same lymphatic vessel. d, A small lymphatic gland. e, The lymphatic vessels which lie between the skin and the muscles of the thigh. f f, Two lymphatic glands at the upper part of the thigh below the groin. g g, Other glands. h, A lymphatic vessel which passes by the side of those glands without communicating with them; and, bending towards the inside of the groin at (i), opens into the lymphatic gland (k). l, l, Lymphatic glands in the groin, which are common to the lymphatic vessels of the genitals, and those of the lower extremity. m, n, A plexus of lymphatic vessels passing on the inside of the iliac artery.

N. B. The lymphatic vessels appear in these plates more regularly cylindrical than they are represented by Nuck Ruysch, and others, in whose plates such vessels are painted more like chains of vesicles than we have ever seen them.

Figure

Figure VI. exhibits a back view of the lower extremity, diſſected ſo as to ſhew the deeper ſeated lymphatic veſſels which accompany the arteries.

N. B. This extremity was dried before the plate was made from it, and the veſſels are therefore much ſhrunk.

A, the os pubis. B, The tuberoſity of the iſchium. C, That part of the os ilium which was articulated with the os ſacrum. D, The extremity of the iliac artery appearing above the groin. E, the knee. F F, The two cut ſurfaces of the triceps muſcle, which was divided to ſhew the lymphatic veſſels that paſs through its perforation along with the crural artery. G, The edge of the muſculus gracilis. H, The gaſtrocnemius and ſoleus, much ſhrunk by being dried, and by the ſoleus being ſeparated from the tibia to expoſe the veſſels. I, The heel. K, The ſole of the foot. L, The ſuperficial lymphatic veſſels paſſing over the knee, to get to the thigh.

On the Out-Lines of Fig. 6.

M, The poſterior tibial artery. a, A lymphatic veſſel accompanying the poſterior tibial artery. b, The ſame veſſel croſſing the artery. c, A ſmall lymphatic gland, through which this deep ſeated lymphatic veſſel paſſes. d, The lymphatic veſſel paſſing under a ſmall part of the ſoleus, which is left attached to the bone, the reſt being removed. e, The lymphatic veſſel, croſſing the popliteal artery. f, g, h, Lymphatic glands in the ham, through which the lymphatic veſſel paſſes. i, The lymphatic veſſel paſſing with the crural artery through the perforation of the triceps muſcle. k, The lymphatic veſſel, after it has paſſed the perforation of the triceps, dividing into branches which embrace the artery (l). m, A lymphatic gland belonging to the deep ſeated lymphatic veſſel. At this place thoſe veſſels paſs to the fore part of the groin, where they communicate with the ſuperficial lymphatic veſſels. n, A part of the ſuperficial lymphatic veſſels appearing on the brim of the pelvis.

SECT. XV. OF THE GENERATIVE ORGANS; OF CONCEPTION, &c.

Art. 1. *The Male Organs.*

THE male organs of generation have been uſually divided into the parts which ſerve to prepare the ſemen from the blood, and thoſe which are deſtined to convey it into the womb. But it ſeems to be more proper to diſtinguiſh them into the *preparing*, the *containing*, and the *expelling* parts, which are the different offices of the *teſtes*, the *veſiculæ ſeminales*, and the *penis*; and this is the order in which we propoſe to deſcribe them.

The teſtes are two glandular bodies, ſerving to ſecrete the ſemen from the blood. They are originally formed and lodged within the cavity of the abdomen; and it is not till after the child is born, or very near that time, that they begin to paſs into the groin, and from thence into the ſcrotum (M). By this diſpoſition they are very wiſely protected from the injuries to which they would be liable to be expoſed, from the different poſitions of the child at the time of parturition. The teſticles in this ſtate are looſely attached to the pſoæ muſcles, by means of the peritoneum by which they are covered; and they are at this time of life connected in a very particular manner to the parietes of the abdomen, and likewiſe to the ſcrotum, by means of a ſubſtance which Mr. Hunter calls the *ligament* or *gubernaculum teſtis*, becauſe it connects the teſtis with the ſcrotum, and directs its courſe in its deſcent. This gubernaculum is of a pyramidal form, with its bulbous head fixed to the lower end of the teſtis and epididymis, and loſes its lower and ſlender extremity in the cellular membrane of the ſcrotum. It is difficult to aſcertain what the ſtructure and compoſition of this gubernaculum is, but it is certainly vaſcular and fibrous; and from certain circumſtances, it ſhould ſeem to be in part compoſed of the cremaſter muſcle, running upwards to join the lower end of the teſtis. We are not to ſuppoſe that the teſticle, when deſcended into the ſcrotum, is to be ſeen looſe as a piece of gut or omentum would be in a common hernial ſac. We have already obſerved, that during its reſidence in the cavity of the abdomen it is attached to the peritoneum, which deſcends with it; ſo that when the ſac is completed in the ſcrotum, the teſticle is at firſt attached only to the poſterior part of it, while the fore part of it lies looſe, and for ſome time affords a communication with the abdomen. The ſpermatic chord, which is made up of the ſpermatic artery and vein, and of the vas deferens or excretory duct of the teſtis, is cloſely attached behind to the poſterior part of this elongation of the peritoneum. But the fore part of the peritoneal ſac, which is at firſt looſe and not attached to the teſticle, cloſes after a certain time, and becomes united to the poſterior part, and thus perfectly ſurrounds the teſticles as it were in a purſe. The teſticles of the fœtus differ only in their ſize and ſituation from thoſe of the adult. In their paſſage from the abdomen they deſcend through the abdominal rings into the ſcrotum, where they are ſupported and defended by various integuments. What the immediate cauſe of this deſcent is, has not yet been ſatisfactorily determined. It has been aſcribed to the effects of reſpiration, but the teſticles have ſometimes been found in the ſcrotum before the child has breathed; and it does not ſeem to be occaſioned by the action of the cremaſter muſcle, becauſe the ſame effect would be liable to happen in the hedge-hog, and ſome other quadrupeds, whoſe teſticles remain in the abdomen during life.

The ſcrotum, which is the external or common covering of both teſticles, is a kind of ſac formed by the common integuments, and externally divided into two equal parts by a prominent line called *raphe*. In the inner part of the ſcrotum we meet with a cellular coat called *dartos* (N), which by its duplicature divides the ſcrotum into two equal parts, and forms what is called *ſeptum ſcroti*, which correſponds with the raphe. The collapſion which is ſo often obſerved to take place in the ſcrotum of the healthy ſubject, when excited by cold or by the ſtimulus of venery, ſeems to be very properly attributed to the contractile motion of the ſkin, and not to any muſcular fibres, as is the caſe in dogs and ſome other quadrupeds.

The ſcrotum, then, by means of its ſeptum, is found to make two diſtinct bags, in which the teſticles, inveſted by their proper tunics, are ſecurely lodged and ſeparated from each other. Theſe coats are the cremaſter, the tunica vaginalis, and the tunica albuginea. The firſt of theſe is compoſed of muſcular fibres, and is to be conſidered only as a partial covering of the teſtis; for it ſurrounds only the ſpermatic chord, and terminates upon the upper and external parts of the tunica vaginalis teſtis; ſerving to draw up and ſuſpend the teſticle (O). The tunica vaginalis teſtis has already been deſcribed as being a thin production of the peritoneum, looſely adhering every where to the teſticle, which it includes as it were in a bag. The tunica albuginea is a firm, white, and very compact membrane of a gliſtening appearance, which immediately inveſts the body of the teſtis and the epididymis; ſerving in ſome meaſure to connect them to each other, but without extending itſelf at all to the ſpermatic chord. This tunica albuginea ſerves ſo confine the growth of the teſtis and epididymis within certain limits, and by giving them a due degree of firmneſs, enables them to perform their proper functions. Having removed this laſt tunic, we diſcover the ſubſtance of the teſticle itſelf, which appears to be made up of an infinite number of very elaſtic filaments, which may be beſt diſtinguiſhed after macerating the teſticle in water. Each teſticle is made up of the ſpermatic artery and vein, and the excretory veſſels or tubuli ſeminiferi. There are likewiſe a great number of abſorbent veſſels, and ſome branches of nerves to be met with in the teſticles.

The ſpermatic arteries ariſe one on each ſide from the aorta, generally about an inch below the emulgents. The right ſpermatic vein commonly paſſes into the vena cava; but the left ſpermatic vein uſually empties itſelf into the emulgent on that ſide; and it is ſuppoſed to take this courſe into the emulgent, that it may avoid paſſing over the aorta, which it would be obliged to do in its way to the vena cava.

The blood is circulated very ſlowly through the ſpermatic artery, which makes an infinite number of circumvolutions in the ſubſtance of the teſticle, where it depoſits the ſemen, which paſſes through the tubuli ſeminiferi. Theſe tubuli ſeminiferi are ſeen running in ſhort waves from the tunica albuginea to the axis of the teſticle; and are divided into diſtinct portions by certain thin membranous productions, which originate from the tunica albuginea. They at length unite, and by an infinite number of convolutions form a ſort of appendix to the teſtis called *epididymis* (P), which is a vaſcular body of an oblong ſhape, ſituate upon the ſuperior part of each teſticle. Theſe tubuli of the epididymis at length form an excretory duct called *vas deferens*, which aſcends towards the abdominal rings, with

(M) It ſometimes happens in diſſecting ruptures, that the inteſtine is found in the ſame ſac, and in contact with the teſtis. This appearance was at firſt attributed to a ſuppoſed laceration of the peritoneum; but later obſervations, by pointing out the ſituation of the teſticles in the fœtus, have led to prove, that the teſtis, as it deſcends into the ſcrotum, carries with it a portion of elongation of the peritoneum, which becomes its tunica vaginalis, or a kind of ſac, in which the teſticle is lodged, as will be explained in the courſe of this ſection. The communication between this ſac and the cavity of the abdomen, is uſually ſoon cut off; but in ſome ſubjects it continues open during life; and when an hernia or deſcent of the inteſtine takes place in ſuch a ſubject it does not puſh down a portion of the peritonæum before it, as it muſt otherwiſe neceſſarily do, but paſſes at once through this opening, and comes in contact with the naked teſticle, conſtituting that particular ſpecies of rupture called *hernia congenita*.

(N) The dartos has uſually been conſidered as a muſcle, and is deſcribed as ſuch both by Douglas and Winſlow. But there being no part of the ſcrotum of the human ſubject which can be ſaid to conſiſt of muſcular fibres, Albinus and Haller have very properly omitted to deſcribe the dartos as a muſcle, and conſider it merely as a cellular coat.

(O) The cremaſter muſcle is compoſed of a few fibres from the obliquus internus abdominis, which uniting with a few from the tranſverſalis, deſcend upon the ſpermatic chord, and are inſenſibly loſt upon the tunica vaginalis of the teſticle. It ſerves to ſuſpend and draw up the teſticle.

(P) The teſticles were named *didymi* by the ancients, and the name of this part as given to it on account of its ſituation upon the teſticle.

Viscera; See System of Anatomy, Part 3. Section 12.

Fig. 3. The Heart in Situ, as it appears when the Vessels are filled with injection.

Fig. 7. Blood Vessels of the Liver, uniting to form vena portæ.

Fig. 1. A Section of the Kidney, shewing its secretions with the Tubuli uriniferi.

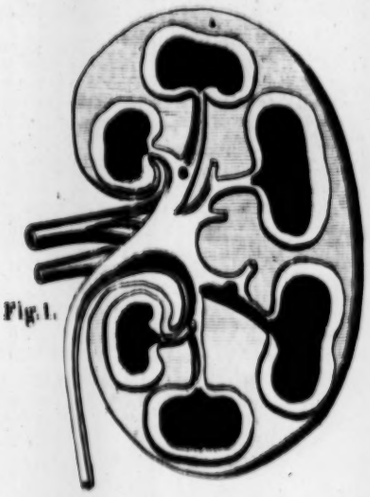

Fig. 9. The Lungs with the Heart, and its Pericardium.

Fig. 2.

Fig. 6. A posterior View of the Stomach when inflated, representing its Vessels & Omentum.

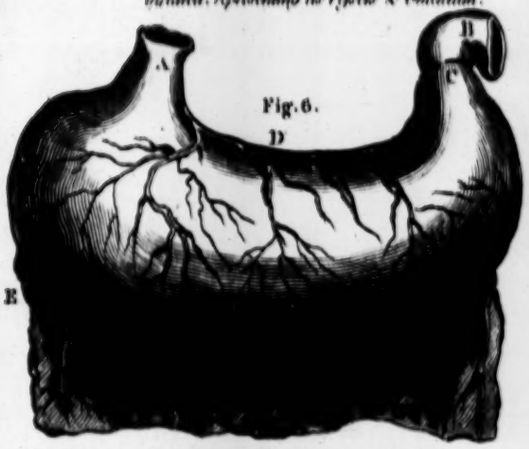

Fig. 4. The Body below the Diaphragm with the Intestines removed, to shew the remaining Viscera & the Thoracic Duct.

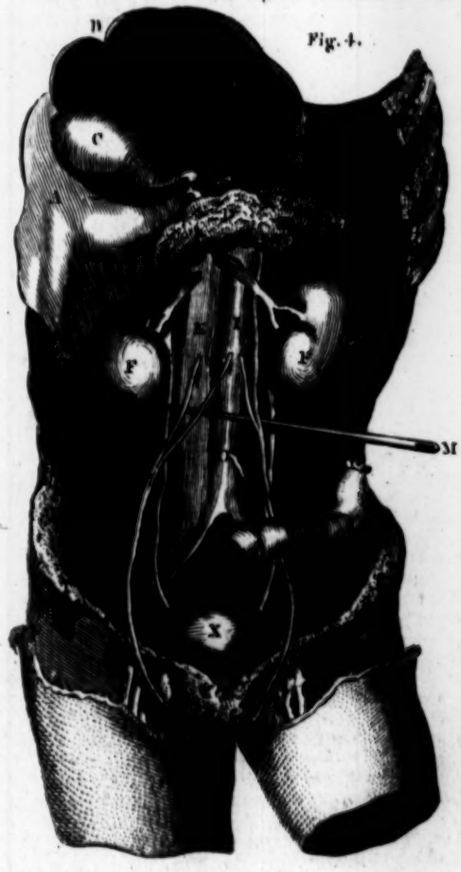

Fig. 3. The Body laid open to shew the Thoracic & Abdominal Viscera in Situ, nothing being removed but the Omentum

the other parts that make up the ſpermatic chord, and then a ſeparation takes place: the nerves and blood-veſſels paſſing on to their ſeveral terminations, and the vas deferens going to depoſit its ſemen in the veſiculæ ſeminales, which are two ſoft bodies of a white and convoluted appearance externally, ſituated obliquely between the rectum and the lower part of the bladder, and uniting together at the lower extremity. From theſe reſervoirs Q, which are plentifully ſupplied with blood-veſſels and nerves, the ſemen is occaſionally diſcharged through two ſhort paſſages, which open into the urethra cloſe to a little eminence called *verumontanum*.

Near this eminence we meet with the proſtrate, which is ſituated at the neck of the bladder, and is deſcribed as being of a glandular ſtructure. It is ſhaped ſomewhat like a heart with its ſmall end foremoſt, and inveſts the origin of the urethra. Internally it appears to be of a firm ſubſtance, and compoſed of ſeveral follicles, ſecreting a whitiſh viſcid fluid, that is diſcharged by ten or twelve excretory ducts into the urethra, on each ſide of the openings of the veſiculæ ſeminales at the ſame time, and from the ſame cauſes that the ſemen is expelled. As this latter fluid is found to be exceedingly limpid in the veſiculæ ſeminales of the dead ſubject, it probably owes its whiteneſs and viſcidity to this liquor of the proſtrate.

The penis, which is to be conſidered as the vehicle or active organ of procreation, is compoſed of two columns, the corpora cavernoſa and corpus ſpongioſum. The corpora cavernoſa, which conſtitute the greateſt part of the penis, may be deſcribed as two cylindrical ligamentous tubes, each of which is compoſed of an infinite number of minute cells of a ſpongy texture, which communicate with each other. Theſe two bodies are of a very pliant texture, and capable of conſiderable diſtenſion; and being united laterally to each other, occaſion by this union a ſpace above and another below. The uppermoſt of theſe ſpaces is filled by the blood-veſſels, and the lower one, which is larger than the other, by the urethra and its corpus ſpongioſum. Theſe two cavernous bodies are at firſt only ſeparated by a partition of tendinous fibres, which allow them to communicate with each other; but they afterwards divaricate from each other like the branches of the letter Y, and diminiſhing gradually in ſize, are attached, one on each ſide, by means of the ligamentum ſuſpenſorium penis to the ramus iſchii, and to the inferior portion of the os pubis.

The corpus ſpongioſum penis, or corpus ſpongioſum urethræ, as it is ſtyled by ſome authors, begins as ſoon as the urethra has paſſed the proſtrate, with a thick origin almoſt like a heart, firſt under the urethra, and afterwards above it, becoming gradually thinner, and ſurrounding the whole canal of the urethra, till it terminates in a conſiderable expanſion, and conſtitutes what is called the *glans penis*, which is exceedingly vaſcular, and covered with papillæ like the tongue. The cuticle which lines the inner ſurface of the urethra, is continued over the glans in the ſame manner as it is ſpread over the lips.

The penis is inveſted by the common integuments, but the cutis is reflected back every where from the glans as it is in the eye-lids; ſo that it covers this part, when the penis is in a relaxed ſtate, as it were with a hood, and from this uſe is called *prepuce*.

The prepuce is tied down to the under part of the glans by a ſmall ligament called *frænum*, which is in fact only a continuation of the cuticle and cutis. There are many ſimple ſabaceous follicles called *glandulæ odoriferæ*, placed round the baſis of the glans; and the fluid they ſecrete ſerves to preſerve the exquiſite ſenſibility of this part of the penis, and to prevent the ill effects of attrition from the prepuce.

The urethra may be defined to be a membranous canal, paſſing from the bladder through the whole extent of the penis. Several very ſmall openings, called *lacunæ*, communicate with this canal, through which a mucus is diſcharged into it; and beſides theſe, there are two glands, firſt deſcribed by Cowper, as ſecreting a fluid for lubricating the urethra, and called *Cowper's glands* (R), and Littre ſpeaks of a gland ſituated near the proſtrate, as being deſtined for the ſame uſe. The urethra being continued from the neck of the bladder, is to be conſidered as making part of the urinary paſſage; and it likewiſe affords a conveyance to the ſemen, which we have obſerved is occaſionally diſcharged into it from the veſiculæ ſeminales. The direction of this canal being firſt under and then before the pubis, occaſion a winding in its courſe from the bladder to the penis, not unlike the turns of the letter *S*.

The penis has three pair of muſcles, the erectores, acceleratores, and tranſverſales. They puſh the blood from the crura to the fore part of the corpora cavernoſa. The firſt originate from the tuberoſity of the iſchium, and terminate in the corpora cavernoſa. The acceleratores ariſe from the ſphincter, and by their inſertion ſerve to compreſs the bulbous part of the urethra; and the tranſverſales are deſtined to afford a paſſage to the ſemen, by dilating the canal of the urethra.

The arteries of the penis are chiefly derived from the internal iliacs. Some of them are ſuppoſed to terminate by pabulous orifices within the corpora cavernoſa and corpus ſpongioſum; and others terminate in veins, which at laſt make up the vena magna dorſi penis, and other ſmaller veins, which are in general diſtributed in like order with the arteries.

Its nerves are large and numerous. They ariſe from the great ſciatic nerve, and accompany the arteries in their courſe through the penis.

We have now deſcribed the anatomy of this organ; and there only remains to be explained, how it is enabled to attain that degree of firmneſs and diſtenſion which is eſſential to the great work of generation.

The greateſt part of the penis has been ſpoken of as being of a ſpongy and cellular texture, plentifully ſupplied with blood-veſſels and nerves, and as having muſcles to move it in different directions. Now, the blood is conſtantly paſſing into its cells through the ſmall branches of the arteries which open into them, and is from thence as conſtantly returned by the veins, ſo long as the corpora cavernoſa and corpus ſpongioſum continue to be in a relaxed and pliant ſtate. But when, from any nervous influence, or other means, which it is not neceſſary here to define or explain, the erectores penis, ejaculatores ſeminis, levatores ani, &c. are induced to contract, the veins undergo a certain degree of compreſſion, and the paſſage of the blood through them is ſo much impeded, that it collects in them in a greater proportion than they are enabled to carry off, ſo that the penis gradually enlarges; and being more and more forcibly drawn up againſt the os pubis, the vena magna itſelf is at length compreſſed, and the penis becomes fully diſtended. But as the cauſes which firſt occaſioned this diſtenſion ſubſide, the penis gradually returns to its ſtate of relaxation.

Art. 2. *Female Organs of Generation.*

Anatomical writers uſually divide the female organs of generation into *external* and *internal*. In the firſt diviſion they include the *mons veneris*, *labia pudendi*, *perinæum*, *clitoris*, *nymphæ*,

(Q) That the bags called *veſiculæ ſeminales* are reſervoirs of ſemen, is a circumſtance which has been by anatomiſts univerſally believed. Mr. J. Hunter, however, from ſeveral circumſtances, has been induced to think this opinion erroneous. He has examined theſe veſiculæ in people who have died ſuddenly, and he found their contents to be different in their properties from the ſemen. In thoſe who had loſt one of the teſticles, or the uſe of one of them by diſeaſe, both the veſiculæ were full, and their contents ſimilar. And in a *fiſtula ſtercoralis*, where there was no communication between the vaſa deferentia and veſiculæ, nor between the veſiculæ and penis, the ſame thing took place. From theſe obſervations, he thinks we have a preſumptive proof, that the ſemen can be abſorbed in the body of the teſticle and in the epididymis, and that the veſiculæ ſecrete a mucus which they are capable of abſorbing when it cannot be made uſe of: That the ſemen is not retained in reſervoirs after it is ſecreted, and kept there till it is uſed; but that it is ſecreted at the time, in conſequence of certain affections of the mind ſtimulating the teſticles to this action. He corroborates his obſervations by the appearance on diſſection in other animals; and here he finds, That the ſhape and contents of the veſiculæ vary much in different animals, while the ſemen in moſt of them he has examined is nearly the ſame: That the vaſa deferentia in many animals do not communicate with the veſiculæ: That the contents of the veſiculæ of caſtrated and perfect animals are ſimilar, and nearly equal in quantity, in no way reſembling the ſemen as emitted from the animal *in coitu*, or what is found in the vas deferens after death. He obſerves likewiſe, that the bulb of the urethra of perfect males is conſiderably larger than in caſtrated animals.

From the whole, he thinks the following inferences may be fairly drawn: That the bags called *veſiculæ ſeminales* are not ſeminal reſervoirs, but glands ſecreting a peculiar mucus; and that the bulb of the urethra is properly ſpeaking the receptacle of the ſemen, in which it is accumulated previous to ejection. But although he has endeavoured to prove that the veſiculæ do not contain the ſemen, he has not been able to aſcertain their particular uſe. He thinks, however, he may be allowed upon the whole to conclude, that they are, together with other parts, ſubſervient to the purpoſes of generation.

Although the author has treated this ſubject very ably, and made many ingenious obſervations, ſome things may be objected to what he has advanced; of which the following are a few: That thoſe animals who have bags called *veſiculæ ſeminales* perform copulation quickly; whereas others that want them, as in the dog kind, are tedious in copulation: That in the human body, at leaſt, there is a free communication between the vaſa deferentia and veſiculæ; and in animals where the author has obſerved no communication between the vaſa deferentia and veſiculæ, there may be a communication by veſſels not yet diſcovered, and which may be compared to the hepato-cyſtic ducts in fowls and fiſhes: That the fluid in the end of the vaſa deferentia and the veſiculæ ſeminales are ſimilar, according to the author's own obſervation: That the veſiculæ in ſome animals increaſe and decreaſe with the teſticle at particular ſeaſons: That in birds and certain fiſhes, there is a dilatation of the ends of the vaſa deferentia, which the author himſelf allows to be a reſervoir for the ſemen. With reſpect to the circumſtance of the bulb of the urethra anſwering the purpoſe of a reſervoir, the author has mentioned no facts which tend to eſtabliſh this opinion. See *Obſervations on certain Parts of the Animal Oeconomy*.

(R) Both Heiſter and Morgagni obſerve, that they have ſometimes not been able to find theſe glands; ſo that they do not ſeem to exiſt in all ſubjects.

and *carunculæ myrtiformes*; and in the latter, the *vagina*, with the *uterus* and its appendages.

The *mons veneris*, which is placed on the upper part of the ſymphyſis pubis, is internally compoſed of adipoſe membranes, which make it ſoft and prominent: it divides into two parts called *labia pudendi*, which deſcending towards the rectum, from which they are divided by the perinæum, form what is called the *fourchette*. The perinæum is that fleſhy ſpace which extends about an inch and an half from the fourchette to the anus, and from thence about two inches to the coccyx.

The labia pudendi being ſeparated, we obſerve a ſulcus called *foſſa magna*; in the upper part of which is placed the clitoris, a ſmall round ſpongy body, in ſome meaſure reſembling the male penis, but impervious, compoſed of two corpora cavernoſa, ariſing from the tuberoſities of the oſſa iſchii; furniſhed with two pair of muſcles, the erectores clitoridis, and the ſphincter or conſtrictor oſtii vaginæ; and terminating in a glans, which is covered with its prepuce. From the lower part, on each ſide of the foſſa paſs the nymphæ, two membranous and ſpongy folds which ſeem deſtined for uſeful purpoſes in parturition, by tending to enlarge the volume of the vagina as the child's head paſſes through it. Between theſe, about the middle of the foſſa magna, we perceive the orifice of the vagina or os externum, cloſed by folds and wrinkles; and about half an inch above this, and about an inch below the clitoris, appears the meatus urinarius or orifice of the urethra, much ſhorter, though ſomewhat larger, than in men, with a little prominence at its lower edge, which facilitates the introduction of the catheter.

The os externum is ſurrounded internally by ſeveral membranous folds called *carunculæ myrtiformes*, which are partly the remains of a thin membrane called *hymen*, that covers the vagina in children. In general the hymen is ſufficiently open to admit the paſſage of the menſes, if it exiſts at the time of their appearance: ſometimes, however, it has been found perfectly cloſed.

The vagina, ſituated between the urethra and the rectum, is a membranous cavity, ſurrounded eſpecially at its external extremity with a ſpongy and vaſcular ſubſtance, which is covered by the ſphincter oſtii vaginæ. It terminates in the uterus, about half an inch above the os tincæ, and is wider and ſhorter in women who have had children than in virgins.

All theſe parts are plentifully ſupplied with blood-veſſels and nerves. Around the nymphæ there are ſebaceous follicles, which pour out a fluid to lubricate the inner ſurface of the vagina; and the meatus urinarius, like the urethra in the male ſubject, is conſtantly moiſtened by a mucus, which defends it againſt the acrimony of the urine.

The *uterus* is a hollow viſcus, ſituated in the hypogaſtric region, between the rectum and bladder. It is deſtined to receive the firſt rudiments of the fœtus, and to aſſiſt in the development of all its parts, till it arrives at a ſtate of perfection, and is fitted to enter into the world, at the time appointed by the wiſe Author of nature. The uterus, in its unimpregnated ſtate, reſembles a pear in ſhape, ſomewhat flattened, with its fundus or bottom part turned towards the abdomen, and its cervix or neck ſurrounded by the vagina. The entrance into its cavity forms a little protuberance, which has been compared to the mouth of a tench, and is therefore called *os tincæ*.

The ſubſtance of the uterus, which is of a conſiderable thickneſs, appears to be compoſed of muſcular and ſmall ligamentous fibres, ſmall branches of nerves, ſome lymphatics, and with arteries and veins innumerable. Its nerves are chiefly derived from the intercoſtal, and its arteries and veins from the hypogaſtric and ſpermatic. The membrane which lines its cervix, is a continuation of the inner membrane of the vagina; but the outer ſurface of the body of the uterus is covered with the peritonæum, which is reflected over it, and deſcends from thence to the inteſtinum rectum. This duplicature of the peritonæum, by paſſing off from the ſides of the uterus to the ſides of the pelvis, is there firmly connected, and forms what are called *ligamenta uteri lata*; which not only ſerve to ſupport the uterus, but to convey nerves and blood-veſſels to it.

The *ligamenta uteri rotunda* ariſe from the ſides of the fundus uteri, and paſſing along within the fore-part of the ligamenta lata, deſcend through the abdominal rings, and terminate in the ſubſtance of the mons veneris. The ſubſtance of theſe ligaments is vaſcular, and although both they and the ligamenta lata admit the uterus in the virgin ſtate, to move only about an inch up and down, yet in the courſe of pregnancy they admit of conſiderable diſtenſion, and after parturition return nearly to their original ſtate with ſurpriſing quickneſs.

On each ſide of the inner ſurface of the uterus, in the angle near the fundus, a ſmall orifice is to be diſcovered, which is the beginning of one of the tubæ fallopianæ. Each of theſe tubes, which are two in number, paſſing through the ſubſtance of the uterus, is extended along the broad ligaments, till it reaches the edge of the pelvis, from whence it reflects back; and turning over behind the ligaments, about an inch of its extremity is ſeen hanging looſe in the pelvis, near the ovarium. Theſe extremities, having a jagged appearance, are called *fimbriæ*, or *morſus diaboli*. Each tuba Fallopiana is uſually about three or four inches long. Their cavities are at firſt very ſmall, but gradually becomes larger, like a trumpet, as they approach the fimbriæ.

Near the fimbriæ of each tuba Fallopiana, about an inch from the uretus, is ſituated an oval body called *ovarium*, of about half the ſize of the male teſticle. Each of theſe ovaria is covered by a production of the peritonæum, and hangs looſe in the pelvis. They are of a flat and angular form, and appear to be compoſed of a white and cellular ſubſtance, in which we are able to diſcover ſeveral minute veſicles filled with a coagulable lymph, of an uncertain number, commonly exceeding 12 in each ovary. In the female of riper years, theſe veſicles become exceedingly turgid, and a kind of yellow coagulum is gradually formed within one of them, which increaſes for a certain time. In conception, one of theſe mature ova is ſuppoſed to be impregnated with the male ſemen, and to be ſqueezed out of its nidus into the Fallopian tube; after which the ruptured part forms a ſubſtance which in ſome animals is of a yellow colour, and is therefore called *corpus luteum*; and it is obſervable, that the number of theſe ſcars or fiſſures in the ovarium, conſtantly correſponds with the number of fœtuſes excluded by the mother.

Art. 3. *Of Conception.*

Man, being ever curious and inquiſitive, has naturally been led to inquire after the origin of his exiſtence; and the ſubject of generation has employed the philoſophical world in all ages: but in following nature up to her minute receſſes, the philoſopher ſoon finds himſelf bewildered, and his imagination often ſupplies that which he ſo eagerly wiſhes to diſcover, but which is deſtined perhaps never to be revealed to him. Of the many theories which have been formed on this ſubject, that of the ancient philoſophers ſeems to have been the moſt ſimple: they conſidered the male ſemen as alone capable of forming the fœtus, and believed that the female only afforded it a lodging in the womb, and ſupplied it with nouriſhment after it was perfectly formed. This opinion, however, ſoon gave place to another, in which the female was allowed a more conſiderable ſhare in conception.

This ſecond ſyſtem conſidered the fœtus as being formed by the mixture of the ſeminal liquor of both ſexes, by a certain arrangement of its ſeveral particles in the uterus. But in the 16th century, veſicles or eggs were diſcovered in the ovaria or female teſticles; the fœtus had been found ſometimes in the abdomen, and ſometimes in the Fallopian tubes; and the two former opinions were exploded in favour of a new doctrine. The ovaria were compared to a bunch of grapes, being ſuppoſed to conſiſt of veſicles, each of which had a ſtalk: ſo that it might be diſengaged without hurting the reſt, or ſpilling the liquor it contained. Each veſicle was ſaid to include a little animal, almoſt complete in all its parts; and the vapour of the male ſemen being conveyed to the ovarium, was ſuppoſed to produce a fermentation in the veſicle, which approached the neareſt to maturity; and thus inducing it to diſengage itſelf from the ovarium, it paſſed into the tuba Fallopiana, through which it was conveyed to the uterus. Here it was ſuppoſed to take root like a vegetable ſeed, and to form, with the veſſels originating from the uterus, what is called the *placenta*; by means of which the circulation is carried on between the mother and the fœtus.

This opinion, with all its abſurdities, continued to be almoſt univerſally adopted till the cloſe of the ſame century, when Leeuwenhoeck, by means of his glaſſes, diſcovered certain opake particles, which he deſcribed as ſo many animalcula, floating in the ſeminal fluid of the male. This diſcovery introduced a new ſchiſm among the philoſophers of that time, and gave riſe to a ſyſtem which is not yet entirely exploded. According to this theory, the male ſemen paſſing into the tubæ Fallopianæ, one of the animalcula penetrates into the ſubſtance of the ovarium, and enters into one of its veſicles or ova. This impregnated ovum is then ſqueezed from its huſk, through the coats of the ovarium, and being ſeized by the fimbriæ, is conducted through the tube to the uterus, where it is nouriſhed till it arrives at a ſtate of perfection. In this ſyſtem there is much ingenuity; but there are certain circumſtances ſuppoſed to take place, which have been hitherto inexplicable. A celebrated modern writer, M. Buffon, endeavours to reſtore, in ſome meaſure, the moſt ancient opinion, by allowing the female ſemen a ſhare in this office; aſſerting, that animalcula or organic particles are to be diſcovered in the ſeminal liquor of both ſexes: he derives the female ſemen from the ovaria, and he contends that no ovum exiſts in thoſe parts. But in this idea he is evidently miſtaken; and the opinion now moſt generally adopted is, that an impregnation of the ovum, by the influence of the male ſemen, is eſſential to conception. That the ovum is to be impregnated, there can be no doubt: but as the manner in which ſuch an impregnation is ſuppoſed to take place, and the means by which the ovum afterwards gets into the Fallopian tube, and from thence into the uterus, are ſtill founded chiefly on hypotheſis, we will not attempt to extend farther the inveſtigation of a ſubject concerning which ſo little can be advanced with certainty. See the Articles CONCEPTION, GENERATION, and the Syſtem of MIDWIFERY, Part I. Sect. I. Art.

Art. 4. *Of the Fœtus in Utero.*

Opportunities of diſſecting the human gravid uterus occurring but ſeldom, the ſtate of the embryo (s) immediately after conception cannot be perfectly known. When the ovum deſcends into the uterus, it is ſuppoſed to be very minute; and it is not till a conſiderable time after conception that the rudiments of the embryo begin to be aſcertained. About the third or fourth week the eye may diſcover the firſt lineaments of the fœtus; but theſe lineaments are as yet very imperfect, it being only about the ſize of a horſe-fly. Two little veſicles appear in an almoſt tranſparent jelly; the largeſt of which is deſtined to become the head of the fœtus, and the other ſmaller one is reſerved for the trunk. But at this period no extremities are to be ſeen; the umbilical cord appears only as a very minute thread, and the placenta does not as yet abſorb the red particles of the blood. At ſix weeks, not only the head but the features of the face begin to be developed. The noſe appears like a ſmall prominent line, and we are able to diſcover another line under it, which is deſtined for the ſeparation of the lips. Two black points appear in the place of eyes, and two minute holes mark the ears. At the ſides of the trunk, both above and below, we ſee four minute protuberances, which are the rudiments of the arms and legs. At the end of eight weeks the body of the fœtus is upwards of an inch in length, and both the hands and feet are to be diſtinguiſhed. The upper extremities are found to increaſe faſter than the lower ones, and the ſeparation of the fingers is accompliſhed ſooner than that of the toes.

At this period the human form may be deciſively aſcertained;—all the parts of the face may be diſtinguiſhed, the ſhape of the body is clearly marked out, the haunches and the abdomen are elevated, the fingers and toes are ſeparated from each other, and the inteſtines appear like minute threads.

At the end of the third month, the fœtus meaſures about three inches: at the end of the fourth month, five inches; in the fifth month, ſix or ſeven inches; in the ſixth month, eight or nine inches; in the ſeventh month, eleven or twelve inches: in the eighth month, fourteen or fifteen inches; and at the end of the ninth month, or full time, from eighteen to twenty-two inches. But as we have not an opportunity of examining the ſame fœtus at different periods of pregnancy, and as their ſize and length may be influenced by the conſtitution and mode of life of the mother, calculations of this kind muſt be very uncertain.

The fœtus during all this time aſſumes an oval figure, which correſponds with the ſhape of the uterus. Its chin is found reclining on its breaſt with its knees drawn up towards its chin, and its arms folded over them. But it ſeems likely, that the poſture of ſome of theſe parts is varied in the latter months of pregnancy, ſo as to cauſe thoſe painful twitches which its mother uſually feels from time to time. In natural caſes, its head is probably placed towards the os tincæ from the time of conception to that of its birth; tho' formerly it was conſidered as being placed towards the fundus uteri till about the eighth or ninth month, when the head, by becoming ſpecifically heavier than the other parts of the body, was ſuppoſed to be turned downwards.

The capacity of the uterus increaſes in proportion to the growth of the fœtus, but without becoming thinner in its ſubſtance, as might naturally be expected. The nouriſhment of the fœtus, during all this time, ſeems to be derived from the placenta, which appears to be originally formed by that part of the ovum which is next the fundus uteri. The remaining part of the ovum is covered by a membrane called *ſpongy chorion* (t); within which is another called *true chorion*, which includes a third termed *amnios* (u): this contains a watery fluid, which is the *liquor amnii* (v), in which the fœtus floats till the time of its birth. On the ſide next the fœtus, the placenta is covered by the amnios and true chorion; on the ſide next the mother it has a production continued from the ſpongy chorion. The amnios and chorion are remarkably thin and tranſparent, having no blood-veſſels entering into their compoſition. The ſpongy chorion is opake and vaſcular.

In the firſt months of pregnancy, the involucra bear a large proportion to their contents; but this proportion is afterwards reverſed, as the fœtus increaſes in bulk.

The placenta, which is the medium through which the blood is conveyed from the mother to the fœtus, and the manner in which this conveyance takes place, deſerve next to be conſidered. The placenta is a broad, flat, and ſpongy ſubſtance, like a cake, cloſely adhering to the inner ſurface of the womb, uſually near the fundus, and appearing to be chiefly made up of the ramifications of the umbilical arteries and veins, and partly of the extremities of the uterine veſſels. The arteries of the uterus diſcharge their contents into the ſubſtance of this cake; and the veins of the placenta, receiving the blood either by a direct communication of veſſels, or by abſorption, at length form the umbilical vein, which paſſes on to the ſinus of the vena porta, and from thence to the vena cava, by means of the canalis venoſus, a communication that is cloſed in the adult. But the circulation of the blood through the heart is not conducted in the fœtus as in the adult: in the latter, the blood is carried from the right auricle of the heart through the pulmonary artery, and is returned to the left auricle by the pulmonary vein; but a dilatation of the lungs is eſſential to the paſſage of the blood through the pulmonary veſſels, and this dilatation cannot take place till after the child is born and has reſpired. This deficiency, however, is ſupplied in the fœtus by an immediate communication between the right and left auricle, through an oval opening in the ſeptum which divides the two auricles, called *foramen ovale*. The blood is likewiſe tranſmitted from the pulmonary artery to the aorta, by means of a duct called *canalis arteriosus*, which, like the canalis venoſus, and foramen ovalæ, gradually cloſes after birth.

The blood is returned again from the fœtus through two arteries called the *umbilical arteries*, which ariſe from the iliacs. Theſe two veſſels taking a winding courſe with the vein, form with that, and the membranes by which they are ſurrounded, what is called the *umbilical chord*. Theſe arteries, after ramifying through the ſubſtance of the placenta, diſcharge their blood into the veins of the uterus; in the ſame manner as the uterine arteries diſcharge their blood into the branches of the umbilical vein. So that the blood is conſtantly paſſing in at one ſide of the placenta and out at the other; but in what particular manner it gets through the placenta is a point not yet determined. See the Article GENERATION, and the Syſtem of MIDWIFERY.

EXPLANATION OF PLATE X.

On the Male Organs of Generation.

Figure I. repreſents a poſterior view of the male organs. A, The under ſurface of the bladder, or that ſide of it which comes in immediate contact with the rectum; the letter A is placed on what is called the fundus of the bladder. B B, The two ureters. C C, Vas deferens. D D, Veſiculæ ſeminales. E, proſtrate glands. F F, Cowper's glands. They are two ſmall glands, each of them nearly the ſize of the common pea, lately diſcovered by Dr. Cowper. G G, Acceleratores muſcles; the bulb of the urethra underneath them is the cauſe of their ſhape in the print. H, The urethra, or common paſſage for the urine and the ſemen.

I I, Muſculi erectores penis. K K, The corpora cavernoſa penis. L. Glans penis; juſt above the letter L was the inſertion of the frœnum, or bridle of the penis, but unavoidably was cut away with the ſkin that covered it.

Figure II. repreſents an anterior view from the ſame ſubject, with the bladder and the urinary canal laid open. A, The upper ſurface of the bladder, or that ſide of it which comes in contact with the ſmall inteſtines. B, The internal coat of the bladder, or the inner ſurface where the urine is contained. C C, Two orifices of the ureters by which the urine comes from the kidney into the bladder. D, D, The ureters. E, E, Vaſa deferentia. F, F, Portions of the Veſiculæ ſeminales ſeen. G G, Proſtrate gland. H, H, The two cut edges of the urethra. I I, Roſtrum or caput gallinaginus. K, K, Two orifices through which the ſemen paſſes at the time of the coctus, from the veſiculæ ſeminales; round theſe two orifices is a circle of excretory ducts, perceptible to the naked eye, which belong to a like number of glands, the whole of the urethra being filled with them, but not apparent enough to be repreſented in the print. L, L, L, Lacunæ of the urethra, or oblong holes leading to capillary blood-veſſels. M, Orifice of the urethra.

Figure III. repreſents a view of the proſtrate gland, veſiculæ ſeminales, bladder, and rectum in ſitu. A, Oſſa pubis. B, Symphyſes pubis. C, Ramus of the os iſchium. D, D. The

(s) The rudiments of the child are uſually diſtinguiſhed by this name till the human figure can be diſtinctly aſcertained, and then it has the appellation of *fœtus*.

(t) Dr. Hunter has deſcribed this as a lamella from the inner ſurface of the uterus. In the latter months of pregnancy it becomes gradually thinner and more connected with the chorion: he has named it *membrana caduca*, or *decidua*, as it is caſt off with the placenta. Signior Scarpa, with more probability, conſiders it as being compoſed of an inſpiſſated coagulable lymph.

(u) In ſome quadrupeds, the urine appears to be conveyed from the bladder through a canal called *urachus*, to the *allantois*, which is a reſervoir, reſembling a long and blind gut, ſituated between the chorion and amnios. The human fœtus ſeems to have no ſuch reſervoir, though ſome writers have ſuppoſed that it does exiſt. From the top of the bladder a few longitudinal fibres are extended to the umbilical chord; and theſe fibres have been conſidered as the urachus, though without having been ever found pervious.

(v) The liquor amnii coagulates like the lymph. It has been ſuppoſed to paſs into the œſophagus, and to afford nouriſhment to the fœtus; but this does not ſeem probable. Children have come into the world without an œſophagus, or any communication between the ſtomach and the mouth; but there has been no well atteſted inſtance of a child's having been born without a placenta; and it does not ſeem likely, that any of the fluid can be abſorbed through the pores of the ſkin, the ſkin in the fœtus being every where covered with a great quantity of mucus.

two

two cut edges of the urethra; it being divided to ſhew the paſſage of the ſeminal ducts into it. E, Caput gallinaginis. F, F. Occuli gallinaginis, or the two orifices of the veſiculæ ſeminales. G, G, The proſtrate glands divided to ſhew the ducts of the veſiculæ ſeminales. H, H. Veſiculæ ſeminales. I, I, Vaſa deferentia. K, The ſame veſſel going round the poſterior ſurface of the bladder, and coming over the brim of the pelvis to go down to the teſticle. L, L, L, The bladder. M, M, The rectum.

Figure IV. repreſents a view of the teſticle, with its coats; in this preparation there is little or no diſſection, but as it is pulled out of the ſcrotum or purſe. A, The ſpermatic chord. B, Tunica vaginalis, the coat which covers this and the teſticle. C, The cremaſter muſcle,

Figure V. repreſents the ſpermatic chord injected, and the coverings removed; we now diſcover in the chord four ſets of veſſels; viz. The vas deferens, the arteries, the veins and abſorbents; alſo the nerve; all of them going and coming from the teſticle. A A, The ſpermatic plexus. B, Vas deferens C, Epididymis. D, Convolutions of the epididymis. E, The body of the teſticle, covered by the tunica albuginea, with a few of its blood-veſſels indiſtinctly ſeen.

EXPLANATION OF PLATE X.

On the Female Organs of Generation.

Figure I. ſhews an anterior view of the uterus, fallopian tubes and vagina. A, Fundus uteri. B, Cervix uteri. C. Os tincæ. D D, The fallopian tubes, one of which is opened to ſhew the paſſage. E, Morſus diaboli. F F, Duplicature of the peritonæum or broad ligament: behind this are the ovarii, (faintly ſeen) two oviform bodies, by the ancients called teſticles. G G, The round ligaments. H, Vagina cut open to ſhew the rugous appearance. I, The orifice of the urethra: round it are marked a few of the excretory ducts, which belong to a like number of glands in the vaginal coat. K, Clitoris.

Figure II. repreſents an anterior view of the bladder, urethra, and pudendum, or external parts of generation. A, The upper and anterior ſurface of the bladder, or what comes in immediate contact with the viſcera of the abdomen. B B, The ureters. C C C, The inner ſurface of the bladder. D, The neck of the bladder. E, Inner ſurface of the urethra. F, The orifice of the urethra. G, Orifice of the vagina. H H, Pudendi labia.

Figure III. repreſents a ſide view of the contents of the pelvis. The parts were firſt diſtended, and then expoſed to the froſt, till frozen into a ſolid maſs, and a lateral ſection made to ſhow their cavities and relative ſituation, which never was repreſented before in any anatomical work whatever. A, The upper and anterior ſurface of the bladder. B, The cavity of the bladder. C, The cavity of the urethra. D, Coats of the bladder and vagina. E, The cavity of the vagina. F, Coats of the vagina and rectum. G, Cavity of the rectum. H, The rectum tied. I, The uterus. K K, The fallopian tubes, or the two paſſages of the uterus into the general cavity of the pelvis. L L, Fimbriæ, or morſus diaboli. M, one of the ovaries ſeen. N N, The broad ligament. O O, Fat and integuments, &c. P, The pudendum.

Figure IV. repreſents a back view from the ſame preparation, to ſhew their relative ſituation and angles of reflexion of the peritonæal coat. When theſe parts are in the body, in order to obtain this view, the ſubject muſt be laid on her back, the abdominal viſcera removed; and then ſtanding acroſs the body, with your back to the ſubjects head, and looking down into the pelvis, you ſee theſe viſcera in the following order: firſt, the rectum; then the uterus; and laſtly, the bladder. A, The bladder. B, The uterus. C C, The fallopian tubes. D D, The fimbriæ, or morſus diaboli. E E, The ovaries. F F, The broad ligament. G, A portion of the rectum tied.

Figure V. ſhews a view of the uterus and its cavity, in the virgin ſtate; a longitudinal ſection, or that part of it cut away, which looks towards the pelvis, the remaining half is here exhibited. A A A, The ſubſtance of the uterus. B, The entrance of the fallopian tube. C, The other fallopian tube ſeen from behind. D D, The cavity of the uterus: the loweſt D is placed on what is called the peniform rugæ of the uterus. E, The os tincæ. F F, Portions of the broad ligament. G G, The round ligament.

PART IV.

OF THE THORAX.

THE THORAX, or CHEST, is that cavity of the trunk which extends from the clavicles, or the lower part of the neck, to the diaphragm, and includes the vital organs, which are the heart and lungs; and likewiſe the trachea and œſophagus.—This cavity is formed by the ribs and vertebræ of the back, covered by a great number of muſcles, and by the common integuments, and anteriorly by two glandular bodies called the *breaſts*. The ſpaces between the ribs are filled up by muſcular fibres, which from their ſituation are called *intercoſtal muſcles*.

SECT. I. OF THE BREASTS.

THE *breaſts* may be defined to be two large conglomerate glands, mixed with a good deal of adipoſe membrane. The glandular part is compoſed of an infinite number of minute arteries, veins, and nerves.

The arteries are derived from two different trunks; one of which is called the *internal*, and the other the *external, mammary artery*. The firſt of theſe ariſes from the ſubclavian, and the latter from the axillary.

The veins every where accompany the arteries, and are diſtinguiſhed by the ſame name. The nerves are chiefly from the vertebral pairs. Like all other conglomerate glands, the breaſts are made up of a great many ſmall diſtinct glands, in which the milk is ſecreted from the ultimate branches of arteries. The excretory ducts of theſe ſeveral glands, gradually uniting as they approach the nipple, form the tubuli lactiferi, which are uſually more than a dozen in number, and open at its apex, but have little or no communication, as has been ſuppoſed, at the root of the nipple. Theſe ducts, in their courſe from the glands, are ſurrounded by a ligamentary elaſtic ſubſtance, which terminates with them in the nipple. Both this ſubſtance, and the ducts which it contains, are capable of conſiderable extenſion and contraction; but in their natural ſtate are moderately corrugated, ſo as to prevent an involuntary flow of milk, unleſs the diſtending force be very great from the accumulation of too great a quantity.

The whole ſubſtance of the nipple is very ſpongy and elaſtic: its external ſurface is uneven, and full of ſmall tubercles. The nipple is ſurrounded with a diſk or circle of a different colour, called the *areola*; and on the inſide of the ſkin, under the areola, are many ſebaceous glands, which pour out a mucus to defend the areola and nipple: for the ſkin upon theſe parts is very thin; and the nervous papillæ lying very bare, are much expoſed to irritation. The breaſts are formed for the ſecretion of milk, which is deſtined for the nouriſhment of the child for ſome time after its birth. This ſecretion begins to take place ſoon after delivery, and continues to flow for many months in very large quantities, if the woman ſuckles her child. The operation of ſuction depends on the principles of the air-pump, and the flow of milk through the lactiferous tubes is facilitated by their being ſtretched out.

The milk, examined chymically, appears to be compoſed of oil, mucilage, and water, and of a conſiderable quantity of ſugar. The generality of phyſiologiſts have ſuppoſed that, like the chyle, it frequently retains the properties of the aliment and medicines taken into the ſtomach; but from ſome late experiments, this ſuppoſition appears to be ill founded.

SECT. II. OF THE PLEURA.

THE cavity of the thorax is every where lined by a membrane of a firm texture called *pleura*. It is compoſed of two diſtinct portions or bags, which, by being applied to each other laterally, form a ſeptum called *mediaſtinum*; which divides the cavity into two parts, and is attached poſteriorly to the vertebræ of the back, and anteriorly to the ſternum. But the two laminæ of which this ſeptum is formed, do not every where adhere to each other; for at the lower part of the thorax they are ſeparated, to afford a lodgement to the heart; and at the upper part of the cavity, they receive between them the thymus.

The pleura is plentifully ſupplied with arteries and veins from the internal mammary and the intercoſtals. Its nerves, which are very inconſiderable, are derived chiefly from the dorſal and intercoſtal nerves. The ſurface of the pleura, like that of the peritonæum and other membranes lining cavities, is conſtantly bedewed with a ſerous moiſture (w), which prevents adheſions of the viſcera.

The mediaſtinum, by dividing the breaſt into two cavities, obviates many inconveniences, to which we ſhould otherwiſe be liable. It prevents the two lobes of the lungs from compreſſing each other when we lie on one ſide; and conſequently contributes to the freedom of reſpiration, which is diſturbed by the leaſt preſſure on the lungs. If the point of a ſword penetrates between the ribs into the cavity of the thorax, the lungs on that ſide ceaſe to perform their office; becauſe the air being admitted through the wound, prevents the dilatation of that lobe; while the other lobe, which is ſeparated from it by the mediaſtinum, remains unhurt, and continues to perform its function as uſual.

SECT. III. OF THE THYMUS.

THE *thymus* is a glandular ſubſtance, the uſe of which is not perfectly aſcertained, its excretory duct not having yet been diſcovered. It is of an oblong figure, and is larger in the fœtus and in young children than in adults, being ſometimes nearly effaced in very old ſubjects. It is placed in the upper part of the thorax, between the two laminæ of the mediaſtinum; but

(w) When this fluid is exhaled in too great a quantity, or is not properly carried off, it accumulates and conſtitutes the hydrops pectoris.

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at first is no altogether contained within the cavity of the cheſt, being found to border upon the upper extremity of the ſternum.

SECT. IV. OF THE DIAPHRAGM.

THE cavity of the thorax is ſeparated from that of the abdomen, by a fleſhy and membranous ſeptum called the *diaphragm* or *midriff*. The greateſt part of it is compoſed of muſcular fibres; and on this account ſyſtematic writers uſually place it very properly among the muſcles. Its middle part is tendinous, and it is covered by the pleura above, and by the peritonæum below. It ſeems to have been improperly named *ſeptum tranſverſum*, as it does not make a plane tranſverſe diviſion of the two cavities, but forms a kind of vault, the fore part of which is attached to the ſternum. Laterally it is fixed to the laſt of the true ribs, and to all the falſe ribs; and its lower and poſterior part is attached to the vertebræ lumborum, where it may be ſaid to be divided into two portions or crura (x). The principal arteries of the diaphragm are derived from the aorta, and its veins paſs into the vena cava. Its nerves are chiefly derived from the cervical pairs. It affords a paſſage to the vena cava through its tendinous part, and to the œſophagus through its fleſhy portion. The aorta paſſes down behind it between its crura.

The diaphragm not only ſerves to divide the thorax from the abdomen, but by its muſcular ſtructure is rendered one of the chief agents in reſpiration. When its fibres contract, its convex ſide, which is turned towards the thorax, becomes gradually flat, and by increaſing the cavity of the breaſt, affords room for a complete dilatation of the lungs, by means of the air which is then drawn into them by the act of inſpiration. The fibres of the diaphragm then relax; and as it reſumes its former ſtate, the cavity of the thorax becomes gradually diminiſhed, and the air is driven out again from the lungs by a motion contrary to the former one, called *exſpiration*. It is in ſome meaſure, by means of the diaphragm, that we void the feces at the anus, and empty the urinary bladder. Beſides theſe offices, the acts of coughing, ſneezing, ſpeaking, laughing, gaping, and ſighing, could not take place without its aſſiſtance; and the gentle preſſure which all the abdominal viſcera receive from its conſtant and regular motion, cannot fail to aſſiſt in the performance of the ſeveral functions which were aſcribed to thoſe viſcera; for a repreſentation of which, ſee Plate IV. and its explanation. See the Article DIAPHRAGM.

SECT. V. OF THE TRACHEA.

THE trachea, or windpipe, is a cartilaginous and membranous canal, through which the air paſſes into the lungs. Its upper part, which is called the *larynx*, is compoſed of five cartilages. The uppermoſt of theſe cartilages is placed over the glottis or mouth of the larynx, and is called *epiglottis*, which has been before ſpoken of, as cloſing the paſſage to the lungs in the act of ſwallowing. At the ſides of the glottis are placed the two arytenoide cartilages, which are of a very complex figure, not eaſy to be deſcribed. The anterior and larger part of the larynx is made up of two cartilages; one of which is called *thyroides* or *ſcutiformis*, from its being ſhaped like a buckler; and the other *cricoides* or *annularis*, from its reſembling a ring. Both theſe cartilages may be felt immediately under the ſkin, at the fore part of the throat; and the thyroides, by its convexity, forms an eminence called *pomum adami*, which is uſually more conſiderable in the male than in the female ſubject. All theſe cartilages are united to each other by means of very elaſtic, ligamentous fibres; and are enabled, by the aſſiſtance of their ſeveral muſcles, to dilate or contract the paſſage of the larynx, and to perform that variety of motion which ſeems to point out the larynx as the principal organ of the voice; for when the air paſſes out through a wound in the trachea, it produces no ſound. Theſe cartilages are moiſtened by a mucus, which ſeems to be ſecreted by minute glands ſituated near them. The upper part of the trachea is covered anteriorly and laterally by a conſiderable body, which is ſuppoſed to be of a glandular ſtructure, and from its ſituation near the thyroid cartilage is called the *thyroid gland*; though its excretory duct has not yet been diſcovered, or its real uſe aſcertained.

The glottis is interiorly covered by a very fine membrane, which is moiſtened by a conſtant ſupply of a watery fluid. From the larynx, the canal begins to take the name of *trachea* or *aſpera arteria*, and extends from thence as far down as the third or fourth vertebra of the back, where it divides into two branches, which are the right and left bronchial tube. Each of theſe bronchi (y) ramifies through the ſubſtance of that lobe of the lungs, to which it is diſtributed, by an infinite number of branches, which are formed of cartilages ſeparated from each other like thoſe of the trachea, by an intervening membranous and ligamentary ſubſtance. Each of theſe cartilages is of an angular figure; and as they become gradually leſs and leſs in their diameter, the lower ones are in ſome meaſure received into thoſe above them, when the lungs, after being inflated, gradually collapſe by the air being puſhed out from them in exſpiration. As the branches of the bronchi become more minute, their cartilages become more and more angular and membranous, till at length they are found to be perfectly membranous, and at laſt become inviſible.

The trachea is furniſhed with fleſhy or muſcular fibres; ſome of which paſs through its whole extent longitudinally, while the others are carried round it in a circular direction; ſo that by the contraction or relaxation of theſe fibres, it is enabled to ſhorten or lengthen itſelf, and likewiſe to dilate or contract the diameter of its paſſage. The trachea and its branches, in all their ramifications, are furniſhed with a great number of ſmall glands which are lodged in their cellular ſubſtance, and diſcharge a mucous fluid on the inner ſurface of theſe tubes. The cartilages of the trachea, by keeping it conſtantly open, afford a free paſſage to the air, which we are obliged to be inceſſantly reſpiring; and its membranous part, by being capable of contraction and dilatation, enables us to receive and expel the air in a greater or leſs quantity, and with more or leſs velocity, as may be required in ſinging or in declamation. This membranous ſtructure of the trachea poſteriorly, ſeems likewiſe to aſſiſt in the deſcent of the food, by preventing that impediment to its paſſage down the œſophagus, which might be expected if the cartilages were complete rings.

The trachea receives its arteries from the carotid and ſubclavian arteries, and its veins paſs into the jugulars. Its nerves ariſe from the recurrent branch of the eighth pair, and from the cervical plexus.

SECT. VI. OF THE LUNGS.

THE lungs fill the greater part of the cavity of the breaſt. They are of a ſoft and ſpongy texture, and are divided into two lobes, which are ſeparated from each other by the mediaſtinum, and are externally covered by a production of the pleura. Each of theſe is divided into two or three leſſer lobes; and we commonly find three in the right ſide of the cavity, and two in the left. To diſcover the ſtructure of the lungs, it is required to follow the ramifications of the bronchi, which were deſcribed in the laſt ſection. Theſe becoming gradually more and more minute, at length terminate in the cellular ſpaces or veſicles, which make up the greateſt part of the ſubſtance of the lungs, and readily communicate with each other. The lungs ſeem to poſſeſs but little ſenſibility. Their nerves, which are ſmall, and few in number, are derived from the intercoſtal and eighth pair. This laſt pair having reached the thorax, ſends off a branch on each ſide of the trachea, called the *recurrent*, which aſcends at the back of the trachea, to which it furniſhes branches in its aſcent, as well as to the œſophagus, but it is chiefly diſtributed to the larynx and its muſcles. By dividing the recurrent and ſuperior laryngeal nerves at their origin, an animal is deprived of its voice.

There are two ſeries of arteries which carry blood to the lungs; theſe are the arteriæ bronchiales, and the pulmonary artery.

The arteriæ bronchiales begin uſually by two branches; one of which commonly ariſes from the right intercoſtal, and the other from the trunk of the aorta; but ſometimes there are three of theſe arteries, and in ſome ſubjects only one. The uſe of theſe arteries is to ſerve for the nouriſhment of the lungs, and their ramifications are ſeen creeping every where on the branches of the bronchi. The blood is brought back from them by the bronchial vein into the vena azygos.

The pulmonary artery and vein are not intended for the nouriſhment of the lungs; but the blood in its paſſage through them is deſtined to undergo ſome changes, or to acquire certain eſſential properties (from the action of the air), which it has loſt in its circulation through the other parts of the body. The pulmonary artery receives the blood from the right ventricle of the heart, and dividing into two branches, accompanies the bronchi every where, by its ramifications through the lungs; and the blood is afterwards conveyed back by the pulmonary vein, which gradually forming a conſiderable trunk, goes to empty itſelf into the left ventricle of the heart; ſo that the quantity of blood which enters into the lungs, is perhaps greater than that which is ſent in the ſame proportion of time through all the other parts of the body.

SECT. VII. OF RESPIRATION.

RESPIRATION conſtitutes one of thoſe functions which are properly termed *vital*, as being eſſential to life; for to live and to breathe are in fact ſynonymous terms. It conſiſts in an al-

(x) Anatomical writers have uſually deſcribed the diaphragm as being made up of two muſcles united by a middle tendon; and theſe two portions or crura form what they ſpeak of as the *inferior muſcle*, ariſing from the ſides and fore part of the vertebræ.

(y) The right bronchial tube is uſually found to be ſomewhat ſhorter and thicker than the left; and M. Portal, who has publiſhed a memoir on the action of the lungs on the aorta in reſpiration, obſerves, that the left bronchial tube is cloſely contracted by the aorta; and from ſome experiments he is induced to conclude, that in the firſt reſpirations, the air only enters into the right lobe of the lungs. *Memoires de l'Academie Royale des Sciences*, 1769.

ternate contraction and dilatation of the thorax, by firſt inſpiring air into the lungs, and then expelling it from them in exſpiration. It will perhaps be eaſy to diſtinguiſh and point out the ſeveral phenomena of reſpiration; but to explain their phyſical cauſe will be attended with difficulty: for it will naturally be enquired, how the lungs, when emptied of the air, and contracted by exſpiration, become again inflated, they themſelves being perfectly paſſive? How the ribs are elevated in oppoſition to their own natural ſituation? and why the diaphragm is contracted downwards towards the abdomen? Were we to aſſert that the air, by forcing its way into the cavity of the lungs, dilated them, and conſequently elevated the ribs, and preſſed down the diaphragm, we ſhould ſpeak erroneouſly. What induces the firſt inſpiration, it is not eaſy to aſcertain; but after an animal has once reſpired, it ſhould ſeem likely that the blood, after exſpiration, finding its paſſage through the lungs obſtructed, becomes a ſtimulus, which induces the intercoſtal muſcles and the diaphragm to contract, and enlarge the cavity of the thorax, in conſequence perhaps of a certain nervous influence, which we will not here attempt to explain. The air then ruſhes into the lungs; every branch of the bronchial tubes, and all the cellular ſpaces into which they open, become fully dilated; and the pulmonary veſſels being equally diſtended, the blood flows through them with eaſe. But as the ſtimulus which firſt occaſioned this dilatation ceaſes to operate, the muſcles gradually contract, the diaphragm riſes upwards again, and diminiſhes the cavity of the cheſt; the ribs return to their former ſtate; and as the air paſſes out in exſpiration, the lungs gradually collapſe, and a reſiſtance to the paſſage of the blood again takes place. But the heart continuing to receive and expel the blood, the pulmonary artery begins again to be diſtended, the ſtimulus is renewed, and the ſame proceſs is repeated, and continues to be repeated, in a regular ſucceſſion during life: for though the muſcles of reſpiration, having a mixed motion, are (unlike the heart) in ſome meaſure dependent on the will, yet no human being, after having once reſpired, can live many moments without it. In an attempt to hold one's breath, the blood ſoon begins to diſtend the veins, which are unable to empty their contents into the heart; and we are able only, during a very little time, to reſiſt the ſtimulus to inſpiration. In drowning, the circulation ſeems to be ſtopped upon this principle; and in hanging, the preſſure made on the jugular veins, may co-operate with the ſtoppage of reſpiration in bringing on death.

Till within theſe few years phyſiologiſts were entirely ignorant of the uſe of reſpiration. It was at length diſcovered in part by the illuſtrious Dr. Prieſtley. He found that the air exſpired by animals was phlogiſticated; and that the air was fitter for reſpiration, or for ſupporting animal life, in proportion as it was freer from the phlogiſtic principle. It had long been obſerved, that the blood in paſſing through the lungs acquired a more florid colour. He therefore ſuſpected, that it was owing to its having imparted phlogiſton to the air: and he ſatisfied himſelf of the truth of this idea by experiments, which ſhowed, that the craſſamentum of extravaſated blood, phlogiſticated air in proportion as it loſt its dark colour. He farther found, that blood thus reddened had a ſtrong attraction for phlogiſton; inſomuch that it was capable of taking it from phlogiſticated air, thereby becoming of a darker colour. From hence it appeared that the blood, in its circulation through the arterial ſyſtem, imbibes a conſiderable quantity of phlogiſton, which is diſcharged from it to the air in the lungs.

This diſcovery has ſince been proſecuted by two very ingenious phyſiologiſts, Dr. Crawford and Mr. Elliot. It had been ſhown by profeſſors Black and Irvine, that different bodies have different capacities for containing fire. For example, that oil and water, when equally hot to the ſenſe and the thermometer, contain different proportions of that principle; and that unequal quantities of it are required, in order to raiſe thoſe ſubſtances to like temperatures. The enquiries of Dr. Crawford and Mr. Elliot tend to prove, that the capacities of bodies for containing fire are diminiſhed by the addition of phlogiſton, and increaſed by its ſeparation: the capacity of calx of antimony, for example, being greater than that of the antimony itſelf. Common air contains a great quantity of fire; combuſtible bodies very little. In combuſtion, a double elective attraction takes place; the phlogiſton of the body being tranſferred to the air, the fire contained in the air to the combuſtible body. But as the capacity of the latter is not increaſed ſo much as that of the former is diminiſhed, only part of the extricated fire will be abſorbed by the body. The remainder therefore will raiſe the temperature of the compound; and hence we may account for the heat attending combuſtion. As the uſe of reſpiration is to dephlogiſticate the blood, it ſeems probable, that a like double elective attraction takes place in this proceſs; the phlogiſton of the blood being tranſferred to the air, and the fire contained in the air to the blood; but with this difference, that the capacities being equal, the whole of the extricated fire is abſorbed by the latter. The blood in this ſtate circulating through the body, imbibes phlogiſton, and of courſe gives out its fire; part only of which is abſorbed by the parts furniſhing the phlogiſton, the remainder, as in combuſtion, becoming ſenſible; and is therefore the cauſe of the heat of the body, or what is called animal heat. In confirmation of this doctrine it may be obſerved, that the venous blood contains leſs fire than the arterial; combuſtible bodies leſs than incombuſtible ones; and that air contains leſs of this principle, according as it is rendered, by combination with phlogiſton, leſs fit for reſpiration (z).

In aſcending very high mountains, reſpiration is found to become ſhort and frequent, and ſometimes to be attended with a ſpitting of blood. Theſe ſymptoms ſeem to be occaſioned by the air being too rare and thin to dilate the lungs ſufficiently; and the blood gradually accumulating in the pulmonary veſſels, ſometimes burſts through their coats, and is brought up by coughing. This has likewiſe been accounted for in a different way, by ſuppoſing that the air contained in the blood, not receiving an equal preſſure from that of the atmoſphere, expands, and at length ruptures the very minute branches of the pulmonary veſſels; upon the ſame principle that fruits and animals put under the receiver of an air-pump, are ſeen to ſwell as the outer air becomes exhauſted. But Dr. Darwin of Litchfield has lately publiſhed ſome experiments, which ſeem to prove, that no air or elaſtic vapour does exiſt in the blood-veſſels, as has been generally ſuppoſed; and he is induced to impute the ſpitting of blood which has ſometimes taken place in aſcending high mountains, to accident, or to violent exertions; as it never happens to animals that are put into the exhauſted receiver of an air pump, where the diminution of preſſure is many times greater than on the ſummit of the higheſt mountains. See the Article RESPIRATION.

SECT. VIII. OF THE VOICE.

RESPIRATION has already been deſcribed as affording us many advantages; and next to that of life, its moſt important uſe ſeems to be that of forming the voice and ſpeech. The ancients, and almoſt all the moderns, have conſidered the organ of ſpeech as a kind of muſical inſtrument, which may be compared to a flute, to an hautboy, to an organ, &c. and they argue after the following manner. The trachea, which begins at the root of the tongue, and goes to terminate in the lungs, may be compared to the pipe of an organ, the lungs dilating like bellows during the time of inſpiration; and as the air is driven out from them in exſpiration, it finds its paſſage ſtraitened by the cartilages of the larynx, againſt which it ſtrikes. As theſe cartilages are more or leſs elaſtic, they occaſion in their turn more or leſs vibration in the air, and thus produce the ſound of the voice; the variation in the ſound and tone of which depends on the ſtate of the glottis, which, when ſtraitened, produces an acute tone, and a grave one when dilated.

The late M. Ferein, communicated to the French Academy of Sciences a very ingenious theory on the formation of the voice. He conſidered the organ of the voice as a *ſtring*, as well as a *wind* inſtrument; ſo that what art has hitherto been unable to conſtruct, and what both the fathers Merſenne and Kircher ſo much wiſhed to ſee, M. Ferein imagined he had at length diſcovered in the human body. He obſerves, that there are at the edges of the glottis certain tendinous chords, placed horizontally acroſs it, which are capable of conſiderable vibration, ſo as to produce ſound, in the ſame manner as it is produced by the ſtrings of a violin or a harpſichord: and he ſuppoſes that the air, as it paſſes out from the lungs, acts as a bow on theſe ſtrings, while the efforts of the breaſt and lungs regulate its motion, and produce the variety of tones. So that according to this ſyſtem the variation in the voice is not occaſioned by the dilatation or contraction of the glottis, but by the diſtenſion or relaxation of theſe ſtrings, the ſound being more or leſs acute in proportion as they are more or leſs ſtretched out. Another writer on this ſubject ſuppoſes, that the organ of voice is a double inſtrument, which produces in uniſon two ſounds of a different nature; one by means of the air, and the other by means of the chords of the glottis. Neither of theſe ſyſtems however, are univerſally adopted. They are both liable to inſuperable difficulties; ſo that the manner in which the voice is formed has never yet been ſatisfactorily aſcertained: we may obſerve, however, that the ſound produced by the glottis is not articulated. To effect this, it is required to paſs through the mouth, where it is differently modified by the action of the tongue, which is either puſhed againſt the teeth, or upwards towards the palate; detaining it in its paſſage, or permitting it to flow freely, by contracting or dilating the mouth.

SECT. IX. OF DEJECTION.

BY dejection we mean the act of voiding the feces at the anus; and an account of the manner in which this is conducted was reſerved for this part of the work, becauſe it ſeemed to require a knowledge of reſpiration to be perfectly underſtood.

The inteſtines were deſcribed as having a periſtaltic motion, by which the feces were gradually advancing towards the anus. Now, whenever the feces are accumulated in the inteſtinum rectum in a ſufficient quantity to become troubleſome, either

(z) See Crawford's Experiments and Obſervations on Animal Heat, and Elliot's Philoſophical Obſervations.

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by their weight or acrimony, they excite a certain uneaſineſs which induces us to go to ſtool.—To effect this, we begin by making a conſiderable inſpiration; in conſequence of which the diaphragm is carried downwards towards the lower belly; the abdominal muſcles are at the ſame time contracted in obedience to the will; and the inteſtines being compreſſed on all ſides, the reſiſtance of the *ſphincter* is overcome, and the feces paſs out at the anus; which is afterwards drawn up by its longitudinal fibres, which are called *levatores ani*, and then by means of its ſphincter is again contracted: but it ſometimes happens, as in dyſenteries for inſtance, that the feces are very liquid, and have conſiderable acrimony; and then the irritation they occaſion is more frequent, ſo as to promote their diſcharge without any preſſure from the diaphragm or abdominal muſcles; and ſometimes involuntarily, as is the caſe when the ſphincter becomes paralytic.

PART V.

ANGIOLOGY, OR A DESCRIPTION OF THE VASCULAR SYSTEM.

SECT. I. THE BLOOD VESSELS.

THE heart has been deſcribed as contracting itſelf, and throwing the blood from its two ventricles into the pulmonary artery and the aorta, and then as relaxing itſelf and receiving a freſh ſupply from two large veins, which are the pulmonary vein and the vena cava. We ſhall now point out the principal diſtributions of theſe veſſels.

The *pulmonary artery* ariſes from the right ventricle by a large trunk, which ſoon divides into two conſiderable branches, which paſs to the right and left lobes of the lungs: each of theſe branches is afterwards divided and ſubdivided into an infinite number of branches and ramifications, which extend through the whole ſubſtance of the lungs; and from theſe branches the blood is returned by the veins, which, contrary to the courſe of the arteries, begin by very minute canals, and gradually become larger, forming at length four large trunks called *pulmonary veins*, which terminate in the *left auricle* by one common opening, from whence the blood paſſes into the *left ventricle*. From this ſame ventricle ariſes the *aorta* or *great artery*, which at its beginning is nearly an inch in diameter: it ſoon ſends off two branches, the *coronaries*, which go to be diſtributed to the heart and its auricles. After this, at or about the third or fourth vertebra of the back, it makes a conſiderable curvature; from this curvature (A) ariſe three arteries; one of which ſoon divides into two branches. The firſt two are the left ſubclavian and the left carotid, and the third is a common trunk to the right ſubclavian and right carotid; though ſometimes both the carotids ariſe diſtinctly from the aorta.

The two *carotids* aſcend within the ſubclavians, along the ſides of the trachea; and when they have reached the larynx, divide into two principal branches, the *internal* and *external carotid*. The firſt of theſe runs a little way backwards in a bending direction; and having reached the under part of the ear, paſſes through the canal in the os petroſum, and entering into the cavity of the cranium, is diſtributed to the brain and the membranes which invelope it, and likewiſe to the eye. The *external carotid* divides into ſeveral branches, which are diſtributed to the larynx, pharynx, and other parts of the neck; and to the jaws, lips, tongue, eyes, temples, and all the external parts of the head.

Each *ſubclavian* is likewiſe divided into a great number of branches. It ſends off the *vertebral artery*, which paſſes through the openings we ſee at the bottom of the tranſverſe proceſſes of the vertebræ of the neck, and in its courſe ſends off many ramifications to the neighbouring parts. Some of its branches are diſtributed to the ſpinal marrow, and after a conſiderable inflection it enters into the cranium, and is diſtributed to the brain. The *ſubclavian* likewiſe ſends off branches to the muſcles of the neck and ſcapula; and the mediaſtinum, thymus, pericardium, diaphragm, the breaſts, and the muſcles of the thorax, and even of the abdomen, derive branches from the ſubclavian, which are diſtinguiſhed by different names, alluding to the parts to which they are diſtributed; as the *mammary*, the *phrenic*, the *intercoſtal*, &c. But notwithſtanding the great number of branches which have been deſcribed as ariſing from the ſubclavian, it is ſtill a conſiderable artery when it reaches the *axilla*, where it drops its former name, which alludes to its paſſage under the clavicle, and is called the *axillary* artery; from which a variety of branches are diſtributed to the muſcles of the breaſt, ſcapula, and arm.—But its main trunk taking the name of *brachialis*, runs along on the inſide of the arm near the os humeri, till it reaches the joint of the fore-arm, and then it divides into two branches. This diviſion however is different in different ſubjects; for in ſome it takes place higher up and in others lower down. When it happens to divide above the joint, it may be conſidered as a happy diſpoſition in caſe of an accident by bleeding; for ſuppoſing the artery to be unfortunately punctured by the lancet, and that the hæmorrhage could only be ſtopped by making a ligature on the veſſel, one branch would remain unhurt, through which the blood would paſs uninterrupted to the fore-arm and hand. One of the two branches of the brachialis plunges down under the flexor muſcles, and runs along the edge of the ulna; while the other is carried along the outer ſurface of the radius, and is eaſily felt at the wriſt, where it is only covered by the common integuments. Both theſe branches commonly unite in the palm of the hand, and form an arterial arch from whence branches are detached to the fingers.

The *aorta*, after having given off at its curvature the carotids and ſubclavians which convey blood to all the upper parts of the body, deſcends upon the bodies of the vertebræ a little to the left, as far as the os ſacrum, where it drops the name of *aorta*, and divides into two conſiderable branches. In this courſe, from its curvature to its bifurcation, it ſends off ſeveral arteries in the following order: 1. One or two little arteries, firſt demonſtrated by Ruyſch as going to the bronchi, and called *arteriæ bronchiales Ruyſchii*. 2. The arteriæ œſophageæ. Theſe are commonly three or four in number. They ariſe from the fore-part of the aorta, and are diſtributed chiefly to the œſophagus. 3. The inferior intercoſtal arteries, which are diſtributed between the ribs in the ſame manner as the arteries of the three or four ſuperior ribs are, which are derived from the ſubclavian. Theſe arteries ſend off branches to the medulla ſpinalis. 4. The diaphragmatic or inferior phrenic arteries, which go to the diaphragm, ſtomach, omentum, duodenum, pancreas, ſpleen, liver, and gall-bladder. 5. The cœliac, which ſends off the coronary-ſtomachic, the ſplenic, and the hepatic artery. 6. The ſuperior meſenteric artery, which is diſtributed to the meſentery and ſmall inteſtines. 7. The emulgents, which go to the kidneys. 8. The arteries, which are diſtributed to the glandulæ renales. 9. The ſpermatic. 10. The inferior meſenteric artery, which ramifies through the lower portion of the meſentery and the large inteſtines.—A branch of this artery which goes to the rectum is called the *internal hæmorrhoidal*. 11. The lumbar arteries, and a very ſmall branch called the *ſacra*, which are diſtributed to the muſcles of the loins and abdomen, and to the os ſacrum and medulla ſpinalis.

The trunk of the aorta, when it has reached the laſt vertebra lumborum, or the os ſacrum, drops the name of *aorta*, and ſeparates into two forked branches called the *iliacs*. Each of theſe ſoon divides into two branches; one of which is called the *internal iliac*, or *hypogaſtric artery*, and is diſtributed upon the contents of the pelvis and upon the muſcles on its outer ſide. One branch called *pudenda communis*, ſends ſmall ramifications to the end of the rectum under the name of *hæmorrhoidales externæ*, and is afterwards diſtributed upon the penis. The other branch, the external iliac, after having given off the circumflex artery of the os ilium and the epigraſtic, which is diſtributed to the recti-muſcles, paſſes out of the abdomen under Poupart's ligament, and takes the name of *crural artery*. It deſcends on the inner part of the thigh cloſe to the os femoris, ſending off branches to the muſcles, and then ſinking deeper in the hind part of the thigh, reaches the ham, where it takes the name of *popliteal:* after this it ſeparates into two conſiderable branches; one of which is called the *anterior tibial artery*; the other divides into two branches, and theſe arteries all go to be diſtributed to the leg and foot.

The blood, which is thus diſtributed by the aorta to all parts of the body, is brought back by the veins, which are ſuppoſed to be continued from the ultimate branches of arteries; and uniting together as they approach the heart, at length form the large trunks, the vena cava aſcendens, and vena cava deſcendens.

All the veins which bring back the blood from the upper extremities, and from the head and breaſt, paſs into the vena cava deſcendens; and thoſe which return it from the lower parts of the body terminate in the vena cava aſcendens; and theſe two cavas uniting together as they approach the heart, open by one common orifice into the left auricle.

It does not here ſeem to be neceſſary to follow the different diviſions of the veins as we did thoſe of the arteries; and it will be ſufficient to remark, that in general every artery is accompanied by its vein, and that both are diſtinguiſhed by the ſame name. But, like many other general rules, this too has its exceptions (B). The veins, for inſtance, which accompany the external and internal carotid, are not called the *carotid veins*, but the *external* and *internal jugular*.—In the thorax there is a vein diſtinguiſhed by a proper name, and this is the *azygos*, or *vena ſine pari*. This vein, which is a pretty con-

(A) Anatomiſts uſually call the upper part of this curvature *aorta aſcendens*; and the other part of the artery to its diviſion at the iliacs, *aorta deſcendens*: but they differ about the place where this diſtinction is to be introduced; and it ſeems ſufficiently to anſwer every purpoſe, to ſpeak only of the aorta and its curvature.

(B) In the extremities, ſome of the deep-ſeated veins, and all the ſuperficial ones, take a courſe different from that of the arteries.

ſiderable

ſiderable one, runs along by the right ſide of the vertebræ of the back, and is chiefly deſtined to receive the blood from the intercoſtals on that ſide, and from the lower half of thoſe on the left ſide, and to convey it into the vena cava deſcendens. In the abdomen we meet with a vein, which is ſtill a more remarkable one, and this is the *vena portæ*, which performs the office both of an artery and a vein. It is formed by a reunion of all the veins which come from the ſtomach, inteſtines, omentum, pancreas, and ſpleen, ſo as to compoſe one great trunk, which goes to ramify through the liver; and after having depoſited the bile, its ramifications unite and bring back into the vena cava, not only the blood which the vena portæ had carried into the liver, but likewiſe the blood from the hepatic artery. Every artery has a vein which correſponds with it; but the trunks and branches of the veins are more numerous than thoſe of the arteries.—The reaſons for this diſpoſition are perhaps not difficult to be explained; the blood in its courſe through the veins is much farther removed from the ſource and cauſe of its motion, which are in the heart, than it was when in the arteries; ſo that its courſe is conſequently leſs rapid, and enough of it could not poſſibly be brought back to the heart in the moment of its dilatation, to equal the quantity which is driven into the arteries from the two ventricles, at the time they contract; and the equilibrium, which is ſo eſſential to the continuance of life and health, would conſequently be deſtroyed, if the capacity of the veins did not exceed that of the arteries, in the ſame proportion that the rapidity of the blood's motion through the arteries exceeds that of its return through the veins.

A large artery ramifying through the body, and continued to the minute branches of veins, which gradually unite together to form a large trunk, may be compared to two trees united to each other at their tops; or rather as having their ramifications ſo diſpoſed that the two trunks terminate in one common point; and if we farther ſuppoſe, that both theſe trunks and their branches are hollow, and that a fluid is inceſſantly circulated through them, by entering into one of the trunks and returning through the other, we ſhall be enabled to conceive how the blood is circulated through the veſſels of the human body.

Every trunk of an artery, before it divides, is nearly cylindrical, or of equal diameter through its whole length, and ſo are all its branches when examined ſeparately. But every trunk ſeems to contain leſs blood than the many branches do into which that trunk ſeparates; and each of theſe branches probably contains leſs blood than the ramifications do into which it is ſubdivided: and it is the ſame with the veins; the volume of their ſeveral ramifications, when conſidered together, being found to exceed that of the great trunk which they form by their union.

The return of the blood through the veins to the heart, is promoted by the action of the muſcles, and the pulſation of the arteries. And this return is likewiſe greatly aſſiſted by the *valves* which are to be met with in the veins, and which conſtitute one of the great diſtinctions between them and the arteries. Theſe valves, which are ſuppoſed to be formed by the inner coat of the veins, permit the blood to flow from the extremities towards the heart, but oppoſe its return. They are moſt frequent in the ſmaller veins. As the column of blood increaſes, they ſeem to become leſs neceſſary; and therefore in the vena cava aſcendens, we meet with only one valve, which is near its origin.

The arteries are compoſed of ſeveral tunics. Some writers enumerate five of theſe tunics; but perhaps we may more properly reckon only three, viz. the *nervous*, *muſcular*, and *cuticular* coats. The veins are by ſome anatomiſts deſcribed as having the ſame number of coats as the arteries; but as they do not ſeem to be irritable, we cannot with propriety ſuppoſe them to have a muſcular tunic. We are aware of Dr. Verſchuir's experiments to prove that the jugular and ſome other veins poſſeſs a certain degree of irritability; but it is certain, that his experiments, repeated by others, have produced a different reſult; and even he himſelf allows, that ſometimes he was unable to diſtinguiſh any ſuch property in the veins. Both theſe ſeries of veſſels are nouriſhed by ſtill more minute arteries and veins, which are ſeen creeping over their coats, and ramifying through their whole ſubſtance, and are called *vaſa vaſorum*; they have likewiſe many minute branches of nerves.

The arteries are much ſtronger than the veins, and they ſeem to require this force to be enabled to reſiſt the impetus with which the blood circulates through them, and to impel it on towards the veins.

When the heart contracts, it impels the blood into the arteries, and ſenſibly diſtends them; and theſe veſſels again contract, as the heart becomes relaxed to receive more blood from the auricles; ſo that the cauſe of the contraction and dilatation of the *arteries* ſeems to be eaſy to be underſtood, being owing in part to their own contractile power, and in part to the action of the heart; but in the *veins*, the effects of this impulſe not being ſo ſenſibly felt, and the veſſels themſelves having little or no contractile power, the blood ſeems to flow in a conſtant and equal ſtream: and this, together with its paſſing gradually from a ſmall channel into a larger one, ſeems to be the reaſon why the *veins* have no pulſatory motion, except the large ones near the heart; and in theſe it ſeems to be occaſioned by the motion of the diaphragm, and by the regurgitation of the blood in the *cavas*.

SECT. II. OF THE PERICARDIUM, AND OF THE HEART AND ITS AURICLES.

The two membranous bags of the pleura, which were deſcribed as forming the mediaſtinum, recede one from the other, ſo as to afford a lodgment to a firm membranous ſac, in which the heart is ſecurely lodged; this ſac, which is the *pericardium*, appears to be compoſed of two tunics, united to each other by a cellular membrane.—The outer coat, which is thick, and in ſome places of a tendinous complexion, is a production of the mediaſtinum; the inner coat, which is extremely thin, is reflected over the auricles and ventricles of the heart, in the ſame manner as the tunica conjunctiva, after lining the eye lids, is reflected over the eye. This bag adheres to the tendinous part of the diaphragm, and contains a coagulable lymph, the *liquor pericardii*, which ſerves to lubricate the heart and facilitate its motions; and ſeems to be ſecreted and abſorbed in the ſame manner as it is in the other cavities of the body.

The arteries of the pericardium are derived from the phrenic, and its veins paſs into veins of the ſame name; its nerves are likewiſe branches of the phrenic. The ſize of the pericardium is adapted to that of the heart, being uſually large enough to contain it looſely. As its cavity does not extend to the ſternum, the lungs cover it in inſpiration; and as it every where inveſts the heart, it effectually ſecures it from being injured by lymph, pus, or any other fluid, extravaſated into the cavities of the thorax.

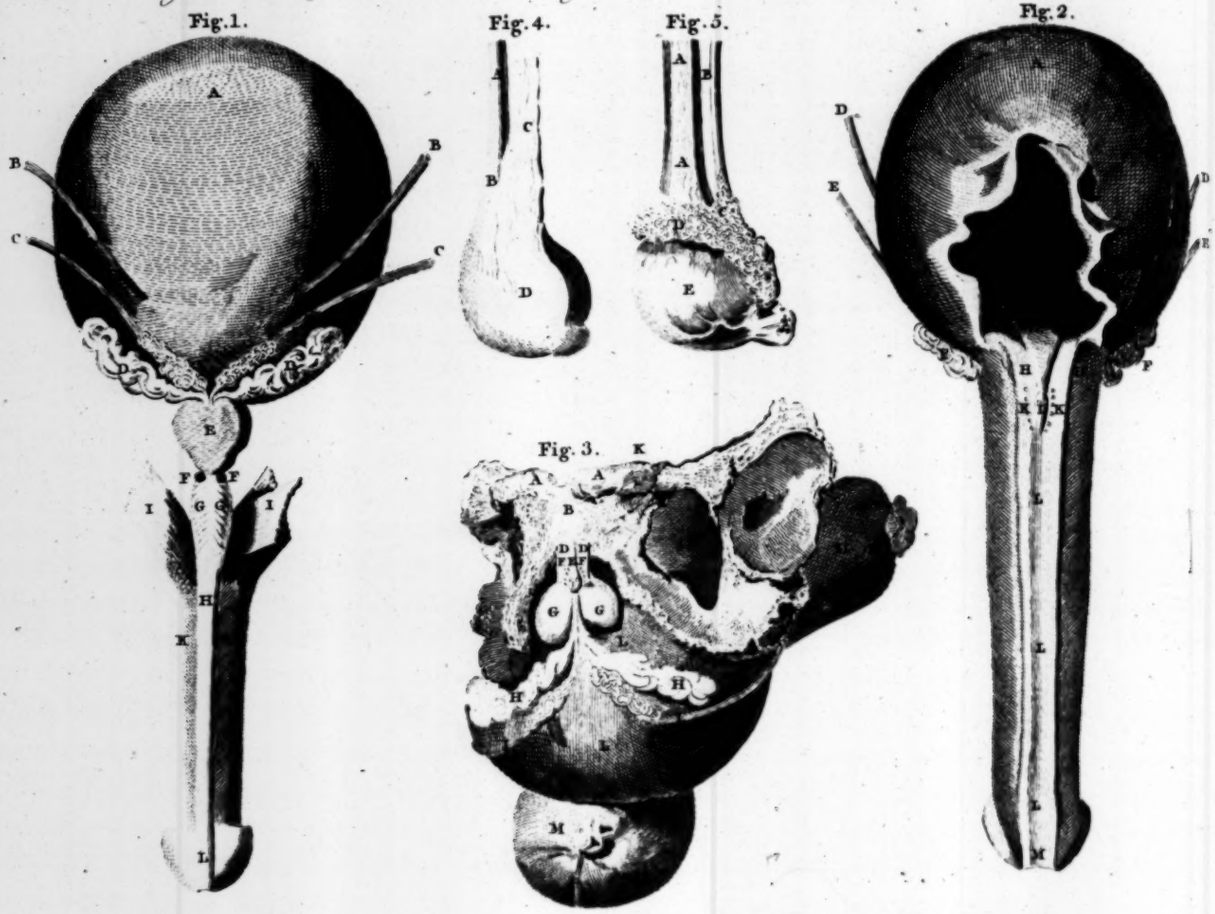
The heart is a hollow muſcle of a conical ſhape, ſituated tranſverſely between the two laminæ of the mediaſtinum, at the lower part of the thorax; having its baſis turned towards the right ſide, and its point or apex towards the left.—Its lower ſurface is ſomewhat flattened towards the diaphragm. Its baſis, from which the great veſſels originate, is covered with fat, and it has two hollow and fleſhy appendages, called *auricles*. —Round theſe ſeveral openings, the heart ſeems to be of a firm ligamentous texture, from which all its fibres ſeem to originate; and as they advance from thence towards the apex, the ſubſtance of the heart ſeems to become thinner. The heart includes two cavities or *ventricles*, which are ſeparated from each other by a fleſhy ſeptum; one of theſe is called the *right*, and the other the *left*, *ventricle*; though perhaps, with reſpect to their ſituation, it would be more proper to diſtinguiſh them into the *anterior* and *poſterior ventricles*.

The heart is exteriorly covered by a very fine membrane; and its ſtructure is perfectly muſcular or fleſhy, being compoſed of fibres which are deſcribed as paſſing in different directions; ſome as being extended longitudinally from the baſis to the apex; others, as taking an oblique or ſpiral courſe; and a third ſort as being placed in a tranſverſe direction (c).—Within the two ventricles we obſerve ſeveral furrows; and there are likewiſe tendinous ſtrings, which ariſe from fleſhy *columnæ* in the two cavities, and are attached to the valves of the auricles: That the uſe of theſe and the other valves of the heart may be underſtood, it muſt be obſerved, that four large veſſels paſs out from the baſis of the heart, viz. two arteries and two veins; and that each of theſe veſſels is furniſhed with a thin membranous production, which is attached all round to the borders of their ſeveral orifices, from whence hanging looſely down, they appear to be divided into two or three diſtinct portions. But as their uſes in the arteries and veins are different, ſo are they differently diſpoſed. Thoſe of the arteries are intended to give way to the paſſage of the blood into them from the ventricles, but to oppoſe its return: and, on the contrary, the valves of the veins are conſtructed ſo as to allow the blood only to paſs into the heart. In conſequence of theſe different uſes, we find the valves of the pulmonary artery and of the aorta attached to the orifices of thoſe veſſels, ſo as to have their concave ſurfaces turned towards the artery; and their convex ſurfaces, which mutually meet together, being placed towards the ventricle, only permit the blood to paſs one way, which is into the arteries. There are uſually three of theſe valves belonging to the pulmonary artery, and as many to the aorta; and from their figure they are called *valvulæ ſemilunares*. The communication between the two great veins and the ventricles is by means of the two appendages or auricles into which the blood is diſcharged; ſo that the other valves which may be ſaid to belong to the veins, are placed in each ventricle, where the auricle opens into it. The valves in the right ventricle are uſually three in number, and are named *valvulæ tricuſpides*; but in the left ventricle we commonly

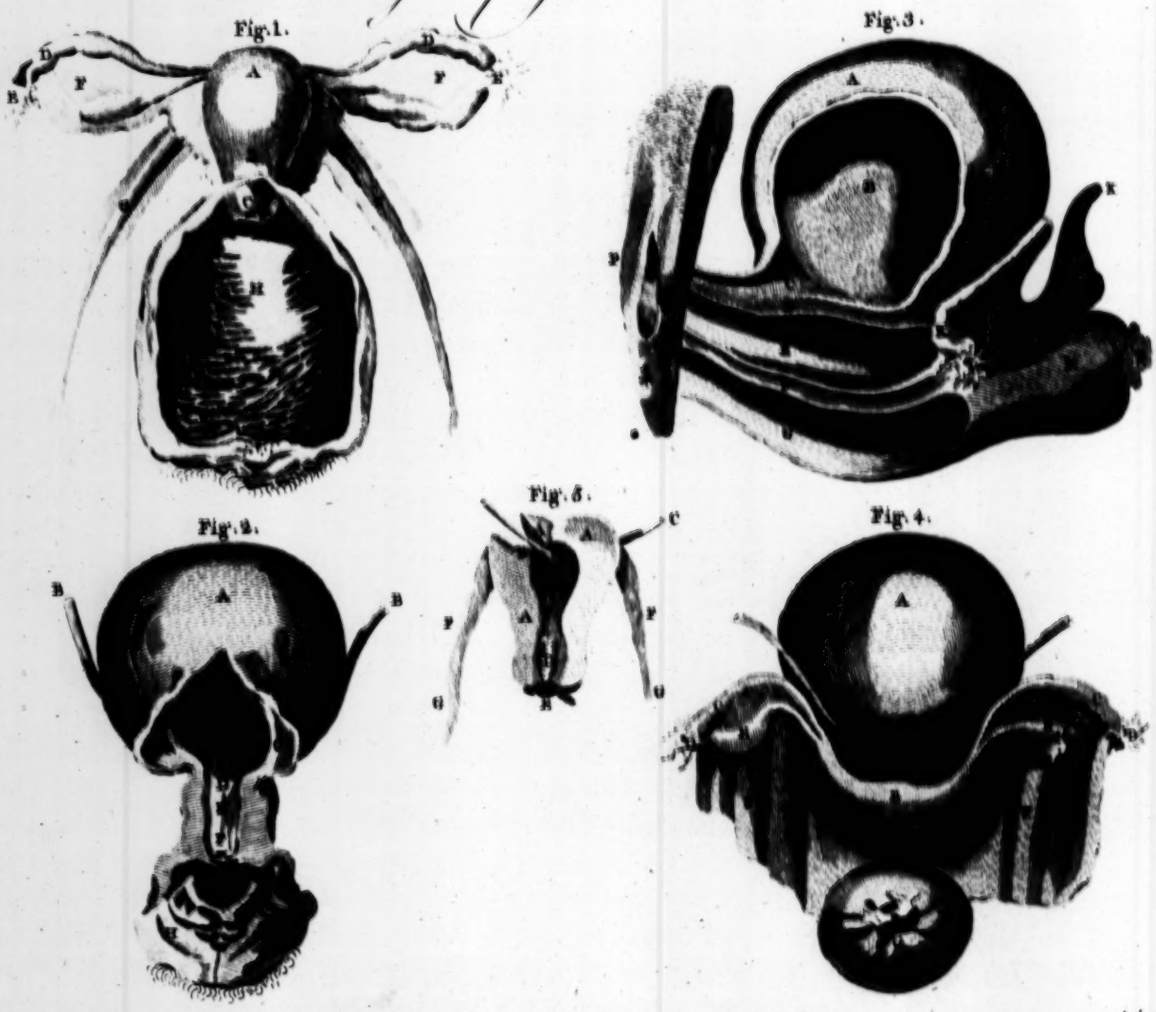
(c) Authors differ about the courſe and diſtinctions of theſe fibres; and it ſeems right to obſerve, that the ſtructure of the heart being more compact than that of other muſcles, its fibres are not eaſily ſeparated.

obſerve

Male Organs of Generation. See System of Anatomy, Part 3. Sect. 15. Article 1.

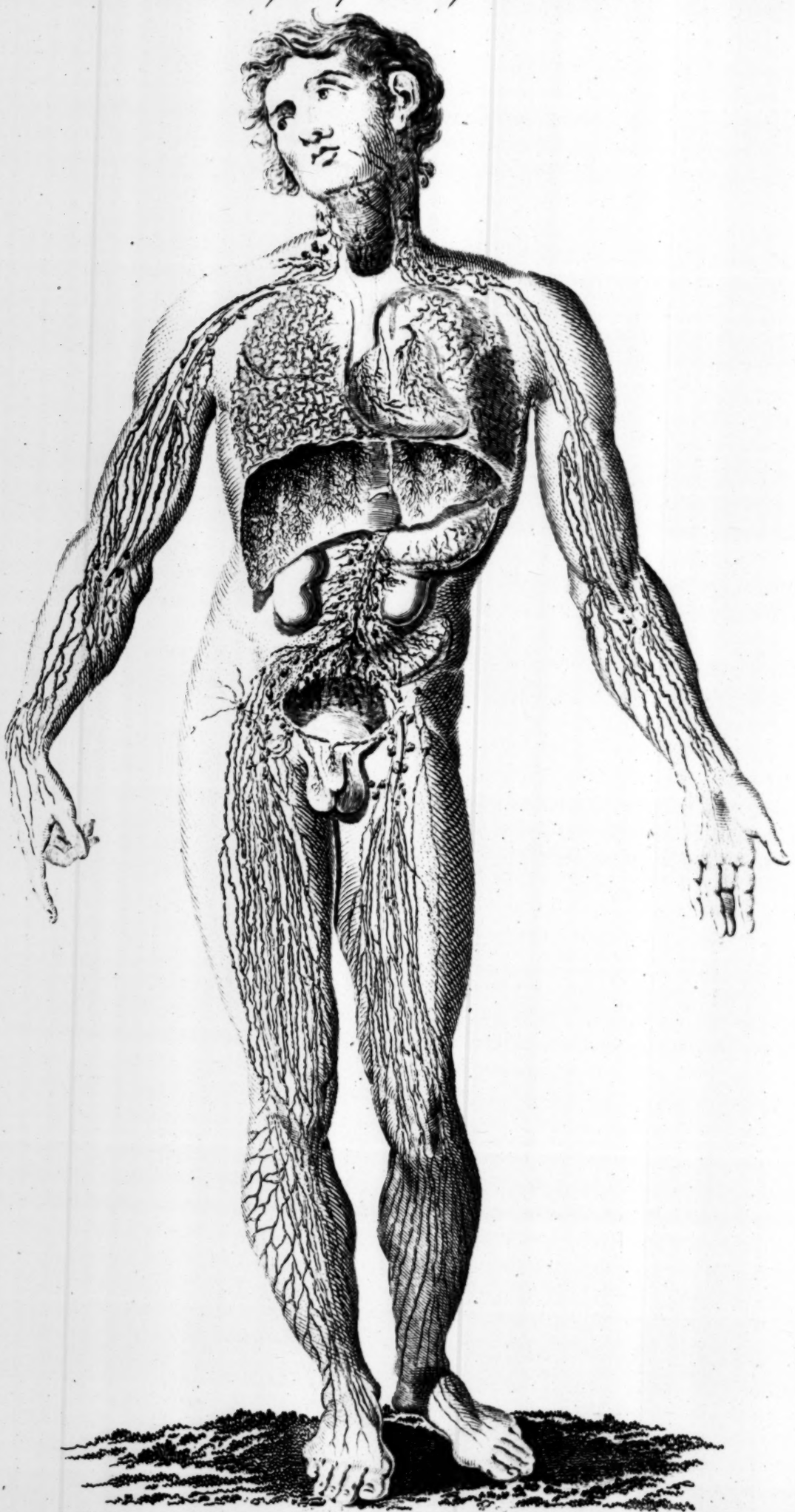


Female Organs of Generation Part 3 Sect 15 Art. 2.



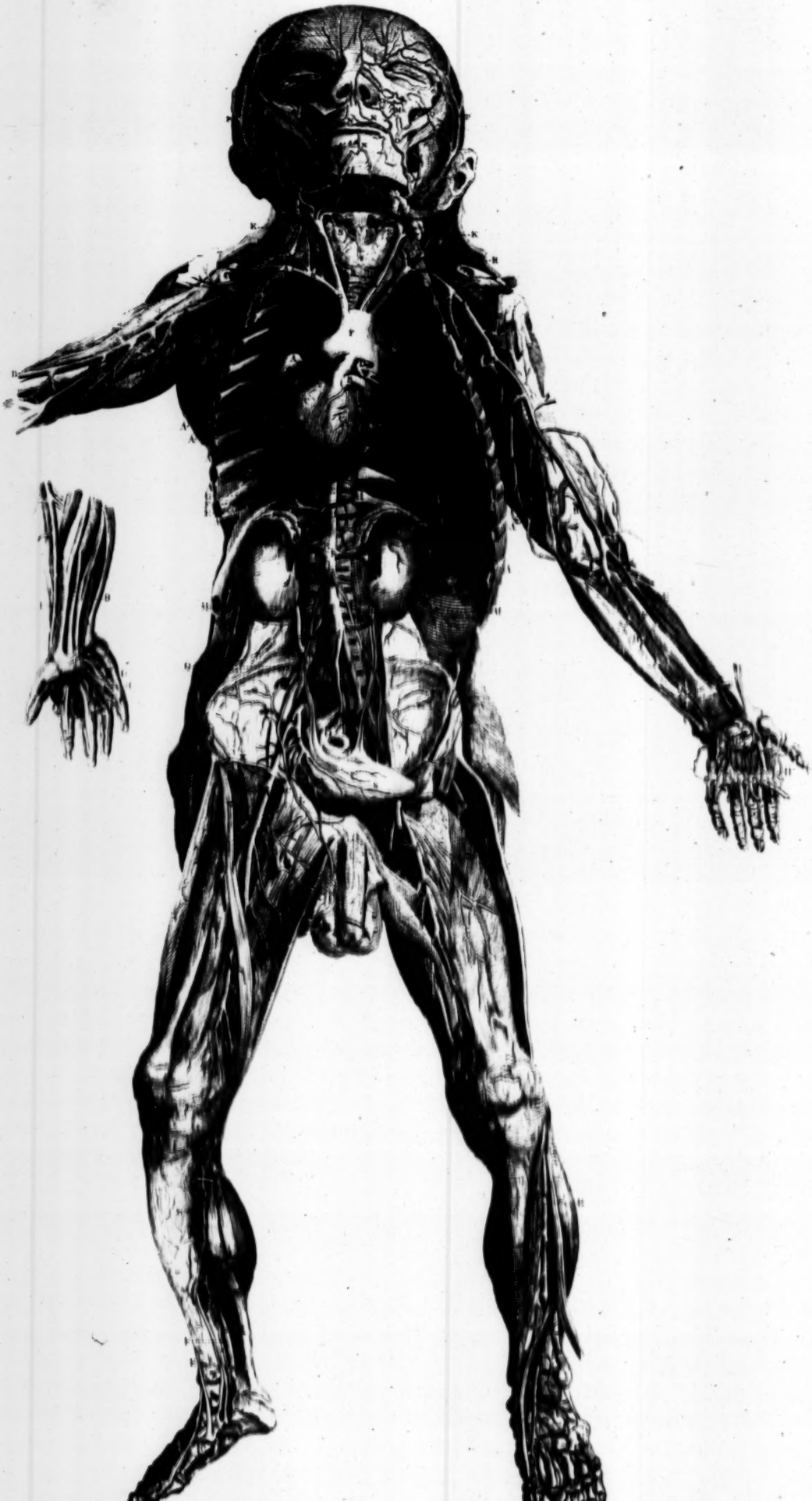
Mirale del. Engraved for Hall's Encyclopædia & Printed for C. Cooke No. 17 Ave Maria Row Aug. 1793. Lodge sculp.

The Absorbent Vessels represented in a Figure supposed to be transparent
to be the System of Anatomy. Part 3. Sect. 1.



This Figure was formed from a singular Idea of the late Dr William Hunter, who to exhibit a general view of the Absorbent Vessels, supposed a Figure to be transparent, in order to shew more connectedly the course and distribution of these Vessels.

A View of the Arteries in the Fœtus, the Parieties of the Thorax, & the Abdomen & Intestines removed, to shew the Arteries with greater precision. See System of Anatomy Part 5. Sect. 3.



Engraved for Halle Encyclopædia, & Printed for C. Cooke, No. 17 Paternoster Row, August 1st 1795.

obſerve only two, and theſe are the *valvulæ mitrales*. The membranes which form theſe valves in each cavity are attached ſo as to project ſomewhat forward; and both the *tricuſpides* and the *mitrales* are connected with the tendinous ſtrings, which were deſcribed as ariſing from the fleſhy *columnæ*. By the contraction of either ventricle the blood is driven into the artery which communicates with that ventricle; and theſe tendinous ſtrings being gradually relaxed as the ſides of the cavity are brought nearer to each other, the valves naturally cloſe the opening into the auricle, and the blood neceſſarily directs its courſe into the then only open paſſage, which is into the artery; but after this contraction, the heart becomes relaxed, the tendinous ſtrings are again ſtretched out, and, drawing the valves of the auricle downwards, the blood is poured by the veins into the ventricle, from whence, by another contraction, it is again thrown into the artery, as will be deſcribed hereafter. The right ventricle is not quite ſo long, though ſomewhat larger, than the left; but the latter has more ſubſtance than the other: and this ſeems to be, becauſe it is intended to tranſmit the blood to the moſt diſtant parts of the body, whereas the right ventricle diſtributes it only to the lungs.

The heart receives its nerves from the par vagum and the intercoſtals. The arteries which ſerve for its nouriſhment are two in number, and ariſe from the aorta. They ſurround in ſome meaſure the baſis of the heart, and from this courſe are called the *coronary arteries*. From theſe arteries the blood is returned by veins of the ſame name into the auricles, and even into the ventricles.

The muſcular bags called the *auricles* are ſituated at the baſis of the heart, at the ſides of each other; and, correſponding with the two ventricles, are like thoſe two cavities diſtinguiſhed into *right* and *left*. Theſe ſacs, which are interiorly unequal, have externally a jagged appendix; which, from its having been compared to the extremity of an ear, has given them their name of *auricles*.

SECT. III. OF THE ACTION OF THE HEART, AURICLES, AND ARTERIES.

The heart, at the time it contracts, drives the blood from its ventricles into the arteries; and the arteries being thus filled and diſtended, are naturally inclined to contract, the moment the heart begins to dilate, and ceaſes to ſupply them with blood. Theſe alternate motions of contraction and dilatation of the heart and arteries, are diſtinguiſhed by the names of *ſyſtole* and *diaſtole*. When the heart is in a ſtate of contraction or ſyſtole, the arteries are at that inſtant diſtended with blood, and in their diaſtole; and it is in this ſtate we feel their pulſatory motion, which we call the *pulſe*. When the heart dilates, and the arteries contract, the blood is impelled onwards into the veins, through which it is returned back to the heart. While the heart, however, is in its ſyſtole, the blood cannot paſs from the veins into the ventricles, but is detained in the auricles, which are two reſervoirs formed for this uſe, till the diaſtole, or dilatation of the heart takes place; and then the diſtended auricles contract, and drive the blood into the ventricles: ſo that the auricles have an alternate ſyſtole and diaſtole as well as the heart.

Although both the ventricles of the heart contract at the ſame time, yet the blood paſſes from one to the other. In the ſame moment, for inſtance, that the left ventricle drives the blood into the aorta, the right ventricle impels it into the pulmonary artery, which is diſtributed through all the ſubſtance of the lungs. The blood is afterwards brought back into the left ventricle by the pulmonary vein, at the ſame time that the blood is returned by the cavas, into the right ventricle, from all the other parts of the body.

This ſeems to be the mode of action of the heart and its veſſels: but the cauſe of this action has, like all other intricate and intereſting ſubjects, been differently explained. It ſeems to depend on the ſtimulus made on the different parts of the heart by the blood itſelf, which by its quantity and heat, or other properties (D), is perhaps capable of firſt exciting that motion, which is afterwards continued through life, independent of the will, by a regular return of blood to the auricles, in a quantity proportioned to that which is thrown into the arteries.

The heart poſſeſſes the *vis inſita*, or principle of irritability, in a much greater degree than any other muſcle of the body. The pulſe is quicker in young than in old ſubjects, becauſe the former are *cæt. par.* more irritable than the latter. Upon the ſame principle we may explain, why the pulſe is conſtantly quicker in weak than in robuſt perſons.

EXPLANATION OF PLATE VIII. repreſenting a front view of the Arteries.

THE HEART, NECK, AND HEAD.

A, Right auricle of the heart. B, Left auricle. C, The ventricles of the heart, with the coronary arteries and veins. D, Pulmonary artery. E, Aorta aſcendens. F, Arch of aorta. G, Trunk of the right ſubclavian, and carotid arteries. H, Left carotid. I, Left ſubclavian. K, Internal carotid. L, External carotid. M, Facial. N, Labial. O, Superior maxillary. P, Occipital. Q, Temporal. R, Vertebral. S, Superior thyroid. T, Lingual.

UPPER EXTREMITY.

A, Axillary artery. B, B, Humeral. C, C, C, Its anaſtomoſing branches. D, Ulnar. E, Radial. F, Interoſſeal. G, External arch in the palm of the hand. H, Internal arch.

THE TRUNK.

A, A, A, Intercoſtals, 12 pair. B, B, Bronchial arteries. C, Phrenic arteries. D, Cœliac arteries giving off. E, Gaſtrica dextera. F, Hepatic artery. G, Splenic. H, Superior meſenteric. I, I, Inferior meſenteric. K, Emulegnt. L, Spermatic. M, M, Five pair of lumbar arteries. N, Sacral artery. O, Hemorrhoidal. P, Biſurcation of the aorta. Q, Q, The two iliacs. R, External iliac. S, Internal iliac. *s*, Veſicales. T, Pudicus internus. U, Obturator. W, Sciatica. X, Epigaſtrica.

LOWER EXTREMITY.

A, A, Crural artery. B, Profundus. C, External pudical. D, Popliteal. E, Anterior tibial. F, Poſterior tibial. G, Interoſſeal. H, External arch of the ſole of the foot. I, Internal arch.

N. B. Almoſt all the arteries go off in pairs, ſo that a deſcription of one ſide of the body is ſufficient.

SECT IV. OF THE CIRCULATION.

After what has been obſerved of the ſtructure and action of the heart and its auricles, and likewiſe of the arteries and veins, there ſeem to be but very few arguments required to demonſtrate the *circulation of the blood*, which has long ſince been eſtabliſhed as a medical truth. This circulation may be defined to be a perpetual motion of the blood, in conſequence of the action of the heart and arteries, which impel it through all the parts of the body, from whence it is brought back by the veins to the heart.

A very ſatisfactory proof of this circulation, and a proof eaſy to be underſtood, may be deduced from the different effects of preſſure on an artery and a vein. If a ligature, for inſtance, is paſſed round an artery, the veſſel ſwells conſiderably between the ligature and the heart; whereas if we tie up a vein, it only becomes filled between the extremity and the ligature, and this is what we every day obſerve in bleeding. The ligature we paſs round the arm on theſe occaſions, compreſſes the ſuperficial veins; and the return of the blood through them being impeded, they become diſtended. When the ligature is too looſe, the veins are not ſufficiently compreſſed, and the blood continues its progreſs towards the heart; and, on the contrary, when it is made too tight, the arteries themſelves become compreſſed; and the flow of the blood through them being impeded, the veins cannot be diſtended.

Another phænomenon, which effectually proves the circulation, is the loſs of blood that every living animal ſuſtains by opening only a ſingle artery of a moderate ſize; for it continues to flow from the wounded veſſel till the equilibrium is deſtroyed which is eſſential to life. This truth was not unknown to the ancients; and it ſeems ſtrange that it did not lead them to a knowledge of the circulation, as it ſufficiently proves, that all the other veſſels muſt communicate with that which is opened. Galen, who lived more than 1500 years ago, drew this concluſion from it; and if we further obſerve, that he deſcribes (after Eraſiſtratus, who flouriſhed about 450 years before him) the ſeveral valves of the heart, and determines their diſpoſition and uſes, it will appear wonderful, that a period of near 2000 years ſhould afterwards elapſe before the true courſe of the blood was aſcertained. This diſcovery, for which we are indebted to the immortal Harvey, has thrown new lights on phyſiology and the doctrine of diſeaſes, and conſtitutes one of the moſt important periods of anatomical hiſtory.

SECT. V. OF THE NATURE OF THE BLOOD.

Blood, recently drawn from a vein into a baſon, would ſeem to be an homogeneous fluid of a red colour (E); but when ſuffered to reſt, it ſoon coagulates, and divides into two parts, which are diſtinguiſhed by the names of *craſſamentum* and *ſerum*. The craſſamentum is the red coagulum, and the ſerum is the water in which it floats. Each of theſe may be again ſeparated into two others; for the craſſamentum, by being repeatedly waſhed in warm water, gives out all its red globules, and what remains appears to be compoſed of the coagulable lymph (F), which is a gelatinous ſubſtance, capable of being hardened by fire till it becomes perfectly horny; and if we expoſe the ſerum to a certain degree of heat, part of it will

(D) Dr. Harvey long ago ſuggeſted, that the blood is poſſeſſed of a living principle; and Mr. J. Hunter has lately endeavoured to revive this doctrine; in ſupport of which he has adduced many ingenious arguments. The ſubject is a curious one, and deſerves to be proſecuted as an inquiry which cannot but be intereſting to phyſiologiſts.

(E) The blood, as it flows through the arteries, is obſerved to be more florid than it is in the veins; and this redneſs is acquired in its paſſage through the lungs. *Vid.* part iv. ſect vii.

(F) It may not be improper to obſerve, that till of late the *coagulable lymph* has been confounded with the *ſerum* of the blood, which contains a ſubſtance that is likewiſe coagulable, though only when

be found to coagulate like the white of an egg, and there will remain a clear and limpid water, reſembling urine both in its appearance and ſmell.

The ſerum and craſſamentum differ in their proportion in different conſtitutions; in a ſtrong perſon, the craſſamentum is in a greater proportion to the ſerum than in a weak one; and the ſame difference is found to take place in diſeaſes (G). See the article BLOOD.

SECT. VI. OF NUTRITION.

THE variety of functions which we have deſcribed as being inceſſantly performed by the living body, and the continual circulation of the blood through it, muſt neceſſarily occaſion a conſtant diſſipation of the ſeveral parts which enter into its compoſition. In ſpeaking of the inſenſible perſpiration, we obſerved how much was inceſſantly paſſing off from the lungs and the ſurface of the ſkin. The diſcharge by urine is likewiſe every day conſiderable; and great part of the bile, ſaliva, &c. are excluded by ſtool. But the ſolid, as well as the fluid parts of the body, require a conſtant renewal of nutritious particles. They are expoſed to the attrition of the fluids which are circulated through them; and the contraction and relaxation they repeat ſo many thouſand times in every day, would neceſſarily occaſion a diſſolution of the machine, if the renewal was not proportioned to the waſte.

It is eaſy to conceive how the chyle formed from the aliment is aſſimilated into the nature of blood, and repairs the loſs of the fluid parts of our body; but how the ſolids are renewed, has never yet been ſatisfactorily explained. The nutritious parts of the blood are probably depoſited by the arteries by exſudation through their pores into the tela cellulosa; and as the ſolid parts of the body are in the embryo only a kind of jelly, which gradually acquires the degree of conſiſtence they are found to have when the body arrives at a more advanced age; and theſe ſame parts which conſiſt of bones, cartilages, ligaments, muſcles, &c. are ſometimes reduced again by diſeaſe to a gelatinous ſtate; we may, with ſome degree of probability, conſider the coagulable lymph as the ſource of nutrition.

If the ſupply of nouriſhment exceeds the degree of waſte, the body increaſes; and this happens in infancy and in youth: for at thoſe periods, but more particularly the former one, the fluids bear a large proportion to the ſolids; and the fibres being ſoft and yielding, are proportionably more capable of extenſion and increaſe. But when the ſupply of nutrition only equals the waſte, we neither increaſe nor decreaſe; and we find this to be the caſe when the body has attained its full growth or *acme:* for the ſolids having then acquired a certain degree of firmneſs and rigidity, do not permit a farther increaſe of the body. But as we approach to old age, rigidity begins to be in exceſs, and the fluids (H) bear a much leſs proportion to the ſolids than before. The diſſipation of the body is greater than the ſupply of nouriſhment; many of the ſmaller veſſels become gradually impervious (I); and the fibres loſing their moiſture and their elaſticity, appear flaccid and wrinkled. The lilies and the roſes diſappear, becauſe the fluids by which they were produced can no longer reach the extremities of the capillary veſſels of the ſkin. As theſe changes take place, the nervous power being proportionably weakened, the irritability and ſenſibility of the body, which were formerly ſo remarkable, are greatly diminiſhed; and in advanced life, the hearing, the eye-ſight, and all the other ſenſes, become gradually impaired. See the Article NUTRITION.

SECT. VII. OF THE GLANDS AND SECRETIONS.

THE glands are commonly underſtood to be ſmall, roundiſh, or oval bodies, formed by the convolution of a great number of veſſels, and deſtined to ſeparate particular humours from the maſs of blood. They are uſually divided into two claſſes; but it ſeems more proper to diſtinguiſh three kinds of glands, viz. the mucous, conglobate, and conglomerate.

The *mucous glands*, or follicles as they are moſt commonly called, are ſmall cylindrical tubes continued from the ends of arteries. In ſome parts of the body, as in the tonſils, for example, ſeveral of theſe follicles may be ſeen folded together in one common covering, and opening into one common ſinus. Theſe follicles are the veſſels that ſecrete and pour out mucus in the mouth, œſophagus, ſtomach, inteſtines, and other parts of the body.

The *conglobate glands* are peculiar to the lymphatic ſyſtem. Every lymphatic vein paſſes through a gland of this kind in its way to the thoracic duct. They are met with in different parts of the body, particularly in the axilla, groin, and meſentery, and are either ſolitary or in diſtinct cluſters.

The *conglomerate glands* are of much greater bulk than the conglobate, and ſeem to be an aſſemblage of many ſmaller glands. Of this kind are the liver, kidnies, &c. Some of them, as the pancreas, parotids, &c. have a granulated appearance. All theſe conglomerate glands are plentifully ſupplied with blood-veſſels; but their nerves are in general very minute, and few in number. Each little granulated portion furniſhes a ſmall tube, which unites with other ſimilar ducts, to form the common excretory duct of the gland.

The principal glands, and the humours they ſecrete, have been already deſcribed in different parts of this work; and there only remains for us to examine the general ſtructure of the glands, and to explain the mechaniſm of ſecretion. On the firſt of theſe ſubjects two different ſyſtems have been formed; each of which has had, and ſtill continue to have, its adherents. One of theſe ſyſtems was advanced by Malpighi, who ſuppoſed that an artery entering into a gland ramifies very minutely through its whole ſubſtance; and that its branches ultimately terminate in a veſicular cavity or follicle, from whence the ſecreted fluid paſſes out through the excretory duct. This doctrine at firſt met with few opponents; but the celebrated Ruyſch, who firſt attempted minute injections with wax, afterwards diſputed the exiſtence of theſe follicles, and aſſerted, that every gland appears to be a continued ſeries of veſſels, which after being repeatedly convoluted in their courſe through its ſubſtance, at length terminate in the excretory duct. Anatomiſts are ſtill divided between theſe two ſyſtems: that of Malpighi, however, ſeems to be the beſt founded.

The mode of ſecretion has been explained in a variety of ways, and they are all perfectly hypothetical. In ſuch an inquiry, it is natural to aſk, how one gland conſtantly ſeparates a particular humour, while another gland ſecretes one of a very different nature from the blood? The bile, for inſtance, is ſeparated by the liver, and the urine by the kidneys. Are theſe ſecretions to be imputed to any particular diſpoſition in the fluids, or is their cauſe to be looked for in the ſolids?

It has been ſuppoſed, that every gland contains within itſelf a fermenting principle, by which it is enabled to change the nature of the blood it receives, and to endue it with a particular property. So that, according to this ſyſtem, the blood, as it circulates through the kidneys, becomes mixed with the fermenting principle of thoſe glands, and a part of it is converted into urine; and again, in the liver, in the ſalival and other glands, the bile, the ſaliva, and other juices, are generated from a ſimilar cauſe. But it ſeems to be impoſſible for any liquor to be confined in a place expoſed to the circulation, without being carried away by the torrent of blood, every part of which would be equally affected; and this ſyſtem of fermentation has long been rejected as vague and chimerical. But as the cauſe of ſecretion continued to be looked for in the fluids, the former ſyſtem was ſucceeded by another, in which recourſe was had to the analogy of the humours. It was obſerved, that if paper is moiſtened with water, and oil and water are afterwards poured upon it, that the water only will be permitted to paſs through it; but that, on the other hand, if the paper has been previouſly ſoaked in oil inſtead of water, the oil only, and not the water, will be filtered through it. Theſe obſervations led to a ſuppoſition, that every ſecretory organ is originally furniſhed with a humour analogous to that which it is afterwards deſtined to ſeparate from the blood; and that in conſequence of this diſpoſition, the ſecretory veſſels of the liver, for inſtance, will only admit the bilious particles of the blood, while all the other humours will be excluded. This ſyſtem is an ingenious one, but the difficulties with which it abounds are unanſwerable: for oil and water are immiſcible; whereas the blood, as it is circulated through the body, appears to be an homogeneous fluid. Every oil will paſs through a paper moiſtened only with one kind of oil; and wine, or ſpirits mixed with water, will eaſily be filtered through a paper previouſly ſoaked in water. Upon the ſame principle, all our humours, though differing in their other properties, yet agreeing in that of being perfectly miſcible with each other, will all eaſily paſs through the ſame filtre.—But theſe are not all the objections to this ſyſtem. The humours which are ſuppoſed to be placed in the ſecretory veſſels for the determination of ſimilar particles from the blood, muſt be originally ſeparated without any ana-

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expoſed to heat, or combined with certain chymical ſubſtances; whereas the other coagulates ſpontaneouſly when expoſed to the air or to reſt.

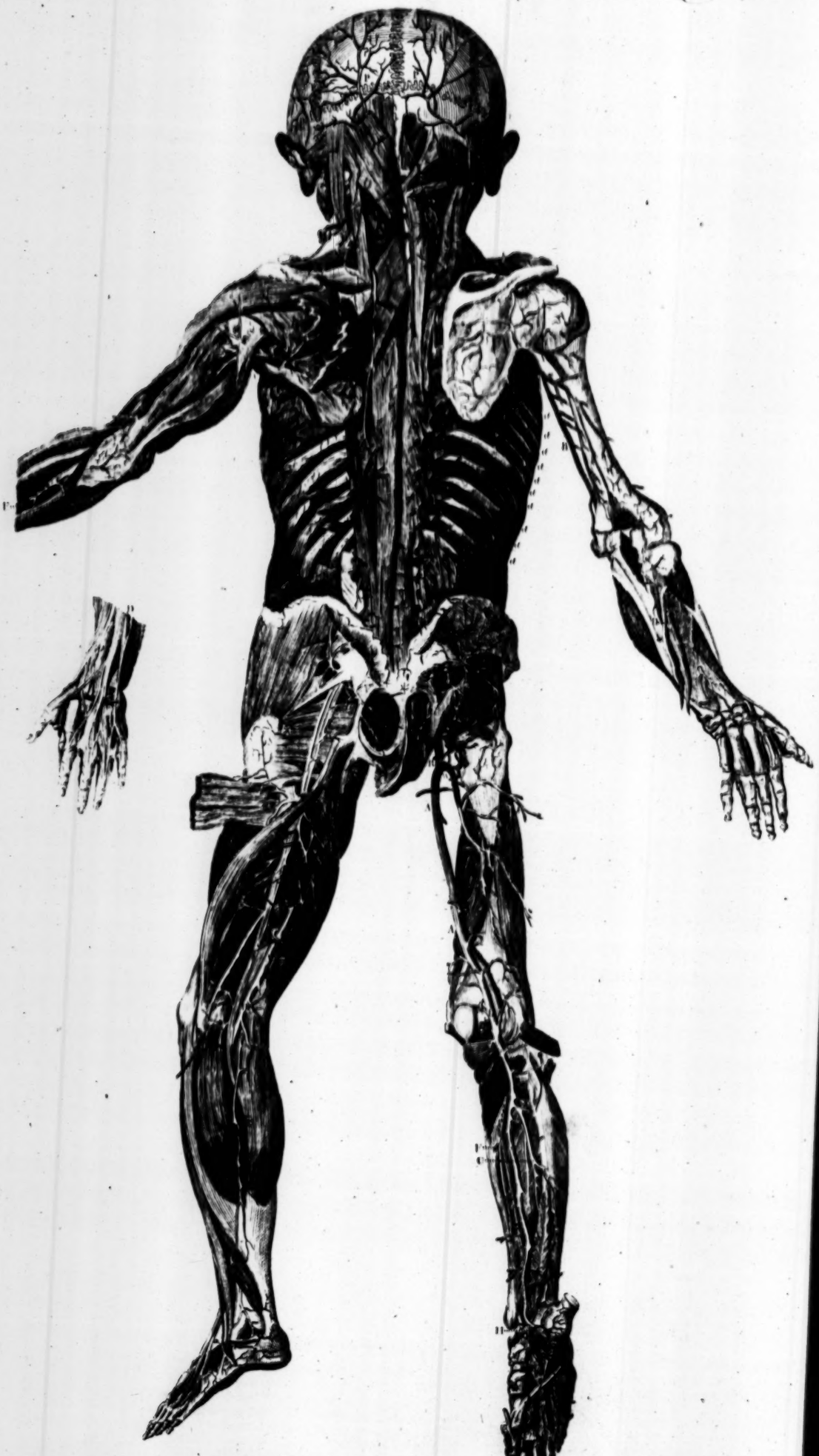
(G) When the blood ſeparates into *ſerum* and *craſſamentum*, if the latter be covered with a cruſt of a whitiſh or buff colour, it has been uſually conſidered as a certain proof of the blood's being in a ſtate of too great viſcidity. This appearance commonly taking place in inflammatory diſeaſes, has long ſerved to confirm the theory which aſcribes the cauſe of inflammation to lentor and obſtructions. But from the late Mr. Hewſon's experiments it appears, that when the action of the arteries is increaſed, the blood, inſtead of being more viſcid, is, on the contrary, more fluid than in the ordinary ſtate, previous to inflammation: and that in conſequence of this, the coagulable lymph ſuffers the red globules, which are the heavieſt part of the blood, to fall down to the bottom before it coagulates: ſo that the craſſamentum is divided into two parts; one of which is found to conſiſt of the coagulable lymph alone (in this caſe termed the *buff*); and the other, partly of this and partly of the red globules.

(H) As the fluids become leſs in proportion to the ſolids, their acrimony is found to increaſe; and this may perhaps compenſate for the want of fluidity in the blood, by diminiſhing its cohesion.

(I) In infancy, the arteries are numerous and large in reſpect to the veins, and the lymphatic glands are larger than at any other time of life; whereas, in old age, the capacity of the venous ſyſtem exceeds that of the arteries, and the lymphatic ſyſtem almoſt diſappears.

logous

Back View of the Arteries, with the Muscles on the right side of the Body dissected off, in order to shew the deep seated Arteries. See System of Anatomy Part 3. Sect. 3.



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logous fluid; and that which happens once may as eaſily happen always. Again, it ſometimes happens, from a vicious diſpoſition, that humours are filtered through glands which are naturally not intended to afford them a paſſage; and when this once has happened, it ought, according to this ſyſtem, to be expected always to do ſo: whereas this is not the caſe; and we are, after all, naturally led to ſeek for the cauſe of ſecretion in the ſolids. It does not ſeem right to aſcribe it to any particular figure of the ſecretory veſſels; becauſe the ſoft texture of thoſe parts does not permit them to preſerve any conſtant ſhape, and our fluids ſeem to be capable of accommodating themſelves to every kind of figure. Some have imputed it to the difference of diameter in the orifices of the different ſecretory veſſels. To this doctrine objections have likewiſe been raiſed; and it has been argued, that the veſſels of the liver, for inſtance, would, upon this principle, afford a paſſage not only to the bile, but to all the other humours of leſs conſiſtence with it. In reply to this objection, it has been ſuppoſed, that ſecondary veſſels exiſt, which originate from the firſt, and permit all the humours thinner than the bile to paſs through them. Each of theſe hypotheſes is probably remote from the truth.

PART VI.

NEUROLOGY, OR A DESCRIPTION OF THE BRAIN AND NERVES.

SECT. I. OF THE BRAIN AND ITS INTEGUMENTS.

THE bones of the cranium were deſcribed in the oſteological part of this work, as incloſing the brain, and defending it from external injury: but they are not its only protection; for when we make an horizontal ſection through theſe bones, we find this maſs every where ſurrounded by two membranes (K), the dura and pia mater.—The firſt of theſe lines is the interior ſurface of the cranium, to which it everywhere adheres ſtrongly (L), but more particularly at the ſutures, and at the many foramina through which veſſels paſs between it and the pericranium. The *dura mater* (M) is perfectly ſmooth and inelaſtic, and its inner ſurface is conſtantly bedewed with a fine pellucid fluid, which every where ſeparates it from the pia mater. The dura mater ſends off ſeveral conſiderable proceſſes, which divide the brain into ſeparate portions, and prevent them from compreſſing each other. Of theſe proceſſes there is one ſuperior and longitudinal, called the *falx*, or *falciform proceſs*, from its reſemblance to a ſcythe. It ariſes from the ſpine of the os frontis, near the criſta galli, and extending along in the direction of the ſagittal ſuture, to beyond the lamboidal ſuture, divides the brain into two hemiſpheres. A little below the lamboidal ſuture, it divides into two broad wings or expanſions called the *tranſverſe* or *lateral proceſſes*, which prevents the lobes of the cerebrum from preſſing on the cerebellum. Beſides theſe there is a fourth, which is ſituated under the tranſverſe proceſſes, and being continued to the ſpine of the occiput, divides the cerebellum into two lobes.

The blood, after being diſtributed through the cavity of the cranium by means of the arteries, is returned, as in the other parts of the body, by veins which all paſs on to certain channels, ſituated behind theſe ſeveral proceſſes. Theſe canals or ſinuſes communicate with each other, and empty themſelves into the internal jugular veins, which convey the blood into the vena cava. They are in fact triangular veins, running through the ſubſtance of the dura mater, and, like the proceſſes, are diſtinguiſhed into *longitudinal* and *lateral*; and where theſe three meet, and where the fourth proceſs paſſes off, we obſerve a fourth ſinus, which is called *torcular*; Herophilus, who firſt deſcribed it, having ſuppoſed that the blood at the union of theſe two veins, is, as it were, in a preſs.

Beſides theſe four canals, which were known to the ancients, modern anatomiſts enumerate many others, by giving the appellation of *ſinuſes* to other veins of the dura mater, which for the moſt part empty themſelves into ſome of thoſe we have juſt now deſcribed. There are the inferior longitudinal ſinus, the ſuperior and inferior petrous ſinuſes, the cavernous ſinuſes, the circular ſinus and the anterior and poſterior occipital ſinuſes. Theſe ſinuſes or veins by being conveyed through a thick denſe membrane, firmly ſuſpended, as the dura mater is, within the cranium, are leſs liable to rupture; at the ſame time they are well ſupported, and by running everywhere along the inner ſurface of the bones, they are prevented from preſſing on the ſubſtance of the brain. To prevent too great a dilatation of them, we find filaments (called *chordæ Williſii*, from their having been firſt noticed by Willis) ſtretched acroſs their cavities; and the oblique manner in which the veins from the brain run through the ſubſtance of the brain into theſe channels, ſerves the purpoſe of a valve, which prevents the blood from turning back into the ſmaller and weaker veſſels of the brain.

The *pia mater* is a much ſofter and finer membrane than the dura mater; being exceedingly delicate, tranſparent, and vaſcular. It inveſts every part of the brain, and ſends off an infinite number of elongations, which inſinuate themſelves between the convolutions, and even into the ſubſtance of the brain. This membrane is compoſed of two laminæ; of which the exterior one is named *tunica arachnoides*, from its thinneſs, which is equal to that of a ſpider's web. Theſe two laminæ are intimately adherent to each other at the upper part of the brain, but are equally ſeparable at the baſis of the brain, and through the whole length of the medulla ſpinalis. The external layer, or tunica arachnoides, appears to be ſpread uniformly over the ſurface of the brain, but without entering into its furrows as the inner layer does; the latter being found to inſinuate itſelf between the convolutions, and even into the interior cavities of the brain. The blood-veſſels of the brain are diſtributed through it in their way to that organ, and are therefore divided into very minute ramifications, before they penetrate the ſubſtance of the brain.

There are ſeveral parts included under the general denomination of *brain*. One of theſe, which is of the ſofteſt conſiſtence, and fills the greateſt part of the cavity of the cranium, is the *cerebrum*, or *brain* properly ſo called. Another portion which is ſeated in the inferior and poſterior part of the head, is the *cerebellum*; and a third, which derives its origin from both theſe, is the *medulla oblongata*.

The *cerebrum* is a medullary maſs of a moderate conſiſtence, filling up exactly all the upper part of the cavity of the cranium, and divided into two hemiſpheres by the falx of the dura mater. Each of theſe hemiſpheres is uſually diſtinguiſhed into *an anterior*, *a middle*, and *a poſterior lobe*. The firſt of theſe is lodged on the orbital proceſſes of the os frontis; the middle lobes lie in the middle foſſæ of the baſis of the cranium, and the poſterior lobes are placed on the tranſverſe ſeptum of the os occipitis, immediately over the cerebellum, from which they are ſeparated by the lateral proceſſes of the dura mater. Theſe two portions afford no diſtinguiſhing mark of ſeparation; and on this account Haller, and many other modern anatomiſts, omit the diſtinction of middle lobe, and ſpeak only of the anterior and poſterior lobes of the brain. The cerebrum appears to be compoſed of two diſtinct ſubſtances. Of theſe, the exterior one, which is of a greyiſh or aſh-colour, is called the *cortex*, and is ſomewhat ſofter than the other, which is very white, and is called *medulla*, or *ſubſtantia alba*.

After having removed the falx, and ſeparated the two hemiſpheres from each other, we perceive a white convex body, the corpus calloſum, which is a portion of the medullary ſubſtance, uniting the two hemiſpheres to each other, and not inveſted by the cortex. By making an horizontal inciſion in the brain, on a level with this corpus calloſum, we diſcover two oblong cavities, named the *anterior* or *lateral ventricles*, one in each hemiſphere. Theſe two ventricles, which communicate with each other by a hole immediately under the plexus choroides, are ſeparated laterally by a very fine medullary partition, called *ſeptum lucidum*, from its thinneſs and tranſparency. The lower edge of this ſeptum is fixed to the fornix, which is a kind of medullary arch (as its name implies) ſituated under the corpus calloſum, and nearly of a triangular ſhape. Anteriorly the fornix ſends off two medullary chords, called its *anterior crura*; which ſeem to be united to each other by a portion of medullary ſubſtance, named *commiſſura anterior cerebri*. Theſe crura diverging from one another, are loſt at the outer ſide of the fore-part of the third ventricle. Poſteriorly the fornix is formed into two other crura, which unite with two medullary protuberances called *pedes hippocampi*, and ſometimes *cornua ammonis*, that extend along the back-part of the lateral ventricles. The concave edge of the pedes hippocampi is covered by a medullary lamina, called *corpus fimbriatum*.

Neither the edges of the fornix, nor its poſterior crura, can be well diſtinguiſhed, till we have removed the plexus choroides. This is a production of the pia mater, which is ſpread over the lateral ventricles. Its looſe edges are collected, ſo as to appear like a vaſcular band on each ſide. When we have removed this plexus, we diſcover ſeveral other protuberances included in the lateral ventricles. Theſe are the corpora ſtriata, the thalami nervorum opticorum, the tubercula quadrugemina, and the pineal gland.

(K) The Greeks called theſe membranes *meninges*; but the Arabians, ſuppoſing them to be the ſource of all the other membranes of the body, afterwards gave them the names of *dura* and *pia mater*; by which they are now uſually diſtinguiſhed.

(L) In young ſubjects this adheſion is greater than in adults; but even then, in the healthy ſubject, it is no where eaſily ſeparable, without breaking through ſome of the minute veſſels by means of which it is attached to the bone.

(M) This membrane is commonly deſcribed as conſiſting of two laminæ; of which the external one is ſuppoſed to perform the office of periоſteum internum to the cranium, while the internal one forms the folds and proceſſes of the dura mater. In the natural ſtate, however, no ſuch ſeparation is apparent; like other membranes, we may indeed divide it, not into two only, but many laminæ; but this diviſion is artificial, and depends on the dexterity of the anatomiſt.

The *corpora ſtriata* are two curved oblong eminences, that extend along the anterior part of the lateral ventricles. They derive their name from their ſtriated appearance, which is owing to an intermixture of the cortical and medullary ſubſtances of the brain. The *thalami nervorum opticorum* are ſo called becauſe the optic nerves ariſe chiefly from them, and they are likewiſe compoſed both of the cortex and medulla. They are ſeparated from the corpora ſtriata only by a kind of medullary chord, the geminum centrum ſemi-circulare. The thalami are nearly of an oval ſhape, and are ſituated at the bottom of the upper cavity of the lateral ventricles. They are cloſely united, and at their convex part ſeem to become one body.

Anteriorly, in the ſpace between the thalami, we obſerve an orifice by which the lateral ventricles communicate, and another leads down from this, under the different appellations of *foramen commune anterius*, *vulva*, *iter ad infundibulum*, but more properly *iter ad tertium ventriculum*; and the ſeparation of the thalami from each other poſteriorly forms another opening or interſtice called *anus*. This has been ſuppoſed to communicate with the third ventricle; but it does not, the bottom of it being ſhut up by the pia mater. The back part of the anus is formed by a kind of medullary band, which connects the thalami to each other, and is called *commiſſura poſterior cerebri*.

Behind the thalami and commiſſura poſterior, we obſerve a ſmall, ſoft, greyiſh, and oval body, about the ſize of a pea. This is the glandula pinealis; it is deſcribed by Galen under the name of *conarion*, and has been rendered famous by Deſcartes, who ſuppoſed it to be the ſeat of the ſoul. Galen ſeems formerly to have entertained the ſame opinion. Some modern writers have, with as little reaſon, imagined that the ſoul is placed in the corpus calloſum. The pineal gland reſts upon four remarkable eminences, diſpoſed in pairs, and ſeated immediately below it. Theſe tubercles, which by the ancients were called *teſtes* and *nates*, have, ſince the time of Winſlow, been more commonly named *tubercula quadrugemina*.

Under the thalami we obſerve another cavity, the third ventricle, which terminates anteriorly in a ſmall medullary canal, the infundibulum, that leads to the glandula pituitaria. It has been doubted, whether the infundibulum is really hollow; but ſome late experiments on this part of the brain by Profeſſor Murray of Upſal, clearly prove it to be a medullary canal, ſurrounded by both laminæ of the pia mater. After freezing the brain, this channel was found filled with ice; and de Haen tells us, he found it dilated, and filled with a calcareous matter (N).

The ſoft ſpongy body in which the infundibulum terminates, was by the ancients ſuppoſed to be of a glandular ſtructure, and deſtined to filter the ſeroſity of the brain. Spigelius pretended to have diſcovered its excretory duct, but it ſeems certain that no ſuch duct exiſts. It is of an oblong ſhape, compoſed, as it were, of two lobes. In ruminant animals it is much larger than in man.

From the poſterior part of the third ventricle, we ſee a ſmall groove or channel, deſcending obliquely backwards. This channel, which is called the *aqueduct of Sylvius*, though it was known to the ancients, opens into another cavity of the brain, placed between the cerebellum and medulla oblongata, and called the *fourth ventricle*.

The *cerebellum*, which is divided into two lobes, is commonly ſuppoſed to be of a firmer texture than the cerebrum; but the truth is, that in the greater number of ſubjects, there appears to be no ſenſible difference in the conſiſtence of theſe two parts. It has more of the cortical than of the medullary ſubſtance in its compoſition. The furrow that divides the two lobes of the cerebellum leads anteriorly to a proceſs, compoſed of medullary and cortical ſubſtances, covered by the pia mater; and which, from its being divided into numerous furrows, reſembling the rings of the earth worm, is named *proceſſus vermiformis*. This proceſs forms a kind of ring in its courſe between the lobes. The ſurface of the cerebellum does not afford thoſe circumvolutions which appear in the cerebrum; but inſtead of theſe, we obſerve a great number of minute furrows, running parallel to each other, and nearly in a tranſverſe direction. The pia mater inſinuates itſelf into theſe furrows.

When we cut into the ſubſtance of the cerebellum, from above downwards, we find the medullary part running in a kind of ramifying courſe, and exhibiting an appearance that has gotten the name of *arbor vitæ*. Theſe ramifications unite to form a medullary trunk; the middle, anterior, and moſt conſiderable part of which forms two proceſſes, the crura cerebelli, which unite with the crura cerebri, to form the medulla oblongata. The reſt furniſhes two other proceſſes, which loſe themſelves under the nates, and thus unite the lobes of the cerebellum to the poſterior part of the cerebrum. Under the nates we obſerve a tranſverſe medullary line, or linea alba, running from one of theſe proceſſes to the other; and between them we find a very thin medullary lamina, covered with the pia mater, which the generality of anatomiſts have (though ſeemingly without reaſon) conſidered as a valve formed for cloſing the communication between the fourth ventricle and the aquæductus Sylvii. Vieuſſens named it *valvula major cerebri*.

The *medulla oblongata* is ſituated in the middle, lower, and poſterior part of the cranium, and may be conſidered as a production or continuation of the whole medullary ſubſtance of the cerebrum and cerebellum, being formed by the union of two conſiderable medullary proceſſes of the cerebrum, called *crura cerebri*, with two other ſmaller ones from the cerebellum, which were juſt now ſpoken of under the name of *crura cerebelli*.

The crura cerebri ariſe from the middle and lower part of each hemiſphere. They are ſeparated from each other at their origin, but are united below, where they terminate in a middle protuberance, the *pons Varolii*, ſo called, becauſe Varolius compared it to a bridge. This name, however, can convey no idea of its real appearance. It is, in fact, nothing more than a medullary protuberance, nearly of a ſemi-ſpherical ſhape, which unites the crura cerebri to thoſe of the cerebellum.

Between the crura cerebri, and near the anterior edge of the pons Varolii, are two tubercles, compoſed externally of medullary, and internally of cineritious, ſubſtance, to which Euſtachius firſt gave the name of *eminentiæ mamillares*. Along the middle of the poſterior ſurface of the medulla oblongata, where it forms the anterior part of the fourth ventricle, we obſerve a kind of furrow which runs downwards and terminates in a point. About an inch above the lower extremity of this fiſſure, ſeveral medullary filaments are to be ſeen running towards it on each ſide in an oblique direction, ſo as to give it the appearance of a writing-pen; hence it is called *calamus ſcriptorius*. From the poſterior part of the pons Varolii, the medulla oblongata deſcends obliquely backwards; at its forepart, immediately behind the pons Varolii, we obſerve two pair of eminences, which were deſcribed by Euſtachius, but received no particular appellation till the time of Vieuſſens, who gave them the names of *corpora olivaria* and *corpora pyramidalia*. The former are the outermoſt, being placed one on each ſide. They are nearly of an oval ſhape, and are compoſed of medulla, with ſtreaks of cortical ſubſtance. Between theſe are the corpora pyramidalia, each of which terminates in a point. In the human ſubject theſe four eminences are ſometimes not eaſily diſtinguiſhed.

The *medulla ſpinalis*, or *ſpinal marrow*, which is the name given to the medullary chord that is extended down the vertebral canal, from the great foramen of the occipital bone to the bottom of the laſt lumbar vertebra, is a continuation of the medulla oblongata. Like the other parts of the brain, it is inveſted by the dura and pia mater. The firſt of theſe, in its paſſage out of the cranium, adheres to the foramen of the os occipitis. Its connection with the ligamentary ſubſtance that lines the cavity of the ſpine, is only by means of cellular membrane; but between the ſeveral vertebræ, where the nerves paſs out of the ſpine, it ſends off prolongations, which adhere ſtrongly to the vertebral ligaments. Here, as in the cranium, the dura mater has its ſinuſes or large veins. Theſe are two in number, and are ſeen running on each ſide of the medullary column, from the foramen magnum of the os occipitis to the lower part of the os ſacrum. They communicate together by ramifying branches at each vertebra, and terminate in the vertebral, intercoſtal, and ſacral veins.

The pia mater is connected with the dura mater by means of a thin tranſparent ſubſtance, which from its indentations between the ſpinal nerves has obtained the name of *ligamentum denticulatum*. It is ſomewhat firmer than the tunica arachnoides, but in other reſpects reſembles that membrane. Its uſe is to ſupport the ſpinal marrow, that it may not affect the medulla oblongata by its weight.

The ſpinal marrow itſelf is externally of a white colour; but upon cutting into it we find its middle part compoſed of a darker coloured maſs, reſembling the cortex of the brain. When the marrow has reached the firſt lumbar vertebræ, it becomes extremely narrow, and at length terminates in an oblong protuberance; from the extremity of which the pia mater ſends off a prolongation or ligament, reſembling a nerve, that perforates the dura mater, and is fixed to the os coccygis.

The medulla ſpinalis gives riſe to 30 or 31 pair of nerves, but they are not all of the ſame ſize, nor do they all run in the ſame direction. The upper ones are thinner than the reſt, and are placed almoſt tranſverſely; as we deſcend we find them running more and more obliquely downwards, till at length their courſe is almoſt perpendicular, ſo that the lowermoſt nerves exhibit an appearance that is called *cauda equina*, from its reſemblance to a horſe's tail.

The arteries that ramify through the different parts of the brain, are derived from the internal carotid and from the vertebral arteries. The medulla ſpinalis is ſupplied by the anterior and poſterior ſpinal arteries, and likewiſe receives branches from the cervical, the inferior and ſuperior intercoſtal, the lumbar, and the ſacral arteries.

(N) The under part of it, however, appears to be impervious; at leaſt no injection that can be depended on has been made to paſs from it into the glandula pituitaria without laceration of parts.

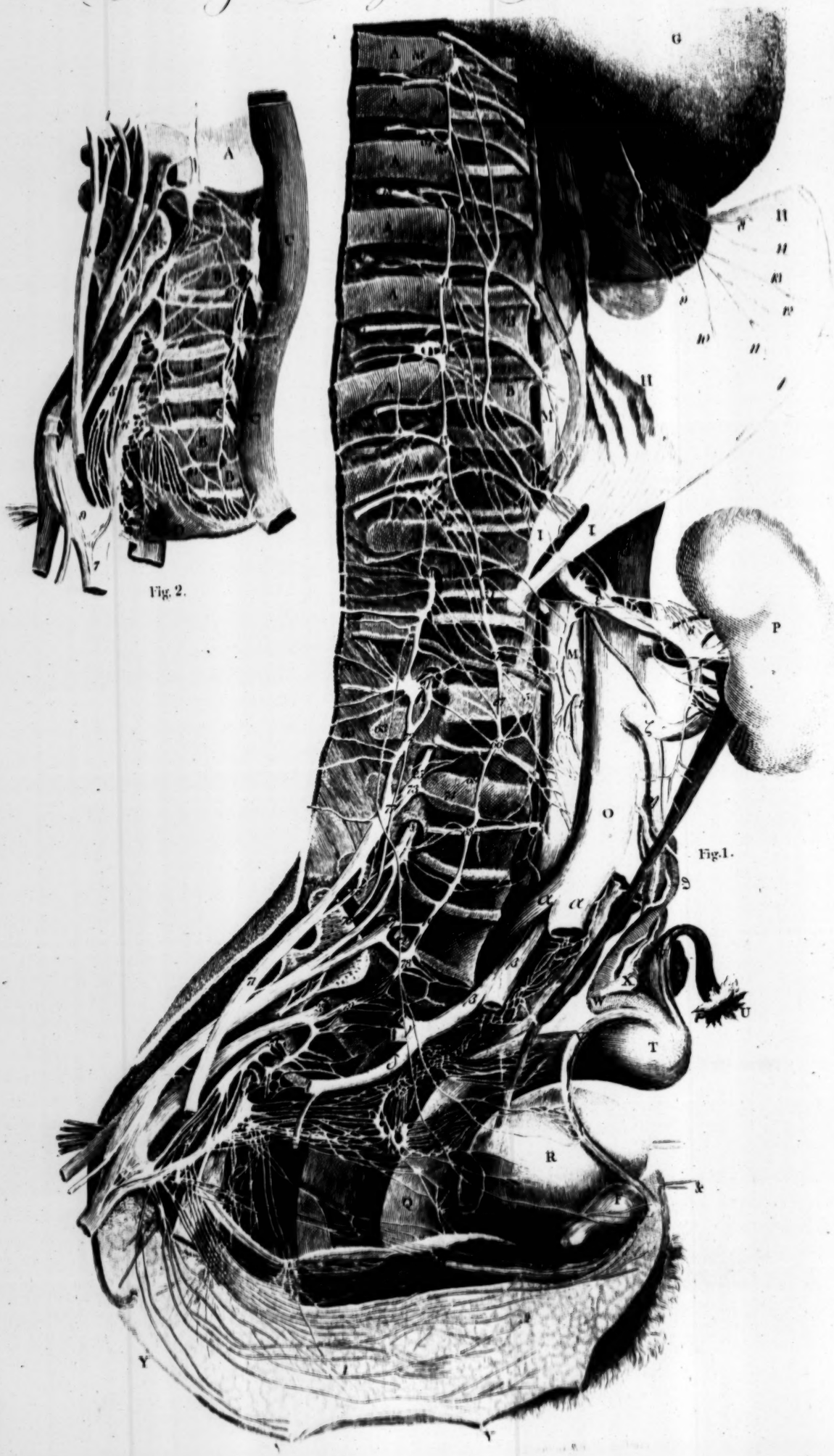

Fig. 2.

Fig. 1.

SECT. II. OF THE NERVES.

THE nerves are medullary chords, differing from each other in ſize, colour, and conſiſtence, and deriving their origin from the medulla oblongata and medulla ſpinalis. There are 39, and ſometimes 40 pair of theſe nerves; nine of which originate from the medulla oblongata, and 30 or 31 from the medulla ſpinalis. They appear to be perfectly inelaſtic, and likewiſe to poſſeſs no irritability. If we irritate muſcular fibres, they immediately contract; but nothing of this ſort happens if we irritate a nerve. They carry with them a covering from the pia mater; but derive no tunic from the dura mater, as hath been generally, though erroneouſly, ſuppoſed, ever ſince the time of Galen, the outer covering of the nerves being in fact nothing more than cellular membrane. This covering is very thick where the nerve is expoſed to the action of muſcles; but where it runs through a bony canal, or is ſecure from preſſure, the cellular tunic is extremely thin, or altogether wanting. We have inſtances of this in the portio mollis of the auditory nerve, and in the nerves of the heart.

By elevating, carefully and gently, the brain from the baſis of the cranium, we find the firſt nine pair ariſing in the following order: 1. The nervi olfactorii, diſtributed through the pituitary membrane, which conſtitutes the organ of ſmell. 2. The optici, which go to the eyes, where they receive the impreſſions of viſible objects. 3. The oculorum motores, ſo called becauſe they are diſtributed to the muſcles of the eye. 4. The pathetici, diſtributed to the ſuperior oblique muſcles of the eyes, the motion of which is expreſſive of certain paſſions of the ſoul. 5. The nerves of this pair ſoon divide into three principal branches, and each of theſe has a different name. Its upper diviſion is the opthalamicus, which is diſtributed to various parts of the eyes, eye-lids, fore-head, noſe, and integuments of the face. The ſecond is called the *maxillaris ſuperior*, and the third *maxillaris inferior*; both which names allude to their diſtribution. 6. The abductores; each of theſe nerves is diſtributed to the abductor muſcle of the eye, ſo called, becauſe it helps to draw the globe of the eye from the noſe. 7. The auditorii (o), which are diſtributed through the organs of hearing. 8. The par vagum, which derives its name from the great number of parts, to which it gives branches both in the thorax and abdomen. 9. The linguales, or hypo-gloſſi, which are diſtributed to the tongue, and appear to contribute both to the organ of taſte, and to the motions of the tongue (p).

It has already been obſerved, that the ſpinal marrow ſends off 30 or 31 pair of nerves; theſe are chiefly diſtributed to the exterior parts of the trunk and to the extremities. They are commonly diſtinguiſhed into the *cervical*, *dorſal*, *lumbar* and *ſacral nerves*. The cervical, which paſs out from between the ſeveral vertebræ of the neck, are eight (q) in number; the dorſal, twelve; the lumbar, five; and the ſacral, five or ſix; the number of the latter depending on the number of holes in the os ſacrum. Each ſpinal nerve at its origin is compoſed of two faſciculi of medullary fibres. One of theſe faſciculi ariſes from the anterior, and the other from the poſterior, ſurface of the medulla. Theſe faſciculi are ſeparated by the ligamentum denticulatum; after which we find them contiguous to one another. They then perforate the dura mater, and unite to form a conſiderable knot or ganglion. Each of theſe ganglions ſends off two branches; one anterior, and the other poſterior. The anterior branches communicate with each other at their coming out of the ſpine, and likewiſe ſend off one, and ſometimes more branches, to aſſiſt in the formation of the intercoſtal nerve.

The knots or ganglions of the nerves juſt now ſpoken of, are not only to be met with at their exit from the ſpine, but likewiſe in various parts of the body. They occur in the nerves of the medulla oblongata, as well as in thoſe of the ſpine. They are not the effects of diſeaſe, but are to be met with in the ſame parts of the ſame nerves, both in the fœtus and adult. They are commonly of an oblong ſhape, and of a greyiſh colour, ſomewhat inclined to red, which is perhaps owing to their being extremely vaſcular. Internally we are able to diſtinguiſh ſomething like an intermixture of the nervous filaments.

The nerves, like the blood-veſſels, in their courſe through the body, communicate with each other; and each of theſe communications conſtitutes what is called a *plexus*, from whence branches are again detached to different parts of the body. Some of theſe are conſtant and conſiderable enough to be diſtinguiſhed by particular names, as the *ſemilunar plexus*; the *pulmonary plexus*; the *hepatic*, the *cardiac*, &c.

It would be foreign to the purpoſe of this work, to follow the nerves through all their diſtributions; but it may be remembered, that in deſcribing the different viſcera, mention was made of the nerves diſtributed to them. There is one pair, however, called the *intercoſtal*, or *great ſympathetic nerve*, which ſeems to require particular notice, becauſe it has an almoſt univerſal connection and correſpondence with all the other nerves of the body. Authors are not perfectly agreed about the origin of the intercoſtal; but it may perhaps not improperly be deſcribed, as beginning from filaments of the fifth and ſixth pair; it then paſſes out of the cranium, through the bony canal of the carotid, from whence it deſcends laterally cloſe to the bodies of the vertebræ, and receives branches from almoſt all the vertebral nerves; forming almoſt as many ganglions in its courſe through the thorax and abdomen. It ſends off an infinite number of branches to the viſcera in thoſe cavities, and forms ſeveral plexus with the branches of the eighth pair or par vagum.

That the nerves are deſtined to convey the principles of motion and ſenſibility to the brain from all parts of the ſyſtem, there can be no doubt: but how theſe effects are produced, no one has ever yet been able to determine. The inquiry has been a conſtant ſource of hypotheſis in all ages, and has produced ſome ingenious ideas, and many erroneous poſitions, but without having hitherto afforded much ſatisfactory information.

Some phyſiologiſts have conſidered a trunk of nerves as a ſolid chord, capable of being divided into an infinite number of filaments, by means of which the impreſſions of feeling are conveyed to the ſenſorium commune. Others have ſuppoſed it to be a canal, which afterwards ſeparates into more minute channels; or, perhaps, as being an aſſemblage of many very ſmall and diſtinct tubes, connected to each other, and thus forming a cylindrical chord. They who contend for their being ſolid bodies, are of opinion, that feeling is occaſioned by vibration; ſo that, for inſtance, according to this ſyſtem, by pricking the finger, a vibration would be occaſioned in the nerve, diſtributed through its ſubſtance; and the effects of this vibration, when extended to the ſenſorium, would be an excital of pain. But the inelaſticity, the ſoftneſs, the connection, and the ſituation of the nerves, are ſo many proofs that vibration has no ſhare in the cauſe of feeling.

Others have ſuppoſed, that in the brain and ſpinal marrow a very ſubtile fluid is ſecreted, and from thence conveyed through the imperceptible tubes, which they conſider as exiſting in the nerves. They have farther ſuppoſed, that this very ſubtile fluid, to which they have given the name of *animal ſpirits*, is ſecreted in the cortical ſubſtance of the brain and ſpinal marrow, from whence it paſſes through the medullary ſubſtance. This, like the other ſyſtem, is founded altogether on hypotheſis; but it ſeems to be an hypotheſis derived from much more probable principles, and there are many ingenious arguments to be brought in its ſupport.

EXPLANATION OF PLATE XII.

Which repreſents the nerves as they paſs off to the thorax, abdomen, and pelvis.

Figure I. A, A, A, A, A, A, A, the ſeven inferior ribs of the right ſide. B, B, B, B, B, B, B, the ſeven inferior vertebræ dorſi. C, C, C, C, C, the five vertebræ lumborum. D, D, the os ſacrum or falſe vertebræ of the ſpine. E, os coccygis. F, the cartilage which forms the ſymphyſis pubes on the left ſide. G, the inferior lobe of the right lung. H, H, the diaphragm. I, I, its cruræ or inferior attachment. K, K, part of the pleura where it forms the poſterior mediaſtinum. L, L, the pericardium containing the heart. M, M, M, the aorta. N, N, the thoracic duct running between the aorta and vena azygos. O, O, the vena cava. P, the right kidney. Q, the vagina. R, The bladder. S, The rectum. T, The uterus. U, The fimbriæ of the fallopian tube. V, The round ligament. W, W, The fallopian tube. X, The ovarium. Y, Y, Y, The ſkin of the nates and perinæum. Z, Z, Labia pudendi. &, The ſkin of the mons veneris. α, Iliac arteries. β, Iliac veins. γ, Right external iliac artery. δ, Right internal iliac artery. ε, Emulgent artery. ζ, Emulgent vein. η, The right ſpermatic vein. ϑ, The right ſpermatic artery. 1, 2, Cutaneous nerves on the nates and perinæum. 3, Plexus of nerves going to the rectum, colon, &c. 4, Meſocolic plexus. 5, Nerves going to the ſpleen; and 6, The renal plexus. 7, Trunk of the phrenic nerve. 8, One of the branches of the phrenic nerve. 9, 10, 11, 12, 13, 14, The branches of the phrenic nerve, which loſe themſelves on the convex ſurface of the diaphragm.

(o) This pair, ſoon after its entrance into the meatus auditorius internus, ſeparates into two branches. One of theſe is of a very ſoft and pulpy conſiſtence; it is called the *portio mollis* of the ſeventh pair, and is ſpread over the inner part of the ear. The other paſſes out through the aqueduct of Fallopius in a firm chord, which is diſtinguiſhed as the portio dura, and is diſtributed to the external ear and other parts of the neck and face.

(p) Heiſter has ſummed up the uſes of theſe nine pair of nerves in the two following Latin verſes:

"*Olfactus, cernens, oculoſque movens, patiensque,*
"*Guſtans, abducens, audiensque, vagansque, loquensque.*"

(q) Beſides theſe, there is another pair called *acceſſorii*, which ariſes from the medulla ſpinalis at its beginning: and aſcending through the great foramen of the os occipitis into the cranium, paſſes out again cloſe to the eighth pair, with which, however, it does not unite; and it is afterwards diſtributed chiefly to the muſcles of the neck, back, and ſcapula. In this courſe it ſends off filaments to different parts, and likewiſe communicates with ſeveral other nerves.

diaphragm. 15, The anaſtomoſing branch of the phrenic nerve, which comes from the cæliac ganglion of the intercoſtal. 16, The ſixth coſtal nerve ſeen anteriorly on the right ſide. 17, The ſeventh coſtal nerve. 18, The eighth coſtal nerve. 19, The ninth coſtal nerve. 20, The tenth coſtal nerve. 21, The eleventh coſtal nerve. 22, The twelfth coſtal nerve. 23, The firſt lumbar nerve of the right ſide ſeen anteriorly. 24, The ſecond lumbar nerve. 25, The third lumbar nerve. 26, The fourth lumbar nerve. 27, The fifth lumbar nerve. 28, The firſt ſacral nerve of the right ſide ſeen anteriorly. 29, The ſecond ſacral nerve. 30, The third ſacral nerve. 31, The fourth ſacral nerve. 32, The trunk of the intercoſtal or great ſympathetic nerve, between the fifth and ſixth dorſal ganglion. 33, The ſixth thoracic ganglion of the intercoſtal nerve. 34, A branch paſſing from the ſixth ganglion to the ſixth coſtal nerve. 35, An anaſtomoſing branch of the fifth and ſixth coſtal nerves. 36, The ſeventh thoracic ganglion. 37, The two branches which unite to form the ſeventh ganglion. 38, The anaſtomoſing branch between the ſixth and ſeventh ganglion. 39, The eighth thoracic ganglion. 40, The trunk of the intercoſtal or the anaſtomoſing branch between the ſeventh and eighth ganglion. 41, The ninth thoracic ganglion. 42, The trunk of the intercoſtal nerve between the eighth and ninth ganglion. 43, The tenth thoracic ganglion. 44, The anaſtomoſing trunk between the ninth and tenth ganglion. 45, The eleventh thoracic ganglion. 46, The intercoſtal nerve between the tenth and eleventh ganglion. 47, 48, Branches going to the intercoſtal muſcles, &c. 49, The firſt lumbar ganglion. 50, The trunk of the intercoſtal nerve, between the laſt thoracic and firſt lumbar ganglions. 51, The firſt branch; and 52, the ſecond branch from the twelfth coſtal nerve, and from the firſt lumbar ganglion. 53, A third branch which terminates in the trunk of the intercoſtal nerve between the firſt and ſecond lumbar ganglions. 54, The trunk of the intercoſtal nerve between the firſt and ſecond lumbar ganglions. 55, 56, Anaſtomoſing branches between the coſtal, and great ſympathetic nerve. 57, The ſecond lumbar ganglion. 58, The firſt branch; and 59, the ſecond branch going off from the lumbar nerves, &c. from the ganglion. 60, 61, Muſcular branches going to the abdominal muſcles. 62 and 63, The ſpermatic nerve dividing into external and internal. 64, The internal ramus to the uterus, ovarium, fallopian tubes, &c. 65, The external ramus, to the external parts of generation. 66, The third lumbar ganglion. 67, The trunk of the intercoſtal nerve, between the ſecond and third lumbar ganglions. 68, The fourth lumbar ganglion. 69, The trunk of the great ſympathetic nerve. 70, The intercoſtal nerve between the fourth and fifth lumbar ganglion. 71, The crural nerve. 72, The firſt branch from the ſecond and third lumbar nerves, which goes to form the crural nerve. 73, The ſecond branch from the third pair of lumbar nerves. 74, The poſterior branch of the third lumbar nerve. 75, The third branch of the crural nerve from the fourth lumbar nerve. 76, The obturator nerve. 77, Three branches from the third lumbar nerve, which form the obturator nerve. 78, The fifth lumbar ganglion. 79, The ſuperior ſacral ganglion. 80, 81, Branches of the ſacral nerves communicating with the intercoſtal nerves.

The intercoſtal nerve in its paſſage downwards, by the ſide of the ſpine, throughout its whole length, is conſtantly detaching branches to the viſcera of the thorax, abdomen, and pelvis, and from this wonderful diſtribution, it forms an almoſt univerſal nervous connection, and on that account it has been called the great ſympathetic nerve.

Figure II. gives a more enlarged view of the ſacral nerves. A, The inferior vertebra of the loins. B, B, Os ſacrum. C, C, The rectum. D, Coccygæus muſcle. E, The articulating ſurface of the ſacrum, where it joins the ilium. 1, The obturator nerve. 2, The crural nerve. 3, The inferior lumbar nerve. 4, The firſt ſacral nerve. 5, The ſecond ſacral nerve. 6, The third ſacral nerve. 7, The large branch of the ſciatic nerve. 8, The ſmaller branch of ditto. 9, The ſciatic nerve. 10, Various anaſtomoſing branches which help to form the intercoſtal or great ſympathetic nerve, and which are ſupplying the poſterior part of the pelvis with nerves.

EXPLANATION OF PLATE XIII.

Which repreſents the nerves of the liver, gall-bladder, pancreas, ſtomach, with their ganglions and organs of digeſtion, &c.

A, A, A, The inferior ſurface of the right lobe of the liver. B, B, B, The inferior ſurface of the left lobe of the liver. C, C, C, The middle lobe or projection of the liver. D, The poſterior lobe of the liver, or lobulus ſpigelii. E, E, The gall-bladder. F, The cyſtic duct. G, The hepatic duct. H, The ductus communis choledochus. I, I, The round ligament of the liver. K, K, The falciform ligament of the liver. L, L, The pancreas. M, M, The ſtomach. N, The greater or upper extremity of the ſtomach. O, The pylorus, or inferior extremity of the ſtomach. P, The cardia. Q, The duodenum. R, R, R, Part of the omentum. S, S, Part of the little omentum. T, T, Lower part of the diaphragm. U, The orifice of the diaphragm, through which the œſophagus paſſes. X, The vena cava. Y, Y, The trunk of the vena portæ. Z, The left hepatic artery.

a, a, The cyſtic artery. b, b, The ſuperior left coronary artery. c, c, c, The inferior left coronary artery. d, The trunk of the gaſtro epiploic artery. f, The common trunk of the right hepatic and coronary artery. g, g, The right hepatic artery. h, h, The cardiac artery. i, The ſtomachic branch from the right hepatic artery. k, The ſuperior right coronary artery. l, l, Branches of the right coronary artery, which are running towards the poſterior part of the ſtomach.

1, The fourth left celiac ganglion. 2, The fifth ditto. 3, The ſixth ditto. 4, The ſeventh ditto. 5, The ninth ditto. 6, The tenth ditto. 7, The third branch of the phrenic hepatic ganglion. 8, The phrenic hepatic ganglion. 9, 10, 11, Cardiac nerves. 12, 13, 14, 15, 16, Branches of the eighth pair of nerves going to the greater curvature of the ſtomach. 17, 18, 19, Branches of the par vagum going to the leſſer curvature of the ſtomach. 20, A plexus of nerves ſurrounding the left hepatic artery, and ſending off branches to the liver. 21, Hepatic plexus ſurrounding the right hepatic artery. 22, Cardiac plexus, from whence go nerves to the ſtomach. 23, Splenic plexus which ſends off nerves to the ſpleen. 24, 25, 26, Nerves of the pancreas. 27, 28, 29, Duodenal nerves, which are beſtowed on the beginning of the inteſtinal canal. 30, Nerves of the pylorus. 31, 32, 33, Nerves of the omentum. 34, 35, Nerves going to the biliary ducts. 36, 37, Nerves of the gall bladder. 38, 39, 40, Hepatic nerves which are entering into the ſubſtance of the liver, ſome of the branches accompanying the hepatic artery, and others the vena portæ. 41, 42, 43, 44, Hepatic ganglions, which are found to vary in their figure, magnitude, and number in various ſubjects.

PART VII.

OF THE SENSES AND THEIR ORGANS.

IN treating of the ſenſes, we mean to confine ourſelves to the external ones of *touch*, *taſte*, *ſmelling*, *hearing*, and *viſion*. The word *ſenſe*, when applied to theſe five, ſeems to imply not only the ſenſation excited in the mind by certain impreſſions made on the body, but likewiſe the organ deſtined to receive and tranſmit theſe impreſſions to the ſenſorium. Each of theſe organs being of a peculiar ſtructure, is ſuſceptible only of particular impreſſions, which will be pointed out as we proceed to deſcribe each of them ſeparately.

SECT. I. OF TOUCH.

THE ſenſe of touch may be defined to be the faculty of diſtinguiſhing certain properties of bodies by the feel. In a general acceptation, this definition might perhaps not improperly be extended to every part of the body poſſeſſed of ſenſibility (a), but it is commonly confined to the nervous papillæ of the cutis, or true ſkin, which, with its appendages, and their ſeveral uſes, have been already deſcribed. The exterior properties of bodies, ſuch as their ſolidity, moiſture, inequality, ſmoothneſs, dryneſs, or fluidity, and likewiſe their degree of heat, ſeem all to be capable of making different impreſſions on the papillæ, and conſequently of exciting different ideas in the ſenſorium commune. But the organ of touch, like all the other ſenſes, is not equally delicate in every part of the body, or in every ſubject; being in ſome much more exquiſite than it is in others.

SECT. II. OF THE TASTE.

THE ſenſe of taſte is ſeated chiefly in the tongue; the ſituation and figure of which are ſufficiently known. On the upper ſurface of this organ we may obſerve a great number of papillæ, which, on account of their difference in ſize and ſhape, are commonly divided into three claſſes. The largeſt are ſituated towards the baſis of the tongue. Their number commonly varies from ſeven to nine, and they ſeem to be mucous follicles. Thoſe of the ſecond claſs are ſomewhat ſmaller, and of a cylindrical ſhape. They are moſt numerous about the middle of the tongue. Thoſe of the third claſs are very minute, and of a conical ſhape. They are very numerous on the apex and edges of the tongue, and have been ſuppoſed to be formed by the extremities of its nerves.

(a) In the courſe of this article, mention has often been made of the ſenſibility or inſenſibility of different parts of the body: it will therefore, perhaps, not be amiſs to obſerve in this place, that many parts which were formerly ſuppoſed to poſſeſs the moſt exquiſite ſenſe, are now known to have but little or no feeling, at leaſt in a ſound ſtate; for in an inflamed ſtate, even the bones, the moſt inſenſible parts of any, become ſuſceptible of the moſt painful ſenſations. This curious diſcovery is due to the late Baron Haller. His experiments prove, that the bones, cartilages, ligaments, tendons, epidermis, and membranes, (as the pleura, pericardium, dura and pia mater, periоſteum, &c.) may in a healthy ſtate be conſidered as inſenſible. As ſenſibility depends on the brain and nerves, of courſe different parts will poſſeſs a greater or leſs degree of feeling, in proportion as they are ſupplied with a greater or ſmaller number of nerves. Upon this principle it is, that the ſkin, muſcles, ſtomach, inteſtines, urinary bladder, ureters, uterus, vagina, penis, tongue, and retina, are extremely ſenſible, while the lungs and glands have only an obſcure degree of feeling.

We

Nerves of the Liver, Gall-Bladder, Pancreas & Stomach.
See System of Anatomy, Part 6. Section 2.

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We obſerve a line, the *linea linguæ mediana*, running along the middle of the tongue, and dividing it as it were into two portions. Towards the baſis of the tongue, we meet with a little cavity, named by Morgagni *foramen cæcum*, which ſeems to be nothing more than a common termination of ſome of the excretory ducts of mucous glands ſituated within the ſubſtance of the tongue. We have already obſerved, that this organ is every where covered by the cuticle, which, by forming a reduplication, called the *frænum*, at its under part, ſerves to prevent the too great motion of the tongue, and to fix it in its ſituation. But, beſides this attachment, the tongue is connected by means of its muſcles and membranous ligaments, to the lower jaw, the os hyoides, and the ſtyloid proceſſes.

The principal arteries of the tongue are the linguales, which ariſe from the external carotid. Its veins empty themſelves into the external jugulars. Its nerves ariſe from the fifth, eighth, and ninth, pair. The variety of taſtes ſeems to be occaſioned by the different impreſſions made on the papillæ by the food. The different ſtate of the papillæ with reſpect to their moiſture, their figure, or their covering, ſeems to produce a conſiderable difference in the taſte, not only in different people, but in the ſame ſubject, in ſickneſs and in health. The great uſe of the taſte ſeems to be to enable us to diſtinguiſh wholeſome and ſalutary food from that which is unhealthy; and we obſerve that many quadrupeds, by having their papillæ (s) very large and long, have the faculty of diſtinguiſhing flavours with infinite accuracy.

SECT. III. OF SMELLING.

The ſenſe of ſmelling, like the ſenſe of taſte, ſeems intended to direct us to a proper choice of aliment, and is chiefly ſeated in the noſe, which is diſtinguiſhed into its external and internal parts. The ſituation and figure of the former of theſe do not ſeem to require a definition. It is compoſed of bones and cartilages, covered by muſcular fibres and by the common integuments. The bones make up the upper portion, and the cartilages the lower one. The ſeptum narium, like the noſe, is likewiſe in part bony, and in part cartilaginous. Theſe bones and their connections were deſcribed in the Oſteology. The internal part of the noſe, beſides the oſſa ſpongioſa, has ſix cavities or ſinuſes, the maxillary, the frontal, and the ſphenoid, which were all deſcribed with the bones of the head. They all open into the noſtrils; and the noſe likewiſe communicates with the mouth, larynx, and pharynx, poſteriorly behind the velum palati.

All theſe ſeveral parts, which are included in the internal diviſion of the noſe, viz. the inner ſurface of the noſtrils, the lamellæ of the oſſa ſpongioſa, and the ſinuſes, are lined by a thick and very vaſcular membrane, which, though not unknown to the ancients, was firſt well deſcribed by Schneider, and is therefore now commonly named *membrana pituitaria Schneideri*. This membrane is truly the organ of ſmelling; but its real ſtructure does not yet ſeem to be perfectly underſtood. It appears to be a continuation of the cuticle, which lines the inner ſurface of the mouth. In ſome parts of the noſe it is ſmooth and firm, and in others it is looſe and ſpongy. It is conſtantly moiſtened by a mucous ſecretion; the finer parts of which are carried off by the air we breathe, and the remainder, by being retained in the ſinuſes, acquires conſiderable conſiſtence. The manner in which this mucus is ſecreted has not yet been ſatisfactorily aſcertained; but it ſeems to be by means of mucous follicles. Its arteries are branches of the internal maxillary and internal carotid. Its veins empty themſelves into the internal jugulars. The firſt pair of nerves, the olfactory, are ſpread over every part of it, and it likewiſe receives branches from the fifth pair.

After what has been ſaid of the pituitary membrane, it will not be difficult to conceive how the air we draw in at the noſtrils, being impregnated with the effluvia of bodies, excites in us that kind of ſenſation we call *ſmelling*. As theſe effluvia, from their being exceedingly light and volatile, cannot be capable in a ſmall quantity of making any great impreſſion on the extremities of the olfactory nerves, it was neceſſary to give conſiderable extent to the pituitary membrane, that by this means a greater number of odoriferous particles might be admitted at the ſame time. When we wiſh to take in much of the effluvia of any thing, we naturally cloſe the mouth, that all the air we inſpire may paſs through the noſtrils; and at the ſame time, by means of the muſcles of the noſe, the noſtrils are dilated, and a greater quantity of air is drawn into them.

In many quadrupeds, the ſenſe of ſmelling is much more extenſive and delicate than it is in the human ſubject; and in the human ſubject it ſeems to be more perfect the leſs it is vitiated by a variety of ſmells. It is not always in the ſame ſtate of perfection, being naturally affected by every change of the pituitary membrane, and of the lymph with which that membrane is moiſtened.

SECT. IV. OF HEARING.

Before we undertake to explain the manner in which we are enabled to receive the impreſſions of ſound, it will be neceſſary to deſcribe the *ear*, which is the *organ of hearing*. It is commonly diſtinguiſhed into external and internal. The former of theſe diviſions includes all that we are able to diſcover without diſſection, and the meatus auditorius, as far as the tympanum; and the latter, all the other parts of the ear.

The *external ear* is a cartilaginous funnel, covered by the common integuments, and attached, by means of its ligaments and muſcles, to the temporal bone. Although capable only of a very obſcure motion, it is found to have ſeveral muſcles. Different parts of it are diſtinguiſhed by different names; all its cartilaginous part is called *ala* or *wing*, to diſtinguiſh it from the ſoft and pendent part below, called the *lobe*. Its outer circle or border is called *helix*, and the ſemicircle within this, *antihelix*. The moveable cartilage placed immediately before the meatus auditorius, which it may be made to cloſe exactly, is named *tragus*; and an eminence oppoſite to this at the extremity of the antihelix, is called *antitragus*. The concha is a conſiderable cavity formed by the extremities of the helix and antihelix. The meatus auditorius, which at its opening is cartilaginous, is lined with a very thin membrane, which is a continuation of the cuticle from the ſurface of the ear.

In this canal we find a yellow wax, which is ſecreted by a number of minute glands or follicles, each of which has an excretory duct. This ſecretion, which is at firſt of an oily conſiſtence, defends the membrane of the tympanum from the injuries of the air; and by its bitterneſs, prevents minute inſects from entering into the ear. But when from neglect or diſeaſe it accumulates in too great a quantity, it ſometimes occaſions deafneſs. The inner extremity of the meatus is cloſed by a thin tranſparent membrane, the membrana tympani, which is ſet in a bony circle like the head of a drum. Under the membrana tympani runs a branch of the fifth pair of nerves, called *chorda tympani*; beyond this membrane is the cavity of the tympanum, which is about ſeven or eight lines wide, and half ſo many in depth; it is ſemiſpherical, and every where lined by a very fine membrane. There are four openings to be obſerved in this cavity. It communicates with the mouth by means of the Euſtachian tube. This canal, which is in part bony and in part cartilaginous, begins by a very narrow opening at the anterior and almoſt ſuperior part of the tympanum, increaſing in ſize as it advances towards the palate of the mouth, where it terminates by an oval opening. This tube is every where lined by the ſame membrane that covers the inſide of the mouth. The real uſe of this canal does not ſeem to have been hitherto ſatisfactorily aſcertained; but ſound would ſeem to be conveyed through it to the membrana tympani, deaf perſons being obſerved to liſten attentively with their mouths open. Oppoſite to this is a minute paſſage, which leads to the ſinuoſities of the maſtoid proceſs; and the two other openings, which are in the internal proceſs of the os petroſum, are the feneſtra ovalis, and feneſtra rotunda, both of which are covered by a very fine membrane.

There are three diſtinct bones in the cavity of the tympanum; and theſe are the malleus, incus, and ſtapes. Beſides theſe there is a fourth, which is the *os orbiculare*, conſidered by ſome anatomiſts as a proceſs of the ſtapes, which is neceſſarily broken off by the violence we are obliged to uſe in getting at theſe bones; but when accurately conſidered, it ſeems to be a diſtinct bone.

The *malleus* is ſuppoſed to reſemble a hammer, being larger at one extremity, which is its head, than it is at the other, which is its handle. The latter is attached to the membrana tympani, and the head of the bone is articulated with the incus.

The *incus*, as it is called from its ſhape, though it ſeems to have leſs reſemblance to an anvil than to one of the dentes molares with its roots widely ſeparated from each other, is diſtinguiſhed into its body and its legs. One of its legs is placed at the entry of the canal which leads to the maſtoid proceſs; and the other, which is ſomewhat longer, is articulated with the ſtapes, or rather with the os orbiculare, which is placed between them.

The third bone is very properly named *ſtapes*, being perfectly ſhaped like a ſtirrup. Its baſis is fixed into the feneſtra ovalis, and its upper part is articulated with the os orbiculare. What is called the *feneſtra rotunda*, though perhaps improperly, as it is more oval than round, is obſerved a little above the other, in an eminence formed by the os petroſum, and is cloſed by a continuation of the membrane that lines the inner ſurface of the tympanum. The ſtapes and malleus are each of them furniſhed with a little muſcle, the ſtapedeus and tenſor tympani. The firſt of theſe, which is the ſmalleſt in the body, ariſes from a little cavern in the poſterior and upper part of the cavity of the tympanum; and its tendon, after paſſing through a hole in the ſame cavern, is inſerted at the back part of the head of the ſtapes. This muſcle, by drawing the ſtapes obliquely upwards, aſſiſts in ſtretching the membrana tympani.

The tenſor tympani (t), or internus mallei as it is called

(s) Malpighi's deſcription of the papillæ, which has been copied by many anatomical writers, ſeems to have been taken chiefly from the tongues of ſheep.

(t) Some anatomiſts deſcribe three muſcles of the malleus; but only this one ſeems to deſerve the name of muſcle; what are called the *externus* and *obliquus mallei*, ſeeming to be ligaments rather than muſcles.

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by ſome writers, ariſes from the cartilaginous extremity of the Euſtachian tube, and is inſerted into the back part of the handle of the malleus, which it ſerves to pull inwards, and of courſe helps to ſtretch the membrana tympani.

The labyrinth is the only part of the ear which remains to be deſcribed. It is ſituated in the os petroſum, and is ſeparated from the tympanum by a partition which is every where bony, except at the two feneſtræ. It is compoſed of three parts; and theſe are the veſtibulum, the ſemicircular canals, and the cochlea.

The *veſtibulum* is an irregular cavity, much ſmaller than the tympanum, ſituated nearly in the centre of the os petroſum, between the tympanum, the cochlea, and the ſemicircular canals. It is open on the ſide of the tympanum by means of the feneſtra ovalis, and communicates with the upper portion of the cochlea by an oblong foramen, which is under the feneſtra ovalis, from which it is ſeparated only by a very thin partition.

Each of the three *ſemicircular canals* forms about half a circle of nearly a line in diameter, and running each in a different direction, they are diſtinguiſhed into *vertical*, *oblique*, and *horizontal*. Theſe three canals open by both their extremities into the veſtibulum: but the vertical and the oblique being united together at one of their extremities, there are only five orifices to be ſeen in the veſtibulum.

The *cochlea* is a canal which takes a ſpiral courſe, not unlike the ſhell of a ſnail. From its baſis to its apex it makes two turns and a half; and is divided into two canals by a very thin lamina or ſeptum, which is in part bony and in part membranous, in ſuch a manner that theſe two canals only communicate with each other at the point. One of them opens into the veſtibulum, and the other is covered by the membrane that cloſes the feneſtra rotunda. The bony lamella which ſeparates the two canals is exceedingly thin, and fills about two thirds of the diameter of the canal. The reſt of the ſeptum is compoſed of a moſt delicate membrane, which lines the whole inner ſurface of the cochlea, and ſeems to form this diviſion in the ſame manner as the two membranous bags of the pleura, by being applied to each other, form the mediaſtinum.

Every part of the labyrinth is furniſhed with a very delicate perioſteum, and filled with a watery fluid, ſecreted as in other cavities. This fluid tranſmits to the nerves the vibrations it receives from the membrane cloſing the feneſtra rotunda, and from the baſis of the ſtapes, where it reſts on the feneſtrum ovale. When this fluid is collected in too great a quantity, or is compreſſed by the ſtapes, it is ſuppoſed to eſcape through two minute canals or aqueducts, lately deſcribed by Dr. Cotunni, an ingenious phyſician at Naples. One of theſe aqueducts opens into the bottom of the veſtibulum, and the other into the cochlea, near the feneſtra rotunda. They both paſs through the os petroſum, and communicate with the cavity of the cranium where the fluid that paſſes through them is abſorbed; and they are lined by a membrane which is ſuppoſed to be a production of the dura mater.

The arteries of the external ear come from the temporal and other branches of the external carotid, and its veins paſs into the jugular. The internal ear receives branches of arteries from the baſilary and carotids, and its veins empty themſelves into the ſinuſes of the dura mater, and into the internal jugular.

The portio mollis of the ſeventh pair is diſtributed through the cochlea, the veſtibulum, and the ſemicircular canals; and the portio dura ſends off a branch to the tympanum, and other branches to the external ear and parts near it.

The *ſenſe of hearing*, in producing which all the parts we have deſcribed aſſiſt, is occaſioned by a certain modulation of the air collected by the funnel-like ſhape of the external ear, and conveyed through the meatus auditorius to the membrana tympani. That ſound is propagated by means of the air, is very eaſily proved by ringing a bell under the receiver of an air-pump; the ſound it affords being found to diminiſh gradually as the air becomes exhauſted, till at length it ceaſes to be heard at all. Sound moves through the air with infinite velocity; but the degree of its motion ſeems to depend on the ſtate of the air, as it conſtantly moves faſter in a denſe and dry, than it does in a moiſt and rarefied air. See the Syſtem of ACOUSTICS, Chap. II.

That the air vibrating on the membrana tympani communicates its vibration to the different parts of the labyrinth, and by means of the fluid contained in this cavity affects the auditory nerve ſo as to produce ſound, ſeems to be very probable; but the ſituation, the minuteneſs, and the variety of the parts which compoſe the ear, do not permit much to be advanced with certainty concerning their mode of action. Some of theſe parts ſeem to conſtitute the immediate organ of hearing, and theſe are all the parts of the veſtibulum: but there are others which ſeem intended for the perfection of this ſenſe, without being abſolutely eſſential to it. It has happened, for inſtance, that the membrana tympani, and the little bones of the ear, have been deſtroyed by diſeaſe, without depriving the patient of the ſenſe of hearing (U). Sound is more or leſs loud in proportion to the ſtrength of the vibration; and the variety of ſounds ſeems to depend on the difference of this vibration; for the more quick and frequent it is, the more acute will be the ſound, and *vice verſa*.

Before we conclude this article, it will be right to explain certain phenomena, which will be found to have a relation to the organ of hearing. Every body has, in conſequence of particular ſounds, occaſionally felt that diſagreeable ſenſation which is uſually called *ſetting the teeth on edge*: and the cauſe of this ſenſation may be traced to the communication which the portio dura of the auditory nerve has with the branches of the fifth pair that are diſtributed to the teeth, being probably occaſioned by the violent tremor produced in the membrana tympani by theſe very acute ſounds. Upon the ſame principle we may explain the ſtrong idea of ſound which a perſon has who holds a vibrating ſtring between his teeth. The humming which is ſometimes perceived in the ear, without any exterior cauſe, may be occaſioned either by an increaſed action of the arteries in the ears, or by convulſive contractions of the muſcles of the malleus and ſtapes, affecting the auditory nerve in ſuch a manner as to produce the idea of ſound. An ingenious philoſophical writer has lately diſcovered, that there are ſounds liable to be excited in the ear by irritation, and without any aſſiſtance from the vibrations of the air.

SECT. V. OF VISION.

THE eyes, which conſtitute the organ of viſion, are ſituated in two bony cavities named *orbits*, where they are ſurrounded by ſeveral parts, which are either intended to protect them from external injury, or to aſſiſt in their motion. The globe of the eye is immediately covered by two eye-lids or palpebræ, which are compoſed of muſcular fibres covered by the common integuments, and lined by a very fine and ſmooth membrane, which is from thence extended over part of the globe of the eye, and is called *tunica conjunctiva*. Each eye-lid is cartilaginous at its edge; and this border, which is called *tarſus*, is furniſhed with a row of hairs named *cilia* or *eye-laſhes*.

The cilia ſerve to protect the eye from inſects and minute bodies floating in the air, and likewiſe to moderate the action of the rays of light in their paſſage to the retina. At the roots of theſe hairs there are ſebaceous follicles, firſt noticed by Meibomius, which diſcharge a glutinous liniment. Sometimes the fluid they ſecrete has too much viſcidity, and the eye-lids become glued to each other.

The upper border of the orbit is covered by the eye-brows or ſupercilia, which by means of their two muſcles are capable of being brought towards each other, or of being carried upwards. They have been conſidered as ſerving to protect the eyes, but they are probably intended more for ornament than utility (X). The orbits, in which the eyes are placed, are furniſhed with a good deal of fat, which affords a ſoft bed on which the eye performs its ſeveral motions. The inner angle of each orbit, or that part of it which is near the noſe, is called *canthus major*, or the *great angle*; and the outer angle, which is on the oppoſite ſide of the eye, is the *canthus minor*, or *little angle*.

The little reddiſh body which we obſerve in the great angle of the eye-lids, and which is called *caruncula lachrymalis*, is ſuppoſed to be of a glandular ſtructure, and, like the follicles of the eye-lids, to ſecrete an oily humour. But its ſtructure and uſe do not ſeem to have been hitherto accurately determined. The ſurface of the eye is conſtantly moiſtened by a very fine limpid fluid called the *tears*, which is chiefly, and perhaps wholly, derived from a large gland of the conglomerate kind, ſituated in a ſmall depreſſion of the os frontis near the outer angle of the eye. Its excretory ducts pierce the tunica conjunctiva juſt above the cartilaginous borders of the upper eye-lids. When the tears were ſuppoſed to be ſecreted by the caruncule, this gland was called *glandula innominata*; but now that its ſtructure and uſes are aſcertained, it very properly has the name of *glandula lachrymalis*. The tears poured out by the ducts of this gland are, in a natural and healthy ſtate, inceſſantly ſpread over the ſurface of the eye, to keep it clear and tranſparent, by means of the eye-lids, and as conſtantly paſs out at the oppoſite corner of the eye or inner angle, through two minute orifices, the puncta lachrymalia (Y); being determined into theſe little openings by a reduplication of the tunica conjunctiva, ſhaped like a creſcent, the two points of which anſwer to the puncta. This reduplication is named *membrana*, or *valvula ſemilunaris*. Each of theſe

(U) This obſervation has led to a ſuppoſition, that a perforation of this membrane may in ſome caſes of deafneſs be uſeful; and Mr. Cheſelden relates, that, ſome years ago, a malefactor was pardoned on condition that he ſhould ſubmit to this operation; but the public clamour raiſed againſt it was ſo great, that it was thought right not to perform it.

(X) It is obſervable, that the eye-brows are peculiar to the human ſpecies.

(Y) It ſometimes happens, that this very pellucid fluid, which moiſtens the eye, being poured out through the excretory ducts of the lachrymal gland faſter than it can be carried off through the puncta, trickles down the cheek, and is then ſtrictly and properly called *tear*.

puncta

Organs of Sense. See System of Anatomy. Part 7. Sect. 5.

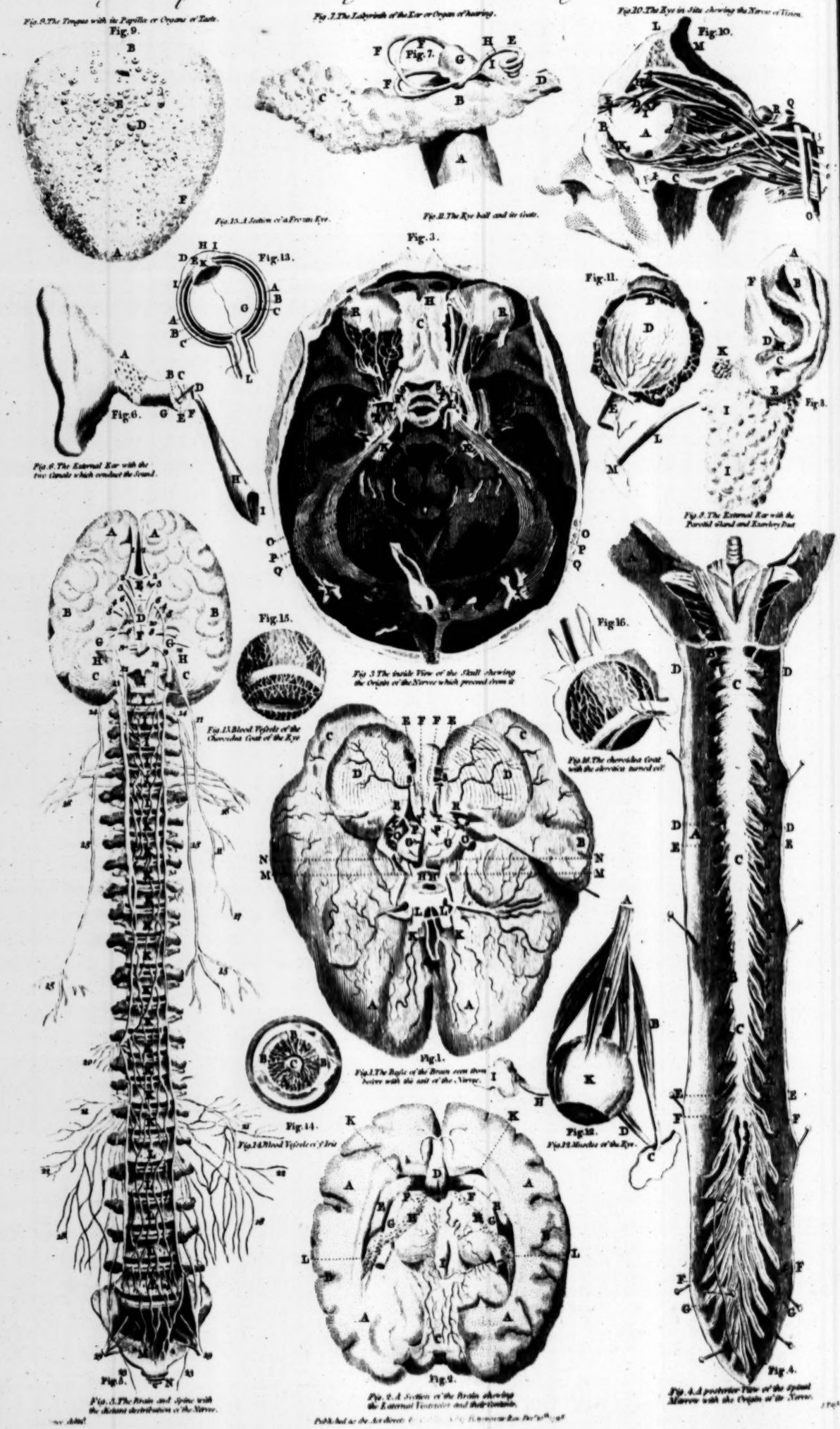
Fig. 9. The Tongue with its Papillæ or Organs of Taste.
Fig. 7. The Labyrinth of the Ear or Organ of hearing.
Fig. 10. The Eye in Situ shewing the Nerves of Vision.
Fig. 13. A Section of a Frozen Eye.
Fig. 11. The Eye ball and its Coats.
Fig. 6. The External Ear with the two Canals which conduct the Sound.
Fig. 3. The inside View of the Skull shewing the Origin of the Nerves which proceed from it.
Fig. 8. The External Ear with the Parotid Gland and Excretory Duct.
Fig. 15. Blood Vessels of the Choroidea Coat of the Eye.
Fig. 16. The choroidea Coat with the sclerotica turned off.
Fig. 1. The Basis of the Brain seen from before with the exit of the Nerves.
Fig. 14. Blood Vessels of Iris.
Fig. 12. Muscles of the Eye.
Fig. 5. The Brain and Spine with the distant distribution of the Nerves.
Fig. 2. A Section of the Brain shewing the Lateral Ventricles and their Contents.
Fig. 4. A posterior View of the Spinal Marrow with the Origin of its Nerves.

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punctа is the beginning of a ſmall excretory tube, through which the tears paſs into a little pouch or reſervoir, the ſaculus lachrymalis, which lies in an excavation formed partly by the naſal proceſs of the os maxillare ſuperius, and partly by the os unguis. The lower part of this ſac forms a duct called the *ductus ad nares*, which is continued through a bony channel, and opens into the noſe, through which the tears are occaſionally diſcharged (z).

The motions of the eye are performed by ſix muſcles; four of which are ſtraight and two oblique. The ſtraight muſcles are diſtinguiſhed by the names of *elevator*, *depreſſor*, *adductor*, and *abductor*, from their ſeveral uſes in elevating and depreſſing the eye, drawing it towards the noſe, or carrying it from the noſe towards the temple. All theſe four muſcles ariſe from the bottom of the orbit, and are inſerted by flat tendons into the globe of the eye. The oblique muſcles are intended for the more compound motions of the eye. The firſt of theſe muſcles, the obliquus ſuperior, does not, like the other four muſcles we have deſcribed, ariſe from the bottom of the orbit, but from the edge of the foramen that tranſmits the optic nerve, which ſeparates the origin of this muſcle from that of the others. From this beginning it paſſes in a ſtraight line towards a very ſmall cartilaginous ring, the ſituation of which is marked in the ſkeleton by a little hollow in the internal orbitar proceſs of the os frontis. The tendon of the muſcle, after paſſing through this ring, is inſerted into the upper part of the globe of the eye, which it ſerves to draw forwards, at the ſame time turning the pupil downwards.

The obliquus inferior ariſes from the edge of the orbit, under the opening of the ductus lachrymalis; and is inſerted ſomewhat poſteriorly into the outer ſide of the globe, ſerving to draw the eye forwards and turn the pupil upwards. When either of theſe two muſcles acts ſeparately, the eye is moved on its axis; but when they act together, it is compreſſed both above and below. The eye itſelf, which is now to be deſcribed, with its tunics, humours, and component parts, is nearly of a ſpherical figure. Of its tunics, the conjunctiva has been already deſcribed as a partial covering, reflected from the inner ſurface of the eye-lids over the anterior portion of the eye. What has been named *albuginea* cannot properly be conſidered as a coat of the eye, being in fact nothing more than the tendons of the ſtraight muſcles ſpread over ſome parts of the ſclerotica.

The immediate tunics of the eye, which are to be demonſtrated when its partial coverings, and all the other parts with which it is ſurrounded, are removed, are the ſclerotica, cornea, choroides, and retina.

The *ſclerotica*, which is the exterior coat, is every where white and opaque, and is joined at its anterior edge to another, which has more convexity than any other part of the globe, and being exceedingly tranſparent, is called *cornea* (A). Theſe two parts are perfectly different in their ſtructure; ſo that ſome anatomiſts ſuppoſe them to be as diſtinct from each other as the glaſs of a watch is from the caſe into which it is fixed. The ſclerotica is of a compact fibrous ſtructure; the cornea, on the other hand, is compoſed of a great number of laminæ united by cellular membrane. By macerating them in boiling water, they do not ſeparate from each other, as ſome writers have aſſerted; but the cornea ſoon ſoftens, and becomes of a glutinous conſiſtence.

The *choroides* is ſo called becauſe it is furniſhed with a great number of veſſels. It has likewiſe been named *uvea*, on account of its reſemblance to a grape. Many modern anatomical writers have conſidered it as a production of the pia mater. This was likewiſe the opinion of the ancients; but the ſtrength and thickneſs of the choroides, when compared with the delicate ſtructure of the pia mater, are ſufficient proofs of their being two diſtinct membranes.

The choroides adheres intimately to the ſclerotica round the edge of the cornea; and at the place of this union we may obſerve a little whitiſh areola, named *ligamentum ciliare*, though it is not of a ligamentous nature. It derives its name from the variety of its colours, and is perforated in its middle. This perforation, which is called the *pupil* or *ſight* of the eye, is cloſed in the fœtus by a very thin vaſcular membrane. This membrana pupillaris commonly diſappears about the ſeventh month.

On the under ſide of the iris we obſerve many minute fibres, called *ciliary proceſſes*, which paſs in radii or parallel lines from the circumference to the centre. The contraction and dilatation of the pupil are ſuppoſed to depend on the action of theſe proceſſes. Some have conſidered them as muſcular, but they are not of an irritable nature; others have ſuppoſed them to be filaments of nerves: but their real ſtructure has never yet been clearly aſcertained.

The poſterior ſurface of the iris, the ciliary proceſſes, and part of the tunica choroides, are covered by a black mucus for the purpoſes of accurate and diſtinct viſion; but the manner in which it is ſecreted, has not been determined.

Immediately under the tunica choroides we find the third and inner coat, called the *retina*, which ſeems to be merely an expanſion of the pulpy ſubſtance of the optic nerve, extending to the borders of the cryſtalline humour.

The greateſt part of the globe of the eye, within theſe ſeveral tunics, is filled by a very tranſparent and gelatinous humour of conſiderable conſiſtence, which, from its ſuppoſed reſemblance to fuſed glaſs, is called the *vitreous humour*. It is inveſted by a very fine and delicate membrane, called *tunica vitrea*, and ſometimes *arachnoides*.—It is ſuppoſed to be compoſed of two laminæ; one of which dips into its ſubſtance, and by dividing the humour into cells adds to its firmneſs. The fore-part of the vitreous humour is a little hollowed, to receive a very white and tranſparent ſubſtance of a firm texture, and of a lenticular and ſomewhat convex ſhape, named the *cryſtalline humour*. It is included in a capſula, which ſeems to be formed by a ſeparation of the two laminæ of the tunica vitrea.

The fore-part of the eye is filled by a very thin and tranſparent fluid, named the *aqueous humour*, which occupies all the ſpace between the cryſtalline and the prominent cornea.—That part of the choroides which is called the *iris*, and which comes forward to form the pupil, appears to be ſuſpended as it were in this humour, and has occaſioned this portion of the eye to be diſtinguiſhed into two parts. One of theſe, which is the little ſpace between the anterior ſurface of the cryſtalline and the iris, is called the *poſterior chamber*; and the other, which is the ſpace between the iris and the cornea, is called the *anterior chamber* of the eye. Both theſe ſpaces are completely filled with the aqueous humour (B).

The eye receives its arteries from the internal carotid, thro' the foramina optica; and its veins paſs through the foramina lacera, and empty themſelves into the lateral ſinuſes. Some of the ramifications of theſe veſſels appear on the inner ſurface of the iris, where they are ſeen to make very minute convolutions, which are ſufficiently remarkable to be diſtinguiſhed by the name of *circulus arterioſus*, though perhaps improperly, as they are chiefly branches of veins.

The optic nerve paſſes in at the poſterior part of the eye, in a conſiderable trunk, to be expanded for the purpoſes of viſion, of which it is now univerſally ſuppoſed to be the immediate ſeat. Beſides the optic, the eye receives branches from the third, fourth, fifth, and ſixth pair of nerves.

The humours of the eye, together with the cornea, are calculated to refract and converge the rays of light in ſuch a manner as to form at the bottom of the eye a diſtinct image of the object we look at; and the point where theſe rays meet is called the *focus* of the eye. On the retina, as in a *camera obſcura*, the object is painted in an inverted poſition; and it is only by habit that we are enabled to judge of its true ſituation, and likewiſe of its diſtance and magnitude. To a young gentleman who was born blind, and who was couched by Mr. Cheſelden, every object (as he expreſſed himſelf) ſeemed to touch his eyes as what he felt did his ſkin; and he thought no objects ſo agreeable as thoſe which were ſmooth and regular, although for ſome time he could form no judgment of their ſhape, or gueſs what it was in any of them that was pleaſing to him.

In order to paint objects diſtinctly on the retina, the cornea is required to have ſuch a degree of convexity, that the rays of light may be collected at a certain point, ſo as to terminate exactly on the retina.—If the cornea is too prominent, the rays, by diverging too ſoon, will be united before they reach the retina, as is the caſe with near-ſighted people or *myopes*; and on the contrary, if it is not ſufficiently convex, the rays will not be perfectly united when they reach the back-part of the eye; and this happens to long-ſighted people or *preſbi*, being found conſtantly to take place as we approach to old age, when the eye gradually flattens (C). Theſe defects are to be ſupplied by means of glaſſes. He who has too prominent an eye, will find his viſion improved by means of a concave glaſs; and upon the ſame principles, a convex glaſs will be found uſeful to a perſon whoſe eye is naturally too flat.

EXPLANATION OF PLATE XI. *On the Organs of Senſe.*

Figure I. the baſis of the brain, ſeen from before. A, A, Its anterior lobes. B, B, Its middle lobes. C, C, Poſterior lobes. D, D, Cerebellum. E, E, Corpora pyramidalia. F, F, Corpora olivaria. G, G, Pons varolii. H, H, Medulla oblongata,

(z) When the ductus ad nares becomes obſtructed in conſequence of diſeaſe, the tears are no longer able to paſs into the noſtrils; the ſaculus lachrymalis becomes diſtended; and inflammation, and ſometimes ulceration, taking place, conſtitute the diſeaſe called *fiſtula lachrymalis*.

(A) Some writers, who have given the name of *cornea* to all this outer coat, have named what is here and moſt commonly called *ſclerotica*, *cornea opaca*; and its anterior and tranſparent portion, *cornea lucida*.

(B) When the cryſtalline becomes opaque, ſo as to prevent the paſſage of the rays of light to the retina, it conſtitutes what is called a *cataract*; and the operation of couching conſiſts in removing the diſeaſed cryſtalline from its bed in the vitreous humour. In this operation the cornea is perforated, and the aqueous humour eſcapes out of the eye, but it is conſtantly renewed again in a very ſhort time. The manner however in which it is ſecreted, has not yet been determined.

(C) Upon this principle, they who in their youth are near-ſighted may expect to ſee better as they advance in life, as their eyes gradually become more flat.

with the origin of the nerves. I, Medulla ſpinalis, at its beginning. K, Olfactory nerves. L, L, Second pair, or the optic. M, M, Third pair, or the pathetic. N, N, Fourth pair. O, O, Fifth pair. P, P, Sixth pair. Q, Q, Seventh pair, or auditory, its portio dura, and mollis. R, R, Eighth pair, or par vagum. S, S, Ninth pair, or lingual. T, T, Vertebral arteries. U, Baſilary artery. V, V, Internal carotids. W, W, Circulus arterioſus Williſii.

Figure II. exhibits an horizontal ſection of the brain, the upper part of the two hemiſpheres being removed to ſhew the two lateral ventricles and their contents. A, A, Medulla of the brain. B, B, Its cortical ſubſtance. C, Part of the cerebellum. D, Corpus calloſum. E, E, Corpora ſtriata. F, F, Thalami nervorum opticorum. G, Fornix. H, H, Plexus choroides. I, Pineal gland. K, K, Anterior cornua of the ventricles. L, L, Poſterior ditto.

Figure III. exhibits the baſis of the cranium, lined by the dura mater, where is ſeen the beginning of many nerves, blood-veſſels, &c. A, A, Tentorium cerebelli. B, Longitudinal ſinus of the dura mater. C, Falciform proceſs. D, D, Lateral ſinuſes. E, E, Arteries of the dura mater. F, F, Carotid arteries. G, G, Opthalmic arteries. H, Criſta galli. I, I, Frontal ſinus. K, K, Fifth pair of nerves. L, L, Fourth pair. M, M, Third pair. N, N, Origin of the intercoſtal nerve. O, O, Seventh pair of nerves. P, P, Eighth pair. Q, Q, Ninth pair. R, Glandula lachrymalis. S, S, Optic nerve. T, T, Sixth pair of nerves. U, Foramen magnum occipitale.

Figure IV. repreſents a poſterior view of the ſpinal marrow. A, The dura matral coat of the ſpinal marrow. B, Ligamentum denticulatum. C, C, The pia matral coat. D, D, Its eight cervical nerves. E, E, Its twelve dorſal. F, F, Its five lumbar nerves. G, G, Its five ſacral nerves.

Figure V. repreſents the more diſtant diſtribution of the nerves, including the inferior part of the brain; the anterior part of the whole ſpine, including the medulla ſpinalis; with the origin and large portions of all the nerves. A, A, The anterior lobes of the cerebrum. B, B, The lateral lobes of the cerebrum. C, C, The two lobes of the cerebellum. D, Tuber annulare. E, The paſſage from the third ventricle to the infundibulum. F, The medulla oblongata, which ſends off the medulla ſpinalis through the ſpine. G, G, That part of the os occipitis which is placed above (H, H) the tranſverſe proceſſes of the firſt cervical vertebra. I, I, &c. The ſeven cervical vertebræ, with their intermediate cartilages. K, K, &c. The twelve dorſal vertebræ, with their intermediate cartilages. L, L, &c. The five lumbar vertebræ, with their intermediate cartilages. M, The os ſacrum. N, The os coccygis.

NERVES. 1 1, The firſt pair of nerves, named olfactory, which go to the noſe. 2 2, The ſecond pair, named optic, which go to form the tunica retina of the eye. 3 3, The third pair, named motores oculi, ſupply moſt of the muſcles of the eye-ball. 4 4, The fourth pair, named pathetic, which are wholly ſpent upon the muſculus trochlearis of the eye. 5 5, The fifth pair divides into three branches. The firſt, named opthalmic, goes to the orbit, ſupplies the lachrymal gland, and ſends branches out to the forehead and noſe. The ſecond, named ſuperior maxillary, ſupplies the teeth of the upper jaw, and ſome of the muſcles of the lips. The third, named inferior maxillary, is ſpent upon the muſcles and teeth of the lower jaw, tongue, and muſcles of the lips. 6 6, The ſixth pair, which, after ſending off the beginning of the intercoſtal or great ſympathetic, is ſpent upon the abductor oculi. 7 7, The ſeventh pair, named auditory, divides into two branches. The largeſt, named portio mollis, is ſpent upon the internal ear. The ſmalleſt, portio dura, joins to the fifth pair within the internal ear, by a reflected branch from the ſecond of the fifth; and within the tympanum, by a branch from the third of the fifth, named chorda tympani.

8 8, The eighth pair, named par vagum, which accompanies the intercoſtal, and is ſpent upon the tongue, larynx, pharynx, lungs, and abdominal viſcera. 9 9, The ninth pair, which are ſpent upon the tongue. 10 10, &c. The intercoſtal, or great ſympathetic, which is ſeen from the ſixth pair to the bottom of the pelvis on each ſide of the ſpine, and joining with all the nerves of the ſpine; in its progreſs ſupplying the heart, and, with the par vagum, the contents of the abdomen and pelvis. 11 11, The acceſſorius, which is ſpent upon the ſterno cleido-maſtoidæus and trapezius muſcles. 12 12, The firſt cervical nerves. 13 13, The ſecond cervical nerves; both ſpent upon the muſcles that lie on the neck, and teguments of the neck and head. 14 14, The third cervical nerves, which, after ſending off (15 15, &c.) the phrenic nerves to the diaphragm, ſupply the muſcles and teguments that lie on the ſide of the neck and top of the ſhoulder. 16 16, The brachial plexus, formed by the fourth, fifth, ſixth, ſeventh cervicals, and firſt dorſal nerves, which ſupply the muſcles and teguments of the ſuperior extremity. 17 17, The twelve dorſal, or proper intercoſtal nerves, which are ſpent upon the intercoſtal muſcles and ſome of the large muſcles which lie upon the thorax. 18 18, The five lumbar pairs of nerves, which ſupply the lumbar and abdominal muſcles, and ſome of the teguments and muſcles of the inferior extremity, making the anterior crural, and obturator nerves. 19 19, The ſacro-ſciatic, or poſterior crural nerve, formed by the two inferior lumbar, and three ſuperior of the os ſacrum. This large nerve ſupplies the greateſt part of the muſcles and teguments of the inferior extremity. 20 20, The ſtomachic plexus, formed by the eighth pair. 21 21, Branches of the ſolar or cœliac plexus, formed by the eighth pair and intercoſtals, which ſupply the ſtomach and chylopoietic viſcera. 22 22, Branches of the ſuperior and inferior meſenteric plexuſes, formed by the eighth pair and intercoſtals, which ſupply the chylopoietic viſcera, with part of the organs of urine and generation. 23 23, Nerves which accompany the ſpermatic cord. 24 24, The hypogaſtric plexus, which ſupplies the organs of urine and generation within the pelvis.

Figure VI. repreſents a view of the poſterior part of the external ear, meatus auditorius, tympanum, with its ſmall bones, and euſtachian tube of the right ſide. a, The back part of the meatus, with the ſmall ceruminous glands. b, The incus. c, Malleus. d, Stapes. e, Os orbicularis. f, The chorda tympani. g, Membrana tympani. h, The euſtachian tube. i, Its mouth from the fauces.

Figure VII. repreſents an enlarged view of the labyrinth of the ear, ſituated in the petrous portion of the temporal bone, as well as of the cavity of the tympanum, and meatus auditorius externus, &c. A, Meatus auditorius externus. B, Cavity of the tympanum. C, Cells of the maſtoid proceſs. D, Euſtachian tube. E, Cochlea. F F F, Three ſemicircular canals. G, The veſtibulum, into which the three ſemicircular canals terminate, as well as the ſuperior ſcala of the cochlea. H, Superior ſcala of the cochlea. I, Inferior ſcala of the cochlea.

Figure VIII. repreſents the parts of the external ear, with the parotid gland and its duct. a a, The helix. b, The antihelix. c, The antitragus. d, The tragus. e, The lobe of the ear. f, The cavitas innominata. g, The ſcapha. h, The concha. i i, The parotid gland. k, A lymphatic gland, which is often found before the tragus. l, The duct of the parotid gland. m, Its opening into the mouth.

Figure IX. repreſents a view of the tongue, with its papillæ, or terminations of the guſtatory nerves, which are the immediate organs of taſte. A, Apex of the tongue. B, Baſis of the tongue. C, Foramen cœcum, a common excretory duct to ſeveral mucous glands in the baſis of the tongue. D, The largeſt and moſt poſterior papillæ are called cupidatæ, and reſemble muſhrooms in their figure. E, Papillæ lenticulares, ſituated in the middle of the tongue, which appear to be perforated like the end of a thimble when magnified. F F F, Papillæ villoſæ, ſituated at the end and ſides of the tongue.

Figure X. repreſents the nerves and muſcles of the right eye, after part of the bones of the orbit have been cut away. A, The eye-ball. B, The lachrymal gland. C, Muſculus abductor oculi. D, Attollens. E, Levator palpebræ ſuperioris. F, Depreſſor oculi. G, Adductor. H, Obliquus ſuperior, with its pulley. I, Its inſertion into the ſclerotic coat. K, Part of the obliquus inferior. L, The anterior part of the os frontis cut. M, The criſta galli of the ethmoid bone. N, The poſterior part of the ſphenoid bone. O, Tranſverſe ſpinous proceſs of the ſphenoid bone. P, The carotid artery, denuded where it paſſes through the bones. Q, The carotid artery within the cranium. R, The ocular artery.

NERVES. a a, The optic nerve. b, The third pair. c, Its joining with a branch of the firſt branch of the fifth pair, to form (l,) the lenticular ganglion, which ſends off the ciliary nerves, (d). e e, The fourth pair. f, The trunk of the fifth pair. g, The firſt branch of the fifth pair, named ophthalmic. h, The frontal branch of it. i, Its ciliary branches, along with which the naſal twig is ſent to the noſe. k, Its branch to the lachrymal gland. l, The lenticular ganglion. m, The ſecond branch of the fifth pair, named ſuperior maxillary. n, The third branch of the fifth pair, named inferior maxillary. o, The ſixth pair of nerves, which ſends off. p, The beginning of the great ſympathetic. q, The remainder of the ſixth pair, ſpent on (c,) the abductor oculi.

Figure XI. ſhews the figure of the eye-ball, and its ſeveral coats. A, Tunica ſclerotica externally. B, Cornea tranſparens. C, Tunica choroidea. D, Tunica retina internally. E, Optic nerve.

Figure XII. ſhews the eye-ball with its muſcles. a, The optic nerve. b, Muſculus trochlearis. c, Part of the os frontis, to which the trochlea or pulley is fixed, through which d, The tendons of the trochlearis paſſes. e, Attollens oculi. f, Adductor oculi. g, Abductor oculi. h, Obliquus inferior. i, Part of the ſuperior maxillary bone to which it is fixed. k, The eye-ball.

Figure XIII. exhibits a ſection of a frozen eye into two equal parts. A, Tunica ſclerotica. B B, Tunica choroides, its two laminæ. C, Retina. D, Cornea. E, Aqueous humour, its two chambers are ſeparated by the iris, into anterior and poſterior chambers. F, Cryſtalline humour. G, Vitreous humour. H, Ciliary proceſſes. I, The iris. K, The pupil, a hole in the center of the iris.

Figure XIV. ſhews the iris after the cornea is removed, where it is dividing the ball of the eye into two parts. A A, The vaſa vorticoſa which are ſeen in the iris. B B, Its connection with the tunica ſclerotica. C, The pupil.

ANATOMY *of plants* may be conſidered as a branch of Comparative Anatomy. The parts of plants which come under anatomical conſideration are, the root, wood, bark, pith, fruit, leaves, flowers, &c. See the Syſtem of BOTANY, Sect. VIII. and the Organization of Timber, under the Article MICROSCOPIC OBJECTS, and Plate III.

The anatomy of vegetables is chiefly owing to the induſtry of Malpighi and Dr. Grew, though conſiderably promoted alſo by Ruyſch, who by a peculiar method of injection has produced divers ſkeletons or ſyſtems of veſſels of fruit, leaves, and the like. Something of the ſame kind has alſo been done by Thummigius. Some pretend to make F. Fabri the father of this ſcience; and alledge that Malpighi took many of his diſcoveries from him. Dr. Highmore in his book of Generation, Dr. Sharrock on the propagation of plants, and Dr. Hook in his *Micrographia*, have alſo given ſome obſervations tending this way, though only collaterally.

ANCESTORS, *progenitors*, are thoſe from whom a perſon is deſcended, excluſive of his immediate parents. Moſt nations have paid honours to their anceſtors. The Ruſſians have ſtill their anniverſary feaſts in memory of them, which they call *roditoli ſabot*, q. d. *kinſfolk's ſabbath*, wherein they make formal viſits to the dead in their graves, and carry them proviſions, and preſents of divers other kinds. They interrogate them, with loud lamentable cries, What they are doing? how they ſpend their time? what it is they want? and the like.

The Quojas, a people of Africa, offer ſacrifices of rice and wine to their anceſtors, before ever they undertake any conſiderable action. The anniverſaries of their deaths are always kept by their families with great ſolemnity. The king invokes the ſoul of his father and mother to make trade flouriſh, and the chace ſucceed. The Chineſe ſeem to have diſtinguiſhed themſelves above all other nations in the veneration they bear their anceſtors. By the laws of Confucius, part of the duty which children owe their parents, conſiſts in worſhipping them when dead. This ſervice, which makes a conſiderable part of the natural religion of the Chineſe, is ſaid to have been inſtituted by the Emperor Kan, the fifth in order from the foundation of that ancient empire. The Chineſe have both a ſolemn and ordinary worſhip which they pay their anceſtors. The former is held regularly twice a year, viz. in ſpring and autumn, with much pomp. A perſon who was preſent at it, gives the following account of the ceremonies on that occaſion.

The ſacrifices were made in a chapel well adorned, where there were ſix altars furniſhed with cenſers, tapers, and flowers. There were three miniſters, and behind them two young acolites: he that officiated was an aged man, and a new Chriſtian. The three former went with a profound ſilence, and frequent genuflexions towards the five altars, pouring out wine: afterwards they drew near to the ſixth, and when they came to the foot of the altar, half bowed down, they ſaid their prayers with a low voice. That being finiſhed, the three miniſters went to the altar, the prieſt took up a veſſel full of wine, and drank; then he lifted up the head of a deer or goat; after which taking fire from the altar, they lighted a bit of paper, and the miniſter of the ceremonies turning towards the people, ſaid with a high voice, that he gave them thanks in the name of their anceſtors, for having ſo well honoured them; and in recompence he promiſed them, on their part, a plentiful harveſt, a fruitful iſſue, good health and long life, and all thoſe advantages that are moſt pleaſing to men.

ANCHILOPS, in ſurgery, denotes an abſceſs, or collection of matter between the great angle of the eye and the noſe. The ſame abſceſs, when broken, is no longer denominated anchilops, but *ægilops*. Strictly ſpeaking, the anchilops is only a tumor not yet ulcerated; nor is the tumor always within the ſaccus lachrymalis, but ſometimes only near it. If the anchilops be ſuffered to remain too long, or be unſkilfully managed, it degenerates, the ſtagnating humours corrupt, and an ulcer is produced. It makes a ſpecies, or rather a degree, of the *fiſtula lachrymalis*. Care muſt be had to examine ſtrictly, whether the abſceſs opens into the lachrymal bag, or whether it be only ſuperficial, between the ſkin and the orbicular muſcle. In the latter caſe, there is no occaſion to fear its changing to a fiſtula, if the matter be not lodged between the bag and the muſcle.

When the tumor is broke, and the tears flow involuntarily, while the os lachrymale is not carious, it is an *ægilops*; but when the ulcer is of a long ſtanding, deep, fetid, and the os lachrymale becomes carious, it is a *fiſtula*. The anchilops is ſometimes attended with an inflammation, and then reſembles a *phlegmon*; but when not inflamed, it approaches nearer to thoſe tumors called *atheromata*, *ſteatomata*, and *meliceridæ*. Its cure is by reſtriction and exciſion; tying it at the root on the glandula lachrymalis; and when ready, cutting it off.

ANCHORED, or ANCHERED, in Heraldry. A croſs *anchored*, or *ancree*, is a form of croſs, ſo called, becauſe the four extremities reſemble the fluke of an anchor. This croſs is ſo like the *croſs moline*, that the reſemblance has occaſioned many miſtakes in heraldry.

ANCHOVY. A ſpecies of the genus Clupea, in the ſyſtem of Ichthyology. For a deſcription of the genus ſee CLUPEA. The anchovy is caught in the months of May, June, and July, on the coaſts of Catalonia, Provence, &c. at which ſeaſon it conſtantly repairs up the ſtreights of Gibraltar, into the Mediterranean. Collins ſays, they are alſo found in plenty on the weſtern coaſts of England and Wales. The fiſhing for them is chiefly in the night-time; when a light being put on the ſtern of their little fiſhing-veſſels, the anchovies flock round and are caught in the nets. When the fiſhery is over, they cut off the heads, take out their gall and guts, and then lay them in barrels and ſalt them. Anchovies ſhould be choſen ſmall, freſh pickled, white on the outſide and red within. They muſt have a round back; for thoſe which were flat or large, are often nothing but ſardines. Beſides theſe qualities, the pickle, on opening the pots or barrels, muſt be of a good taſte, and not have loſt its flavour.

ANCHYLOSIS, in ſurgery, is when a junCture or articulation becomes immoveable. Anchyloſis bears an affinity to contractures, ſhrinkings, or witherings of the parts. This ſymptom ſometimes happens in fractures near the joints, where the nutritious juice oozes into the cavities thereof. This diſeaſe, when once formed, is incurable; but while yet freſh, is ſometimes removed by motion, friction, and the uſe of diſcutient medicines.

ANCIENT, in its uſual ſenſe, denotes a thing which exiſted in times long ago; in which ſenſe *ancient* ſtands oppoſite to *modern*. *Ancient* differs from *antique* as the genus from its ſpecies. We ſay *ancient* nations, *ancient* architecture, ſculpture, philoſophy, &c. *ancient* manner, ceremonies, poets, phyſicians, and the like. See ANTIQUITIES.

ANCIENT *demeſne*, or *domain*, in law, is a tenure whereby all manors belonging to the crown in William the Conqueror's and St. Edward's time were held. The number, names, &c. hereof, were entered by the Conqueror, in a book called Domeſday Book, yet remaining in the Exchequer; ſo that ſuch lands as by that book appeared to have belonged to the crown at that time are called ancient demeſne. The tenants in ancient demeſne are of two ſorts: one who hold their lands frankly by charter; the other by copy of court-roll, or by the verge, at the will of the lord, according to the cuſtom of the manor. The advantages of this tenure are, 1. That tenants holding by charter cannot be rightfully impleaded out of their manor; and, when they are, they may abate the writ by pleading the tenure. 2. They are free from toll for all things relating to their livelihood, and huſbandry; nor can be impanelled on any inqueſt.

Theſe tenants held originally by plowing the king's land, plaſhing his hedges, and the like ſervice, for the maintenance of his houſhold; and it was on this account that ſuch liberties were given them, for which they may have writs of *monſtraverunt* to ſuch as take the duties of toll, &c. No lands are to be accounted ancient demeſne, but ſuch as are held in ſoccage. Whether land be ancient demeſne or not, ſhall be tried by the Book of Domeſday. See that Article.

ANCLE, *luxated*, in ſurgery.—The ancle is ſubject to be luxated, either in running, in jumping, or even in walking; and that in all four directions, either inward or outward, backward or forward. When the ancle is luxated inward, the bottom of the foot is turned outward; and, on the contrary, when it is luxated outward, the bottom of the foot is turned inward, which latter caſe is indeed much more frequent than the others. If it is diſlocated forward, the heel becomes ſhorter, and the foot longer than it ſhould be; and if backward, the contrary ſigns to theſe will appear. The ancle, however, can ſcarce poſſibly be luxated outwards, unleſs the fibula be ſeparated from the tibia, or elſe quite broken, which may happen to the external ancle; nor is it uncommon for a luxation of the ancle to be attended with very grievous ſymptoms, eſpecially when occaſioned by ſome great external violence. Nor can it indeed well happen otherwiſe in this caſe, ſince the diſtortion of the foot muſt neceſſarily overſtrain the adjacent tendons, ligaments, and nerves, and thence excite very violent pains, and other bad ſymptoms: or the veins and arteries may alſo be very eaſily lacerated, which will occaſion a large extravaſation of blood about the whole foot, and too often give riſe to a gangrene.

It is however neceſſary to obſerve, that the ancle is not always luxated, after it has been violently ſtrained by leaping, or turning the foot on one ſide; for it ſometimes happens that the ancle is not diſlocated on theſe occaſions, but only the parts violently contuſed and ſtrained. The ancle, when truly luxated, is more or leſs difficult to be reduced, according to the violence of the force by which the accident was occaſioned. The moſt ready way, however, of reducing a luxation of the ancle, is to place the patient upon a bed, ſeat, or table, letting the leg and foot be extended in oppoſite directions by two aſſiſtants, while the ſurgeon replaces the bones with his hands and fingers in their proper ſituation. When the foot is by this means reſtored to its proper poſition, it is to be well bathed with oxycrate and ſalt, and then carefully bound up with a proper bandage. The patient muſt be enjoined to keep his bed for a conſiderable time, till the bad ſymptoms are gone, and the ancle has recovered its ſtrength ſo far as to bear the weight of the body, without any uneaſineſs or danger.

We have an account of the *menſes* regularly evacuated at an ulcer of the *ancle*, in the Medic. Eſſ. Edinb. vol. iii. art. 9.

ANCYLOBLEPHARON, (from αγκυλος *bent*, and βλεφαρον *an eye-lid*); a diſeaſe of the eye, which cloſes the eye-lids. Sometimes the eye-lids grow together, and alſo to the tunica albuginea of the eye, from careleſſneſs when there is an ulcer in theſe parts. Both theſe caſes are called *ancyloblepharon* by the Greeks. This diſorder muſt be diſtinguiſhed from that coalition of the eye-lids which happens from viſcid matter gluing them together. If the coheſion is on the cornea, the ſight is inevitably loſt. This hath ſometimes happened in the ſmall pox. If there is only a growing together of the eye-lids, they may be ſeparated with the ſpecillum, and pledgets kept between them to prevent their re-union. If the eye-lids adhere to the eye, they are to be ſeparated by a fine-edged knife; and their re-union is to be prevented by a proper uſe of injections, and lint placed between them, after dipping it in ſome proper liniment.

ANCYLOGLOSSUM, (from αγκυλος *crooked*, and γλωσσα *the tongue*); a contraction of the ligaments of the tongue. Some have this imperfection from their birth, others from ſome diſeaſe. In the firſt caſe, the membrane which ſupports the tongue is too ſhort or too hard: in the latter, an ulcer under the tongue, healing and forming a cicatrix, is ſometimes the cauſe: theſe ſpeak with ſome difficulty. The ancyloglotti by nature are late before they ſpeak; but when they begin, they ſoon ſpeak properly. Theſe we call *tongue-tied*. Mauricean ſays, that in this caſe it is a ſmall membranous production, which extends from the frænulum to the tip of the tongue, that hinders the child from ſucking, &c. He juſtly condemns the cruel practice among nurſes, of tearing this membrane with their nails; for thus ulcers are ſometimes formed, which are of difficult cure: he adviſes to ſnip it with ſciſſars in two or three places, taking care not to extend the points of the ſciſſars ſo far as the frænulum. The inſtances rarely occur which require any kind of aſſiſtance; for if the child can thruſt the tip of its tongue to the outer edge of its lip, this diſeaſe does not exiſt; and if the tongue is not greatly reſtrained, the frænulum will ſtretch by the child's ſucking and crying. For further directions, ſee the Syſtem of MIDWIFERY, Part IX. Sect. III.

ANDREW, *Knights of St. Andrew*, or the thiſtle. For the riſe, inſtitution, origin, &c. of this Order, ſee the Article KNIGHTS OF THE THISTLE. For the regalia, &c. ſee the Syſtem of HERALDRY, Plate VI.

ANDROGYNES, in natural hiſtory, a name given to thoſe living creatures which, by a monſtrous formation of their generative parts, ſeem (for it is only ſeeming) to unite in themſelves the two ſexes, that of the male and of the female. This *lusus naturæ*, this defect, or perhaps redundancy, in the animal ſtructure, is deſcribed by medical authors in the following manner. "There is a depravation in the ſtructure of the parts intended by nature for propagation, when, beſides thoſe concealed parts that are found neceſſary for the diſcharge of prolific functions, the *pudenda* of the other ſex likewiſe appear. This monſtrous production of nature is diverſified in four different ways; of which three appear in males and one in females. In men, the female pudendum, cloathed with hair, ſometimes appears contiguous to the perinæum; at other times, in the middle of the ſcrotum; at other times, which conſtitutes the third diverſity, through that part itſelf which in the midſt of the ſcrotum exhibits the form of a pudendum, urine is emitted. Near that part which is the teſt of puberty, and above the pudendum, even in females, the maſculine genitals appear in ſome, conſpicuous in all their three forms, one reſembling the *virectum* or yard, the other the two teſticles: but for the moſt part it happens, that, of the two inſtruments of generation, one is feeble and inert; and it is extremely rare that both are found ſufficiently valid and proper for feats of love; nay, even in a great many, both theſe members are deficient and impotent, ſo that they can perform the office neither of a male nor of a female.

"With reſpect to them, it appears, from a collation of all the circumſtances which have been obſerved by naturaliſts worthy of credit, that there is no ſuch thing as a perfect *androgyne*, or real hermaphrodite; that is to ſay, a living creature which, by its unnatural, or rather preternatural ſtructure, poſſeſſes the genuine powers of both ſexes, in ſuch a manner as to be qualified for performing the functions of either with ſucceſs: the irregularity of their fabrication almoſt always conſiſts in ſomething ſuperfluous added to one of the two ſexes, which gives it the appearance of the other, without beſtowing the real and characteriſtical diſtinction; and every *hermaphrodite* is almoſt always a very woman. Since this monſtrous exhibition of nature is not ſuch as to abrogate the rights or deſtroy the character of humanity amongſt human beings, this involuntary misfortune implies no right to deprive thoſe upon whom it is inflicted by nature, of the privileges natural to every citizen; and as this deficiency is no more infectious than any other corporeal mutilation, it is not eaſy to ſee why marriage ſhould be prohibited to one of theſe unhappy beings, merely on account of its equivocal appearance, which acts in the character of its prevailing ſex. If ſuch a creature, by the defect of its conſtruction, ſhould be barren; this does not infer any right of diſſolving the marriage which it may have contracted, more than the ſame ſterility proceeding from any cauſe whether known or unknown, if his or her conſort ſhould not on that account require a divorce. It is only the licentious abuſe either of one or the other ſex which can be ſubjected to the animadverſion of the police." See HERMAPHRODITE.

Such are the ſentiments of the authors of the French Encyclopedie. After all, we cannot forbear to add, that from ſuch heterogeneous matches nature ſeems to recoil with innate and inextinguiſhable horror. Nor are any of theſe invincible averſions implanted in our frame without a final cauſe worthy of its Author. We would aſk theſe free-thinking gentlemen, in caſes where the ſexes are ſo unnaturally confounded, how the police can, by its moſt ſevere and rigorous animadverſions, either detect or prevent thoſe licentious abuſes againſt which they remonſtrate? Since, therefore, an evil ſo baneful to human ſociety could no otherwiſe be prevented than by the ſanction of Nature againſt ſuch horrible conjunctions, the inſtinctive antipathy which they inſpire was highly worthy of her wiſdom and purity.

ANDROGYNES, in ancient mythology, creatures of whom, according to the fable, each individual poſſeſſed the powers and characters of both ſexes, having two heads, four arms, and two feet. The word itſelf is compounded of two Greek radical words; ανδρ, in genitive ανδρος, a *male*; and γυν, a *female*. Many of the rabbinical writers pretend, that Adam was created double, one body being male, the other female, which in their origin not being eſſentially joined, God afterwards did nothing but ſeparate them.

The idea of theſe *androgynes* might be borrowed from a paſſage in Moſes, where that hiſtorian of the birth and infancy of nature deſcribes Adam as calling Eve *bone of his bone* and *fleſh of his fleſh*. However this may be, the fable of Plato has been uſed with great ingenuity by a French poet, who has been rendered almoſt as conſpicuous by his misfortunes as his verſes. With the ancient philoſopher, he attributes the propenſity which attracts one of the ſexes towards the other, to the natural ardour which each half of the *androgynes* feels for re-union; and their inconſtancy, to the difficulty which each of the ſeparated parts encounters in its efforts to recover its proper and original half. If a woman appears to us amiable, we inſtantly imagine her to be that moiety with whom we ſhould only have conſtituted one whole, had it not been for the inſolence of our original double-ſexed progenitor:

The heart, with fond credulity impreſs'd,
Tells us the half is found, and hopes for reſt;
But 'tis our curſe, that ſad experience ſhows,
We neither find our half, nor gain repoſe.

ANDROGYNOUS, in zoology, an appellation given to animals which have both the male and female ſex in the ſame individual.—In botany, the term is applied to ſuch plants as bear both male and female flowers on the ſame root.

ANDROIDES, in mechanics, a human figure, which, by certain ſprings or other movements, is capable of performing ſome of the natural motions of a living man. The motions of the human body are more complicated, and conſequently more difficult to be imitated, than thoſe of any other creature; whence the conſtruction of an *androides*, in ſuch a manner as to imitate any of theſe actions with tolerable exactneſs, is juſtly ſuppoſed to indicate a greater ſkill in mechanics than any other piece of workmanſhip whatever.

A very remarkable figure of this kind appeared in Paris, in the year 1738. It repreſented a flute-player, and was capable of performing many different pieces of muſic on the German flute; which, conſidering the difficulty of blowing that inſtrument, the different contractions of the lips neceſſary to produce the diſtinctions between the high and low notes, and the complicated motions of the fingers, muſt appear truly wonderful. This machine was the invention of M. Vaucanſon, member of the Royal Academy of Sciences; and a particular deſcription of it was publiſhed in the Memoirs of the Academy for that year.

The figure itſelf was about five feet and an half in height, ſituated at the end of an artificial rock, and placed upon a ſquare pedeſtal four feet and an half high and three and an half broad. The air entered the body by three pipes ſeparated one from the other. It was conveyed to them by nine pair of bellows, three of which were placed above and ſix below. Theſe were made to expand and contract regularly in ſucceſſion, by means of an axis of ſteel turned round by ſome clock-work. On this axis were different protuberances at proper diſtances, to which were fixed cords thrown over pullies, and terminating in the upper boards of the bellows, ſo that, as the axis turned, theſe boards were alternately raiſed and let down. A contrivance was alſo uſed to prevent the diſagreeable hiſſing fluttering noiſe uſually attending the motion of bellows. This was by making the cord, by which the bellows was moved, preſs, in its deſcent, upon one end of a ſmaller lever, the other end

end of which afcending forced open the ſmall leathern valve that admitted the air, and kept it ſo, till, the cord being relaxed by the deſcent of the upper board, the lever fell, and the air was forced out. Thus the bellows performed their functions conſtantly without the leaſt hiſſing or other noiſe by which it could be judged in what manner the air was conveyed to the machine. The upper boards of three of the pair of bellows were preſſed down by a weight of four pounds, that of three others by a weight of two pounds, and thoſe of the three remaining ones by nothing but their own weight.

The three tubes, by which the air entered, terminated in three ſmall reſervoirs in the trunk of the figure. There they united, and, aſcending towards the throat, formed the cavity of the mouth, which terminated in two ſmall lips adapted in ſome meaſure to perform their proper functions. Within this cavity alſo was a ſmall moveable tongue; which by its play, at proper periods, admitted the air, or intercepted its paſſage to the flute.

The fingers, lips, and tongue, received their proper directions by means of a ſteel cylinder turned by clock-work. It was divided into 15 equal parts, which by means of pegs, preſſing upon the ends of 15 different levers, cauſed the other extremities to aſcend. Seven of theſe levers directed the fingers, having wires and chains affixed to their aſcending extremities, which being attached to the fingers, cauſed them to aſcend in proportion as the other extremity was preſſed down by the motion of the cylinder, and *vice verſa*. Thus the aſcent or deſcent of one end of a lever produced a ſimilar aſcent or deſcent in the correſponding finger, by which one of the holes of the flute was occaſionally opened or ſtopped, as by a living performer. Three of the levers ſerved to regulate the ingreſs of the air, being contrived ſo as to open and ſhut, by means of valves, the three reſervoirs of air above mentioned, ſo that more or leſs ſtrength might be given, and a higher or lower note produced as occaſion required. The lips were, by a ſimilar mechaniſm, directed by four levers, one of which opened them, to give the air a freer paſſage; the other contracted them; the third drew them backward; and the fourth puſhed them forward. The lips were projected upon that part of the flute which receives the air; and, by the different motions already mentioned, modified the tone in a proper manner.—The remaining lever was employed in the direction of the tongue, which it eaſily moved ſo as to ſhut or open the mouth of the flute.

Thus we ſee how all the motions neceſſary for a German-flute player could be performed by this machine; but a conſiderable difficulty ſtill remains, namely, how to regulate theſe motions properly, and make each of them follow in juſt ſucceſſion. This, however, was effected by the following ſimple method. The extremity of the axis of the cylinder was terminated on the right ſide by an endleſs ſcrew, conſiſting of twelve threads, each placed at the diſtance of a line and an half from the other. Above this ſcrew was fixed a piece of copper, and in it a ſteel pivot, which, falling in between the threads of the ſcrew, obliged the cylinder to follow the threads, and, inſtead of turning directly round, it was continually puſhed to one ſide. Hence, if a lever was moved, by a peg placed on the cylinder, in any one revolution, it could not be moved by the ſame peg in the ſucceeding revolution, becauſe the peg would be moved a line and an half beyond it by the lateral motion of the cylinder. Thus, by an artificial diſpoſition of theſe pegs in different parts of the cylinder, the ſtatue was made, by the ſucceſſive elevation of the proper levers, to exhibit all the different motions of a flute-player, to the admiration of every one who ſaw it.

The conſtruction of machines capable of imitating even the mechanical actions of the human body, ſhow exquiſite ſkill; but what ſhall we ſay of one capable, not only of imitating actions of this kind, but of acting as external circumſtances require, as though it were endowed with life and reaſon? This, nevertheleſs, has been done. M. de Kempelen, a gentlemen of Preſburg in Hungary, excited by the performances of M. de Vaucanſon, at firſt endeavoured to imitate them, and at laſt far excelled them. This gentleman conſtructed an Androides capable of playing at cheſs!—Every one who is in the leaſt acquainted with this game muſt know, that it is ſo far from being mechanically performed, as to require a greater exertion of the judgment and rational faculties than is ſufficient to accompliſh many matters of greater importance. An attempt, therefore, to make a wooden cheſs-player, muſt appear as ridiculous as to make a wooden preacher or counſellor of ſtate. That this machine really was made, however, the public have had ocular demonſtration. The inventor came over to England in 1783, where he remained above a year with his automaton.

It is a figure as large as life, in a Turkiſh dreſs, ſitting behind a table with doors, of three feet and a half in length, two in depth, and two and a half in height. The chair on which it ſits is fixed to the table, which runs on four wheels. The automaton leans its right arm on the table, and in its left hand holds a pipe: with this hand it plays after the pipe is removed. A cheſs-board of 18 inches is fixed before it. This table, or rather cupboard, contains wheels, levers, cylinders, and other pieces of mechaniſm; all which are publicly diſplayed. The veſtments of the automaton are then lifted over its head, and the body is ſeen full of ſimilar wheels and levers. There is a little door in its thigh, which is likewiſe opened; and with this, and the table alſo open, and the automaton uncovered, the whole is wheeled about the room. The doors are then ſhut, and the automaton is ready to play; and it always takes the firſt move. At every motion the wheels are heard; the image moves its head, and looks over every part of the cheſs-board. When it checks the queen, it ſhakes its head twice, and thrice in giving check to the king. It likewiſe ſhakes its head when a falſe move is made, replaces the piece, and makes its own move; by which means the adverſary loſes one.

M. de Kempelen remarks as the moſt ſurpriſing circumſtance attending his automaton, that it had been exhibited at Preſburg, Vienna, Paris, and London, to thouſands, many of whom were mathematicians and cheſs-players, and yet the ſecret by which he governed the motion of its arm was never diſcovered. He prided himſelf ſolely on the conſtruction of the mechanical powers by which the arm could perform ten or twelve moves. It then required to be wound up like a watch, after which it was capable of continuing the ſame number of motions.

The automaton could not play unleſs Mr. de Kempelen or his ſubſtitute was near it to direct its moves. A ſmall ſquare box, during the game, was frequently conſulted by the exhibitor; and herein conſiſted the ſecret, which he ſaid he could in a moment communicate. He who could beat Mr. de Kempelen was, of courſe, certain of conquering the automaton. It was made in 1769. His own account of it was: "C'eſt une bagatelle qui n'eſt pas ſans merite du cote du mechaniſme, mais les effets n'en paroiſſent ſi merveilleux que par la hardieſſe de l'idee, & par l'heureux choiz des moyens employes pour faire illuſion." The ſtrongeſt and beſt-armed loadſtone was allowed to be placed on the machine by any of the ſpectators.

As the inventor of this admirable piece of mechaniſm hath not yet thought proper to communicate to the public the means by which it is actuated, it is in vain for any, except thoſe who are exquiſitely ſkilled in mechanics, to form conjectures concerning them.—Many other curious imitations of the human body, as well as that of other animals, have been exhibited, though none of them equal to the laſt mentioned one. See the article AUTOMATON.

ANDROMEDA, in aſtronomy, a conſtellation of the northern hemiſphere, repreſenting the figure of a woman chained. The ſtars in the conſtellation *Andromeda*, in Ptolemy's catalogue, are 23, in Tycho's 23, in Hevelius's 47, in Mr. Flamſted's no leſs than 66. See the ſyſtem, Sect. VIII. and Plate VI. fig. 1.

ANEMOMETER, a machine wherewith to meaſure the ſtrength of the wind. The *anemometer* is variouſly contrived. In the Philoſophical Tranſactions we have one deſcribed, wherein the wind being ſuppoſed to blow directly againſt a flat ſide, or board, which moves along the graduated limb of a quadrant, the number of degrees it advances ſhews the comparative force of the wind.

ANEMONE, *wind-flower*: A genus of the polygnia order, belonging to the polyandria claſs of plants. Of this genus Dr. Linnæus enumerates 21 ſpecies; but thoſe valuable on account of the beauty of the flowers are only the following. 1. The nemoroſa, which grows wild in the woods in many parts of Britain, where it flowers in April and May. The flowers are white, purple, or reddiſh purple, ſometimes ſingle, and ſometimes double, ſo that they make a pretty appearance. 2. The appennina is likewiſe a native of Britain, growing in woods. The flowers of this ſpecies, like the laſt, are ſometimes ſingle, and ſometimes double; their colours are white, blue, or violet. They appear in April. 3. The coronaria. 4. The hortenſis. Theſe two are natives of the Levant, particularly of the Archipelago iſlands, where the borders of the fields are covered with them of the moſt beautiful colours. When they grow wild, the flowers are commonly ſingle; but by culture they are greatly improved: they become large and double, making ſome of the greateſt ornaments of gardens. Their principal colours are red, white, purple, and blue; ſome of them are finely variegated with red, white, purple, and many intermediate ſhades of theſe colours. As all the fine varieties of theſe flowers were firſt obtained from ſeeds, ſo no good floriſt that hath garden-room ſhould neglect to ſow them. There are ſome fine blue colours amongſt the ſingle anemonies, which, with the ſcarlets and reds, make a beautiful mixture. Horned cattle, when removed from the higher grounds into woods and woody paſtures, frequently eat the wood-anemone; and according to Linnæus and Gunner, many obſervations have proved that it cauſes the bloody flux among them. For the management of theſe flowers, ſee the treatiſe on GARDENING, Part II. Months of February, June, Auguſt, September, and November.

ANETHUM, *dill* and *fennel*: A genus of the digynia order, belonging to the pentandria claſs of plants.

Medicinal Uſes. Of the firſt ſpecies, *dill*, only the ſeeds are uſed. They are of a pale yellowiſh colour, in ſhape nearly oval, convex on one ſide, and flat on the other. Their taſte is moderately warm and pungent; their ſmell aromatic, but not of the moſt agreeable kind. Several preparations of them are kept in the ſhops. They are recommended as a carminative, in flatulent colics, proceeding from a cold cauſe or a viſcidity of the juices.—Of *fennel* both the ſeeds and roots are uſed in medicine. The ſeeds of both the fennels have an aromatic ſmell, and a moderately warm pungent taſte: thoſe of the ſweet fennel are in flavour moſt agreeable, and have alſo a conſiderable degree of ſweetneſs; hence our colleges have directed the uſe of theſe only. They are ranked among the four greater hot ſeeds, and not undeſervedly looked upon as good ſtomachics and carminatives. A ſimple water is prepared from them in the ſhops; they are ingredients alſo in the compound ſpirit of juniper, and ſome other officinal compoſitions. The root is far leſs warm, but has more of a ſweetiſh taſte, than the ſeeds: it is one of the five roots called *openers*; and has ſometimes been directed in aperient apozems. Boerhaave ſays, that this root agrees in taſte, ſmell, and medical qualities, with the celebrated *ginſeng* of the Chineſe; from which, however, it appears to be very conſiderably different.—The leaves of fennel are weaker than either the roots or ſeeds, and have very rarely been employed for any medicinal uſe.

ANEURISM, in ſurgery, a ſoft, throbbing, ruddy tumor, occaſioned by a dilatation, or by a wound of an artery. The word comes from ἀνευρύνω, *dilato*, *I dilate*. Surgeons diſtinguiſh two kinds of *aneuriſm*, which they call the true and the ſpurious. The true aneuriſm is formed by a dilatation only of the artery, either all round, or only one ſide, much in the manner of the *varices*, or tumor of the veins; this has always a pulſation. This kind of aneuriſm is ſeldom fatal; though reckoned, when large, incurable; the chief inconveniences are, the magnitude of the tumor, and the pulſation.

Mr. Littre gives us the hiſtory of an aneuryſma of this kind, in the aorta, the cauſe whereof he attributes to an extraordinary diminution of the cavity of the axillary and ſubclavian arteries. Hiſt. d l'Acad. Roy. an. 1710. Another hiſtory of an aneuryſma of the ſame part we have, by Mr. Laſage, in the Philoſophical Tranſactions. It was occaſioned by ſome violent ſhocks the patient received on the breaſt, which threw him into ſpitting of blood, and ſoon after formed the tumor, whereof he died. Upon diſſection the aneuryſma was found ſo big, that it filled the whole cavity of the thorax on the right ſide. There is another remarkable hiſtory of an aneuriſm, in the London Medical Obſervations. There is alſo a remarkable caſe of the ſame kind, with an account of the uncertainty of diſcovering the ſymptoms of the diſeaſe, by Joſ. Warner, F.R.S. Phil. Tranſ. vol. l. part i. No. 44. an. 1757.

The ſpurious aneuriſm is, when the artery having been opened, by puncture or inciſion, or other accident, the blood is extravaſated between the muſcles and integuments, and the limb appears ſwelled and livid, and there is little or no pulſation. The moſt common ſeat of an aneuriſm is in the brachial artery, and its moſt common occaſion a puncture of that artery in bleeding; but the ſame accident may happen to any artery, and from various cauſes, and is often the caſe in the internal arteries, from falls, blows, and violent ſtrains; in the arm it often happens from the outer coat only of the artery having been cut in bleeding, and the inner one giving way by degrees, as not of ſtrength to bear the impulſe of the blood. Theſe are at firſt very ſmall, and diſregarded by the patient, but they grow at length to the ſize of an egg, and ſometimes even to that of a man's head.

The aneuriſms of the great internal arteries are the moſt fatal of all; thoſe of their external branches are often remedied, but thoſe in the arm frequently after the operation are attended with a waſting of the arm, and an amputation becomes neceſſary. The natural burſting of an aneuriſm is very dangerous, as the patient may be loſt in a minute's time, if the artery be not compreſſed above; ſometimes ſurgeons have alſo opened the larger aneuriſms, miſtaking them for abſceſſes.

The method of curing a ſlight aneuriſm in the arm, or elſewhere, is either by deligation and compreſſion, or by inciſion: the firſt ought always to be the firſt tried, and is either done by ſtrait bandages with compreſſes, or by an engine invented for that purpoſe. Small aneuriſms are often thus cured; but when large and dangerous, the operation by the knife muſt be uſed. In this the firſt care is to ſtop the courſe of the blood by the tournequet; the ſecond to denudate the artery, and free it from the adjacent integuments; and the laſt to contract or conſtringe it either by medicine or ligature.

The ſpurious aneuriſm is often produced by the burſting of the true kind, under the integuments; and in this caſe is to be treated as the true, and cured by the operation with the knife, and by ligature, or cauſtics: but in all theſe caſes, the ligature ſeems the beſt method.

When any part of an artery has loſt its ſpring, it is leſs capable than before to reſiſt the impulſe of the blood. This part of a canal, which is continually puſhed by the blood, muſt therefore become gradually more and more dilated; and by degrees there becomes formed in the part that ſort of tumor which ſurgeons and anatomiſts call an aneuriſm by dilatation, or the true aneuriſm, and this dilated part of the veſſel is, properly ſpeaking, a kind of bag through which the blood that firſt formed it is continually paſſing. When an artery has been by any means wounded, the blood which eſcapes through the orifice cauſes another ſort of tumor; and this is called an aneuriſm by wounding, or a ſpurious aneuriſm. Heiſter.

The moſt common aneuriſms by wound happen from bleeding in the arm; in theſe, if the artery be but ſlightly wounded, and the bandage and compreſs properly applied, the cure is often performed, ſo that no farther miſchief enſues; but if the wound is larger or the compreſſion leſs regular, bad ſymptoms come on ſooner or later, and there often is a neceſſity at laſt of ſubmitting to the operation of opening the ſkin, diſperſing the blood, and cloſing the veſſel. Mem. Acad. Scienc. Par. 1736.

Dr. Hunter, who has treated largely on this ſubject, divides aneuriſms into four kinds, the *true*, the *falſe*, the *mixed*, and the *variceſe*. The *true* aneuriſm is formed by a dilatation of the artery, and may happen in any part of the body. The *falſe* aneuriſm is formed by a rupture, or wound, in the coats of the artery, and may be either *diffuſed* or *circumſcribed*. The *mixed* aneuriſm is formed partly by wound, or rupture, in the artery, and partly by dilatation. The *variceſe* aneuriſm is owing to the wound of an artery through a vein, ſo that the blood paſſes from the trunk of the artery into the trunk of the vein, and ſo back to the heart. See Lond. Med. Obſ. and Inq. vol. i. art. 26. vol. ii. art. 30 and 36. vol. iii. art. 37. 12.

If an artery happens to be cut, the blood guſhes out impetuouſly by ſtarts, and is not eaſily ſtopped; and an inflammation and diſcoloration of the part ſucceed, with a tumor, and inability to move the part. The ſymptoms are nearly the ſame in caſe of a corroſion of the coats of the artery; only in this caſe they are leſs violent. If the blood ceaſe to flow from the wounded artery, and pour itſelf between the interſtices of the muſcles, recourſe is had to manual operation; which being neglected, the extirpation of the limb frequently becomes unavoidable. See caſes of aneuriſms with remarks, by Dr. Donald Monro, in the third volume of Eſſ. Phyſ. and Liter. Edinb. 1771. art. 12. p. 178.

ANGEL, a ſpiritual intelligent ſubſtance; the firſt in rank and dignity among created beings. The word angel, ἄγγελος, is not properly a denomination of nature but of office; denoting as much as *nuncius*, *meſſenger*, a perſon employed to carry one's orders, or declare his will. Thus it is St. Paul repreſents angels, Heb. i. 14. where he calls them *miniſtering ſpirits*; and yet cuſtom has prevailed ſo much, that angel is now commonly taken for the denomination of a particular nature. The exiſtence of angels is ſuppoſed in all religions, though it is incapable of being proved *a priori*. Indeed the ancient Sadducees are repreſented as denying all ſpirits; and yet the Samaritans and Caraites, who are reputed Sadducees, openly allow them: witneſs Abuſaid, the author of an Arabic verſion of the Pentateuch; and Aaron, a Caraite Jew, in his comment on the Pentateuch; both extant in manuſcript in the late king of France's library.

The heathen philoſophers and poets were alſo agreed as to the exiſtence of intelligent beings, ſuperior to man; as is ſhewn by St. Cyprian, in his treatiſe of the vanity of idols, from the teſtimonies of Plato, Socrates, Triſmegiſtus, &c. Authors are not ſo unanimous about the nature as about the exiſtence of angels. Clemens Alexandrinus believed they had bodies; which was alſo the opinion of Origen, Cæſarius, Tertullian, and ſeveral others. Athanaſius, St. Baſil, St. Gregory Nicene, St. Cyril, St. Chryſoſtom, &c. hold them to be mere ſpirits.

Authors are divided as to the time of the creation of angels; ſome will have it to have been before the creation of our world, or even before all ages, that is, from eternity; this was Origen's opinion, who, according to Leontius, held that all ſpirits, angels, devils, and even human ſouls, were from eternity. Others hold angels to have been created before the world, yet not from eternity; of which opinion are Nazianzen and others. Others again maintain that they were created at the ſame time with our world, but on what day is diſputed. Theodoret and Epiphanius fix their date from the firſt day.

It is acknowledged that Moſes has not expreſsly mentioned angels by name; yet their creation is undoubtedly implied: for the heavens muſt include all that are in them; and therefore it is that the divine penman ſays, in the concluſion of his narrative, "Thus the heavens and the earth were finiſhed, and *all* the hoſt of them." Of the *hoſts* of heaven, the angels muſt form a conſiderable part; they are expreſsly called the *heavenly hoſt*, and the *armies of heaven*, Dan. iv. 35. Luke ii. 13. And if divine authority be admitted as deciſive, the reaſons adduced by Jehovah for the ſanctification of a ſabbath, demonſtrate that they did not exiſt previous to the creation of the heavens. It is, ſurely, aſſerted with propriety, that in *ſix days* the Lord made heaven and earth, the ſea, and ALL that in them is. Similar to which is a declaration of the divine hiſtorian relating to the ſame fact. "And God bleſſed the ſeventh day and ſanctified it; *becauſe* that in it he had reſted from ALL his work

which

which God created and made," Gen. ii. 3. Now if angels exiſted prior to the ſix days of creation, the language of Moſes is far from being accurate and intelligible; and eſpecially when it is conſidered that the obſcurity might have been removed by adding, "from all the work which God had *then* created and made."

But if angels were created before the heavens, where could they exiſt? For, as the learned Gill has remarked, "though angels have no bodies, and ſo are not in place circumſcriptively; yet as they are creatures, they muſt have an *ubi*, a ſomewhere in which they are definitively; ſo that they are here, and not there, and much leſs everywhere: Now where was there an *ubi*, a ſomewhere, for them to exiſt in, before the heavens and the earth were made? It is moſt reaſonable therefore, to conclude, that as God prepared an habitation for all the living creatures before he made them; as the ſea for the fiſhes, the expanſe or air for the fowls, and the earth for men and beaſts; ſo he made the heavens firſt, and then the angels to dwell in them."

That this was the fact, will appear very evident, if the words of Moſes be impartially conſidered. "In the beginning (ſays he) God created the heavens and the earth;" which words muſt refer to either the beginning of *creation* or of *time*: if to the former, and angels previouſly exiſted, the language is neither *intelligible* nor conformable to *truth*: if to the latter, the difficulty remains; for what is time but the meaſure of created exiſtence. "Time (ſays the judicious Charnock) began with the foundation of the world: before the beginning of the creation and the beginning of time, there could be nothing but eternity; nothing but what was uncreated, that is, nothing but what was without beginning." But if angels were in a preexiſtent ſtate, the hiſtorian's language is unaccountably ſtrange and inaccurate: for if the phraſe *in the beginning*, which is remarkably emphatical, refer to the creation of the heavens and the earth *only*, they are unhappily expreſſed; ſo expreſſed, indeed, as to convey no meaning to thoſe who conſider words as the vehicle of thought, and as intended to expreſs clearly to others the meaning of the writer. For the *natural obvious* ſenſe is as follows—"In the beginning of the creation of the heavens and the earth, God created the heavens and the earth;" which language is not only a departure from that perſpicuity and preciſion which diſtinguiſh all his narrations, but entirely irrational and abſurd.

That the words *in the beginning* refer to the firſt creation, cannot be doubted, if it be remembered that JEHOVAH himſelf founds a claim to *eternity* on this very ground: "Before the day was, I am he."—"Before the mountains were brought forth, or ever thou hadſt formed the earth and the world, even from everlaſting to everlaſting, thou art God." Iſ. xliii. 13. Pſ. ix. 2. See alſo Prov. viii. 22, 29, &c. Now there could be no propriety in this kind of reaſoning, if angels or any other creature exiſted before the creation of the world, becauſe all claims to eternity from ſuch premiſſes would apply even to Gabriel as well as to JEHOVAH. "Before the world was," is, in Scripture language, a phraſe always expreſſive of eternity; and on this principle the evangeliſt John aſſerts the divinity of Jeſus Chriſt in the firſt chapter of his hiſtory. For this purpoſe he alludes to the words of Moſes, and introduces his divine Maſter to notice by celebrating the firſt act of his creative power. "In the beginning (ſays he) was the Word;" that is, Dr. Doddridge remarks, before the foundation of the world, or the firſt production of any creature: and Dr. Sherlock is clearly of opinion, that the words, in their moſt common and uſual acceptation, ſignify the firſt creation of all things, and are a demonſtration of the divinity of Chriſt. Of the ſame mind was Dr. Owen. He ſays, that if the phraſe *beginning* does not abſolutely and formally expreſs *eternity*, yet it doth a pre-exiſtence to the whole creation, which amounts to the ſame thing; for nothing can pre-exiſt before all creatures but the nature of God, which is eternal, unleſs we ſuppoſe a creature before the creation of any. But what is meant by this expreſſion is fully declared by other paſſages of Scripture: "I was ſet up from everlaſting, before the *beginning*, or ever the earth was;" "Glorify thou me with thine own ſelf, with the glory which I had with thee before the world was;" both which paſſages not only explain the text, but undeniably prove the pre-exiſtence of Chriſt the ſon of God. It ſhould be remembered, that, in the paſſage under conſideration, the Evangeliſt's argument for the *divinity* of Jeſus Chriſt is grounded on his pre-exiſting the creation of the world; and it is conſequently aſſerted, that he is the creator of all things: but if angels had a being before the period to which he alludes, the argument loſes all its force, and no more proves the divinity of Chriſt than the divinity of an angel.

As to the nature of theſe beings, we are told, that they are ſpirits: but whether pure ſpirits diveſted of all matter, or united to ſome thin bodies, or corporeal vehicles, has been a controverſy of long ſtanding. Not only the ancient philoſophers, but ſome of the Chriſtian fathers were of opinion, that angels were cloathed with ethereal, or fiery bodies, of the ſame nature with thoſe which we ſhall one day have, when we come to be equal to them. But the more general opinion, eſpecially of later times, has been, that they are ſubſtances entirely ſpiritual, though they can at any time aſſume bodies, and appear in human or other ſhapes. That the angelical powers and abilities vaſtly excel thoſe of man, cannot be denied, if we conſider that their faculties are not clogged or impeded, as ours are, by any of thoſe imperfections which are inſeparable from corporeal being: ſo that their underſtandings are always in perfect vigour; their inclinations regular; their motions ſtrong and quick; their actions irreſiſtible by material bodies, whoſe natural qualities they can controul, or manage to their purpoſes, and occaſion either bleſſings or calamities, public or private, here below.

Beſides their attendance on God, and their waiting and executing of his commands, they are alſo preſumed to be employed in taking care of mankind and their concerns: and that every man had ſuch a tutelar or guardian angel, even from his birth, was a firm belief and tradition among the Jews. The heathens were alſo of the ſame perſuaſion, and thought it a crime to neglect the admonitions of ſo divine a guide. Socrates publicly confeſſed himſelf to be under the direction of ſuch an angel, or dæmon, as ſeveral others have ſince done. And in this tutelar genius of each perſon they believed his happineſs and fortune depended. Every genius did his beſt for the intereſt of his client; and if a man came by the worſt, it was a ſign the ſtrength of his genius was inferior to that of his opponent, that is, of an inferior order; and this was governed by chance. There were ſome genii, whoſe aſcendent was ſo great over others, that their very preſence entirely diſconcerted them; which was the caſe of that of Auguſtus in reſpect of that of Marc Anthony; and for the ſame reaſon, perhaps, ſome perſons have wit, and ſpeak well, when others are abſent, in whoſe preſence they are confounded and out of countenance. The Romans thought the tutelar genii of thoſe who attained the empire, to be of an eminent order; on which account they had great honours ſhown them. Nations and cities alſo had their ſeveral genii. The ancient Perſians ſo firmly believed the miniſtry of angels, and their ſuperintendance over human affairs, that they gave their names to their months, and the days of their month; and aſſigned them diſtinct offices and provinces.

In the Alcoran, we find frequent mention of angels.—The Muſſulmen believe them of different orders or degrees, and to be deſtined for different employments both in heaven and on earth. They attribute exceeding great power to the angel Gabriel; as to be able to deſcend in the ſpace of an hour from heaven to earth; to overturn a mountain with a ſingle feather of his wing, &c. The angel Aſrael, they ſuppoſe, is appointed to take the ſouls of ſuch as die; and another angel, named Eſraphil, they ſay, ſtands with a trumpet ready in his mouth to proclaim the day of judgment.

Some ſpeculative men have diſtributed them into nine orders, according to the different names by which they are there called; and reduced thoſe orders into three hierarchies, as they call them; to the firſt of which belong ſeraphim, cherubim, and thrones; to the ſecond, dominions, virtues, and powers; and to the third, principalities, arch-angels, and angels. They imagine farther, that there are ſome who conſtantly reſide in heaven; others who are miniſters, and ſent forth, as there is occaſion, to execute the orders they receive from God by the former. The Jews reckon but four orders or companies of angels, each headed by an arch-angel; the firſt order being that of Michael, the ſecond of Gabriel, the third of Uriel, and the fourth of Raphael: but though the Jews believe them to be four, yet it ſeems there were rather ſeven. The Perſians alſo held there were ſubordinate degrees among the angels.

Although the angels were originally created perfect, good, and obedient to their Maſter's will, yet ſome of them ſinned, and kept not their firſt eſtate, but left their habitation; and ſo, of the moſt bleſſed and glorious, became the moſt vile and miſerable of all God's creatures. They were expelled the regions of light, and caſt down to hell, to be reſerved in everlaſting chains under darkneſs, until the day of judgment. With heaven they loſt their heavenly diſpoſition, which delighted once in doing good and praiſing God; and fell into a ſettled rancour againſt him, and malice againſt men: their inward peace was gone; all deſire of doing good departed from them; and, inſtead thereof, revengeful thoughts and deſpair took poſſeſſion of them, and created an eternal hell within them.

When, and for what offence, theſe apoſtate ſpirits fell from heaven, and plunged themſelves into ſuch an abyſs of wickedneſs and woe, are queſtions very hard, if not impoſſible, to be determined by any clear evidence of Scripture. As to the time, we are certain that it could not be before the ſixth day of creation; becauſe on that day it is ſaid, "God ſaw every thing that he had made, and behold it was very good." Some have imagined it to have been after; and that carnality, or luſting to converſe with women upon earth, was the ſin which ruined them: an opinion built on a miſtaken interpretation of Scripture, as if angels were meant by *the ſons of God* who are ſaid to have begotten the mighty men of old on the daughters of men. Others have ſuppoſed, that the angels, being informed of God's intention to create man after his own image, and to dignify his nature by Chriſt's aſſuming of it, and think-

ing their glory to be eclipſed thereby, envied man's happineſs, and ſo revolted: and with this opinion that of the Mahometans has ſome affinity; who are taught, that the devil, who was once one of thoſe angels who are neareſt to God's preſence, and named Azazil, forfeited paradiſe for refuſing to pay homage to Adam at the command of God. But on what occaſion ſoever it firſt ſhowed itſelf, pride ſeems to have been the leading ſin of the angels; who, admiring and valuing themſelves too much on the excellence of their nature and the height of their ſtation, came at length to entertain ſo little reſpect for their Creator, as to be guilty of downright rebellion and apoſtacy.

Scripture informs us, that theſe fallen angels were in great numbers, and that there was alſo ſome order and ſubordination preſerved among them; one eſpecially being conſidered as their prince, and called by ſeveral names, Beelzebub, Satan, or Sammaël by the Jews; Ahârimam, by the Perſians; and Eblis, by the Mahometans. Their conſtant employment is not only doing evil themſelves, but endeavouring by all arts and means to ſeduce and pervert mankind, by tempting them to all kind of ſin, and thereby bringing them into the ſame deſperate ſtate with themſelves. On a ſubject of this nature it would be imprudent to indulge a ſpirit of conjecture: Scripture is the only ſtandard by which truth and error can be tried, and to this we muſt ultimately appeal.

Angel is likewiſe a title given to biſhops of ſeveral churches. In this ſenſe is St. Paul underſtood by ſome authors, where he ſays, *Women ought to be covered in the church becauſe of the angels*. The learned Dr. Prideaux obſerves, that the miniſter of the ſynagogue, who officiated in offering up the public prayers, being the mouth of the congregation, delegated by them as their repreſentative, meſſenger, or angel, to ſpeak to God in prayer for them, was therefore, in the Hebrew language, called the *angel* of the church; and from thence the biſhops of the ſeven churches of Aſia are, by a name borrowed from the ſynagogue, called the *angels* of thoſe churches.

ANGER, a violent paſſion of the mind, conſiſting in a propenſity to take vengeance on the author of ſome real or ſuppoſed injury done the offended party. Anger is either deliberative or inſtinctive; and the latter kind is raſh and ungovernable, becauſe it operates blindly, without affording time for deliberation or foreſight. Biſhop Butler very juſtly obſerves, that anger is far from being a ſelfiſh paſſion, ſince it is naturally excited by injuries offered to others as well as to ourſelves; and was deſigned by the Author of nature not only to excite us to act vigorouſly in defending ourſelves from evil, but to intereſt us in the defence or reſcue of the injured and helpleſs, and to raiſe us above the fear of the proud and mighty oppreſſor. Neither, therefore, is all anger ſinful: hence the precept, "Be ye angry and ſin not."—It becomes ſinful, however, and contradicts the rule of ſcripture, when it is conceived upon ſlight and inadequate provocations, and when it continues long. It is then contrary to the amiable ſpirit of charity, which "ſuffereth long, and is not eaſily provoked." Hence theſe other precepts, "Let every man be ſlow to anger;" and "Let not the ſun go down upon your wrath."

Theſe precepts, and all reaſoning indeed upon the ſubject, ſuppoſe the paſſion of anger to be within our power; and this power conſiſts not ſo much in any faculty we have of appeaſing our wrath at the time (for we are paſſive under the ſmart which an injury or affront occaſions, and all we can then do is to prevent its breaking out into action), as in ſo mollifying our minds by habits of juſt reflection, as to be leſs irritated by impreſſions of injury, and to be ſooner pacified.

As reflections proper for this purpoſe, and which may be called the *ſedatives* of anger, the following are ſuggeſted by Archdeacon Paley in his excellent treatiſe of *Moral and Political Philoſophy*—"The poſſibility of miſtaking the motives from which the conduct that offends us proceeded; how often *our* offences have been the effect of inadvertency, when they were miſtaken for malice; the inducement which prompted our adverſary to act as he did, and how powerfully the ſame inducement has, at one time or other, operated upon ourſelves; that he is ſuffering perhaps under a contrition, which he is aſhamed, or wants opportunity, to confeſs; and how ungenerous it is to triumph by coldneſs or inſult over a ſpirit already humbled in ſecret; that the returns of kindneſs are ſweet, and that there is neither honour nor virtue nor uſe in reſiſting them—for ſome perſons think themſelves bound to cheriſh and keep alive their indignation, when they find it dying away of itſelf. We may remember that others have their paſſions, their prejudices, their favourite aims, their fears, their cautions, their intereſts, their ſudden impulſes, their varieties of apprehenſion, as well as we: we may recollect what hath ſometimes paſſed in our own minds, when we have got on the wrong ſide of a quarrel, and imagine the ſame to be paſſing in our adverſary's mind now; when we became ſenſible of our miſbehaviour, what palliations we perceived in it, and expected others to perceive; how we were affected by the kindneſs, and felt the ſuperiority, of a generous reception and ready forgiveneſs; how perſecution revived our ſpirits with our enmity, and ſeemed to juſtify the conduct in ourſelves which we before blamed. Add to this, the indecency of extravagant anger; how it renders us, whilſt it laſts, the ſcorn and ſport of all about us, of which it leaves us, when it ceaſes, ſenſible and aſhamed; the inconveniences and irretrievable miſconduct into which our iraſcibility has ſometimes betrayed us; the friendſhips it has loſt us; the diſtreſſes and embarraſſments in which we have been involved by it, and the ſore repentance which on one account or other it always coſts us.

Anger is of ſuch a nature, that it quickly throws the whole nervous ſyſtem into preternatural commotions by a violent ſtricture of the nervous and muſcular parts: and ſurpriſingly augments not only the *ſyſtole* of the heart, and of its contiguous veſſels, but alſo the tone of the fibrous parts in the whole body. It is alſo certain, that this paſſion, by the ſpaſmodic ſtricture it produces in the parts, exerts its power principally on the ſtomach and inteſtines, which are highly nervous and membranous parts; whence the ſymptoms are more dangerous, in proportion to the greater conſent of the ſtomach and inteſtines with the other nervous parts, and almoſt with the whole body. The unhappy influence of anger likewiſe, on the biliary and hepatic ducts, is very ſurpriſing; ſince by an intenſe conſtriction of theſe, the liver is not only rendered ſcirrhous, but ſtones alſo are often generated in the gall-bladder, and biliary ducts; theſe accidents have ſcarcely any other origin than an obſtruction of the free motion and efflux of the bile, by means of this violent ſtricture. From ſuch a ſtricture of theſe ducts likewiſe proceeds the jaundice, which in proceſs of time lays a foundation for calculous concretions in the gall-bladder. Laſtly, by increaſing the motion of the fluid, or the ſpaſms of the fibrous parts, by means of anger, a larger quantity of blood is propelled with an *impetus*, to certain parts; whence it happens, that they are too much diſtended, and the orifices of the veins diſtributed there, opened. It is evident from experience that anger has a great tendency to excite enormous hæmorrhages, either from the noſe, the aperture of the pulmonary artery, the veins of the arms; or in women from the uterus; eſpecially in thoſe previouſly accuſtomed and diſpoſed to ſuch evacuations. For the influence of this paſſion on the perſpiration and urine of human bodies, ſee PERSPIRATION, &c.

ANGINA, in medicine, an inflammation about the muſcles of the larynx or pharynx, attended with an acute fever, difficulty of ſwallowing, and danger of ſuffocation. The angina is the ſame with what we commonly call *quinzy*. It is an inflammation in the parts of the throat ſubſervient to reſpiration, ſpeech, and deglutition. For deſcription, cauſes, prognoſis, and cure, ſee the ſyſtem, Genus XI.

ANGINA *gangrena*, or *aquoſa*, the ulcerated, malignant, putrid *ſore throat*; on which there are various treatiſes by Fothergill, Huxham, Northcote, &c. See the ſame ſyſtem and genus for the prognoſis and cure of this malady.

ANGINA *pectoris*, in medicine, a name given to a diſeaſe, dangerous and not uncommon, firſt deſcribed by Dr. W. Heberden, and ſo called from the ſeat of the diſorder, and the ſenſe of ſtrangling and anxiety with which it is attended. The doctor's account of it is in the ſecond volume of the London Medic. Tranſ. p. 59, &c. See alſo Medic. and Phil. Comment. vol. ii. p. 95. The patient while walking, eſpecially if ſoon after eating, is affected with a painful ſenſation in his breaſt; at firſt, it is removed by his ſtanding ſtill, but afterwards it does not go off ſo ſuddenly; it comes on in bed, obliges the patient to get up, and continues for an hour and more; ſometimes, though rarely, it attacks the patient ſtanding or ſitting ſtill. It is brought on by trivial accidents, coughing, &c. or any ſlight diſturbance. In ſome it is worſt in winter, in others in ſummer. The pulſe, ſometimes at leaſt, is not diſturbed, conſequently the heart is not affected by the pain. People affected with it often die ſuddenly, but ſome continue ſubject to it for twenty and odd years. The ſeat of it ſeems to be in or about the *os ſternum*, towards the left ſide, and a pain in the middle of the left arm ſometimes accompanies it. The cauſe is probably a ſpaſm, or cramp, or an ulcer, or both. Wine, or other cordials, taken at bed-time, prevent or weaken night-fits, but opium is the moſt effectual relief; ten, fifteen, or twenty drops of the Thebaic tincture, taken at bed-time, may be ſafely continued as long as requiſite. This diſeaſe has been ſince accurately deſcribed, and ſuitable preventives or remedies propoſed.

ANGIOSPERMIA, in botany, a term uſed by Linnæus, to expreſs a certain ſeries of the Didynamiæ or plants of the verticillate kind, which have their ſeeds not lodged naked within the cup. They are by this diſtinguiſhed from the *gymnoſpermia*, which have them ſo; whereas the *angioſpermia* have them incloſed in a capſule, and adhering to a placenta placed in the middle of that capſule. See the ſyſtem, Sect. V. and Plate V.

ANGLE, in geometry, the aperture or mutual inclination of two lines, which meet, and form an angle in their point of interſection. See the ſyſtem, Part I. Sect. I. and Plate I. Fig. I. For various theorems reſpecting this part of the ſcience, ſee Sect. III. and the ſeveral references to Plate I. Theſe will be found fully to explain and demonſtrate this branch of the elements of geometry.

ANGLE *of incidence*, in catoptrics, is the leſſer angle, made by an incident ray of light, with the plane of a ſpeculum; or, if the ſpeculum be concave or convex, with a tangent in the point of incidence.

ANGLE *of refraction*, in dioptrics, the angle which a ray of light refracted by any medium, makes with a perpendicular to that point of the ſurface on which it was incident. See the ſyſtem of OPTICS.

ANGLER, a fiſherman, or other perſon, who practiſes angling. See the article ANGLING. Anglers are to be diſtinguiſhed from poachers. Some make the ſame difference between them that is between the fair trader and ſmuggler. Accordingly the legiſlature has made the latter penal, but laid no reſtraint on the former. Angling can do no prejudice to the fiſh of a river. Anglers fiſh for their recreation, not for lucre; whereas poachers make it their livelihood.

ANGLING, in a general ſenſe, denotes the art of catching fiſh with a rod, to which are fitted a line, hook, and bait. To avoid the prolixity, and conſequently perplexity, of thoſe elaborate and dark treatiſes which have been written on the ſubject, we ſhall point out ſome conciſe though intelligent inſtructions, which will ſubſerve the purpoſe of an elaborate treatiſe, relative to the various kinds of fiſh, the places where they are to be found, the ſeaſon of the year for catching them, the proper time of the day, the depth, and the neceſſary baits to be uſed for each; the whole of which will appear at one diſtinct and intelligent view from the following table:

Names	Where found	Seaſon	Time to angle	Depth from ground	Baits			
					Flies No.	Paſtes No.	Worms No.	Fiſh and Inſects No.
Bream	Rough ſtream, river, or mid. pond.	April to Mich.	Sun riſe to 9, 3 to ſun ſet	Touch ground	1, 3		1, 2, 3, 4, 5, 6, 7	No. 8
Barbel	Gravel bank in curt. under bridges	April to Aug.	Very early or late	Touch ground		2	2, 6, 7	
Bleak	Sandy bottm. deep river, ſhip ſterns*	May to Oct.	All day	6 inches from bottom	1, 2	2	2, 3, 8	
Carp	Still deep mud bottm. pond or river	May to Aug.	Sun riſe to 9, 3 to ſun ſet	3 in. from bottom, hot wea. mid water		1, 3, 4	1, 2, 3, 4, 7	
Chub, or Chevin	Ditto.	May to Dec.	Ditto	Ditto	1, 2, 3, 4, 5	2	1, 2, 4, 5	7, 8
Dace	Sandy bottm. deep river, ſhip ſterns*	May to Oct.	All day	6 to 12 inches from bottom	1, 2, 3, 4, 5	3, 4	1, 2, 3, 4, 5, 8	
Gudgeon	Gravel ſhoals	May to Oct.	All day	Near or on ground		3, 4	2, 8	
Pike	Near clay banks	All the year	All day	Mid water	with ſtrong line, float, and ſnap book fixed on ſhore			1, 2, 3, 4, 5, 6, 7
Pearch	River, in ſtream } Gravel, or Pond, deepeſt part } weedy bottm.	May to Aug. Aug. to May	Sun riſe to 10, 2 to 4, ſet Middle of day	Mid water 6 inches from bottom	2	2	3, 5, 7, 8	1, 6
Pope	Deep holes in rivers	May to Oct.	All day	Ditto	5		All	
Roach	Sandy bottm. deep river, ſhip ſterns*	May to Oct.	All day	3, 6 inches	1, 2, 4, 5	3, 4	All	8
Salmon	Deep rivers	March to Sept.	6 to 9, and 3 to 6	Mid water to bottom	All large		1, 5, 6, 7	1
Smelts	Ship ſterns and docks*	April to Oct.	All day	Mid water to bottom, variable	All ſmall		1, 2, 5	Bits of ſmelts
Trout	Purling ſtream and eddies of ſtony bottom river	March to Mich.	All day	Cold w. 6 in. to 9, hot w. top to mid w.	1, 2, 3, 4, 5		1, 2, 5, 6, 7, 8	1, 3
Tench	Mud bottom river or pond	All the year	Sun riſe to 9, 3 to ſun ſet	Cold w. 3 in. fr. bottm. hot w. m'd water		1, 3, 4	1, 3, 4, 5, 6, 7	
Umber, or Grayling	Clay bottom, ſwift ſtream	All the year	All day	Cold w. 6 to 9 in. hot w. top to mid water	1, 2, 3, 4, 5		1, 2, 3, 4, 5, 6, 7, 8	1, 8

* To fiſh at ſterns, let the bait ſink 2 or 3 yards: in this a paternoſter line is commonly uſed, that is 5 or 6 hooks on a line about 4 or 5 inches diſtance. Bait as above.

BAITS.

Deſcription of the reſpective Flies, Paſtes, Worms, Fiſh, and Inſects, to be uſed as Baits for the different ſorts of Fiſh, as numbered in the above table.

FLIES.

1. Stone fly, found under hollow ſtones at the ſide of rivers. It is of a brown colour with yellow ſtreakes on the back and belly, and has large wings. It is in ſeaſon from April to July.

2. Green Drake, found among ſtones by the ſides of rivers. It has a yellow body, ribbed with green, is long and ſlender, his wings like a butterfly's, his tail turns on his back. From May to Midſummer it is very good.

3. Oak fly, found in the body of an old oak or aſh, with its head downwards. It is of a brown colour, and excellent from May to September for trout. Put a cod bait or gentle on the point, and let it ſink a few inches in clear water.

4. Palmer fly or worm, found on leaves of plants, and commonly called a caterpillar. When it comes to a fly, it is excellent for trout.

5. Ant fly, found in ant hills; to be uſed from June to September.

The beſt way to angle with a fly is down the river.

PASTES.

1. Take the blood of ſheeps heart, mix it with honey and flower worked to a proper conſiſtency.

2. Take old cheeſe grated a little, butter ſufficient to work it, colour it with ſaffron; if in winter uſe ruſty bacon inſtead of butter.

3. Crumbs of bread chewed or worked with honey or ſugar; moiſten it with gum ivy water.

4. Bread chewed and worked in the hand till ſtiff.

WORMS.

1. The earth bob, found in ſandy ground after plowing; it is white, and bigger than a gentle, with a red head. Another is found in heathy ground, with a black or blue head. Keep them in an earthen veſſel covered well, and a ſufficient quantity of the mould they harbour in. They are excellent from April to November.

2. Gentles, to be had from putrid fleſh: let them lye in wheat bran a few days before uſed.

3. Flag worms, found in roots of flags. It is of a pale yellow, longer and thinner than a gentle, and muſt be ſcowered like them.

4. Cow turd bob or clap bait, found under a cow turd from May to Michaelmas; it is like a gentle, but larger. Keep it in its native earth, the ſame as the earth bob.

5. Cadis worm, or cod bait, found under looſe ſtones, in ſhallow rivers; they are yellow, bigger than a gentle, with a black or blue head. In ſeaſon from April to July. Keep them in flannel bags.

6. Lob worm, found in gardens. It is very large, having a red head, a ſtreak down the back, and a flat broad tail.

7. Marſh worm, found in marſhy ground. Keep it in moſs ten days or more before you uſe it. Its colour is a bluiſh red, and it is a good bait from March to Michaelmas.

8. Brandling red worm or blood worm, found in rotten dung-hills and tanners bark. It is a ſmall red worm, and very good for all ſmall fiſh: it has ſometimes a yellow tail, and is called tag tail.

FISH AND INSECTS.

1. Minnow. 2. Gudgeon. 3. Roach. 4. Dace. 5. Smelt. 6. Yellow frog. 7. Snail ſlit. 8. Graſshopper.

N. B. Artificial flies reſembling the natural, may be had at the ſhops where fiſhing tackle is ſold. Alſo moſt ſorts of worms ready ſcowered and fit for uſe; and they will direct what tackle is proper for each ſort of fiſhing.

There are ſeveral prudential rules to be obſerved by thorough anglers: ſuch as not to wear any white or ſhining apparel, but be clothed in a dark ſky colour: to invite the fiſh to the place intended for angling, by caſting in, from time to time, proper foods, as boiled corn, worms, and garbage: to keep them together in the time of angling, by throwing in grains of ground malt; or ſinking a box of worms with ſmall holes for them to creep ſlowly out at, &c. To draw ſalmon or trout together, anglers uſe a compoſition of fine clay incorporated with blood, and ground malt. To learn what bait is beſt for any fiſh at any time; after having caught one, they ſlit his gills, and take out the ſtomach, and thus find what he laſt fed on. The angler's firſt buſineſs is to prepare for catching the fiſh by inviting them about him; the method of doing this in ſtanding waters, is by throwing in grains, chopped worms, and the like; but the chief difficulty is in running rivers and brooks. The method in this caſe is to prepare a tin-box capable of holding ſome hundred of worms, bored on all ſides, and full of holes of ſuch a ſize as they may be juſt able to crawl out at: there muſt be a plummet faſtened to this box to ſink it, and a line to draw it back at pleaſure; in this caſe it is to be thrown into the water at a proper place, above which the angler may ſtand under cover. The worms will ſlowly and gradually crawl out of this box, and the fiſh will be gathered about to feed on them; the baited hook is to be thrown in higher up, and carried down by the ſtream. If this method does not bring the fiſh about the place in a little time, there is reaſon to ſuſpect that ſome pike lies lurking thereabout, and deters them; in this caſe, it is proper to throw out a baited hook, and he will generally be taken: after this the attempt will ſucceed. The angling rod muſt be kept in a moderate ſtate, neither too dry nor too moiſt; in the firſt caſe it will be brittle, in the other rotten. When paſtes are uſed, it is proper to mix a little tow with them, and rub them over with honey; finally a ſmall anointing them with butter is of great uſe to keep them from being waſhed off the hook. The eyes of any fiſh that is taken are an excellent bait for almoſt any other kind of fiſh. Places where there are many weeds, or old ſtumps of trees, harbour fiſh in great numbers, and they uſually bite freely there, but there is danger of entangling the line, or faſtening the hook to the weeds. In caſe of this accident, recourſe is to be had to a ring of lead, of about ſix inches round, faſtened to a ſmall pack-thread; this ring is to be thruſt over the rod, and let fall into the water. It will deſcend to the place where the hook is entangled, and then by pulling the pack-thread gently, the hook will be ſoon diſengaged, or at the worſt it can only be broke off near the

end of the line; whereas when this is not employed, the rod itself is ſometimes broken, or the line nearer its upper end. In an eaſterly wind there is never much ſport for the angler; the ſoutherly winds are the beſt for his purpoſe, and a warm but lowering day is moſt of all to be choſen; a gentle wind after a ſudden ſhower to diſturb the water makes a very good opportunity for the angler; the cooler the weather in the hotteſt months, the better, but in winter on the contrary the warmer the day the better. A cloudy day after a bright moonlight night is always a good day for ſport, for the fiſh do not care to go after prey in the bright moon-ſhine, and are therefore hungry the next morning. The openings of ſluices and mill-dams always bring fiſh up the current, to ſeek for the food which is brought with the ſtream, and angling in theſe places is uſually ſucceſsful. It is very good angling a little before the fiſh ſpawn, for then their bellies being full, they frequent ſandy fords, to rub and looſen their bellies; at which time they will bite freely. In waters which ebb and flow, it is beſt angling at the ebb; but if the tide be not ſtrong, the flood is to be preferred. One general rule to be obſerved in angling is, always to place yourſelf, particularly if the water be ſhallow, in ſuch a manner that your ſhadow does not at any time lie upon the ſurface.

ANGLING, *ground*, the art of catching fiſh under water without a float, only with a plumb of lead, or a bullet. This method is moſt expedient in cold weather, when the fiſh ſwim low. The bullet is to be placed nine inches from the baited hook; the top of the rod is to be very gentle, that the fiſh may more eaſily run away with the bait, and not be ſcared with the ſtiffneſs of it. The angler in this way is not to ſtrike as ſoon as he feels the fiſh bite, but ſlacken his line a little, to give the fiſh an opportunity to ſwallow the hook. The tackle here is to be fine and ſlender, ſtrong and big lines being apt to fright the fiſh. Morning and evening are the chief ſeaſons for the ground-line for trout, but in a cloudy day, or a muddy water, you may fiſh at ground from morn to night.

ANGLING, *night*, a method of catching large and ſhy fiſh in the night. Trout, and many others of the better ſorts of fiſh, are naturally ſhy and fearful; they therefore prey in the night, as the ſecureſt time. The method of taking them on this plan is thus: the tackle muſt be ſtrong, and need not be ſo fine as for day-fiſhing, when every thing is ſeen; the hook muſt be baited with a large earthworm, or a black ſnail, and thrown out into the river; there muſt be no lead to the line, ſo that the bait may not ſink, but be kept drawling along, upon or near the ſurface. Whatever trout is near the place will be brought thither by the noiſe, and motion of the water, and will ſeize the worm, or ſnail. The angler will be alarmed by the noiſe which the fiſh makes in riſing, and is to give him line, and time to ſwallow the hook; then a ſlight twitch ſecures him. The beſt and largeſt trouts are found to bite thus in the night, and they riſe moſtly in the ſtill and clear deeps, not in the ſhallow ſwift currents. Sometimes though there are fiſh about the place, they will not riſe at the bait; in this caſe, the angler muſt put on ſome lead to his line, and ſink it to the bottom.

ANGLO-SAXON *language*, that ſpoke by the ancient Angli or Saxons, who ſettled in England. It was thus called from the people, who were partly Angli, partly Saxon. It is otherwiſe denominated ſimply Saxon. The Anglo-Saxon, or Engliſh-Saxon, is properly the original Engliſh; being the language which our Saxon anceſtors firſt eſtabliſhed in this iſland.—It is now called Anglo-Saxon, to diſtinguiſh it from the modern or preſent Engliſh.

ANGUIS, the ſnake, in the Linnæan ſyſtem of Amphibiology, makes a diſtinct and large genus of the order of ſerpents, and claſs of amphibious animals. The characters are theſe: they are ſquamous or ſcaly in the belly and under the tail, without any ſcuta. There are fifteen ſpecies of the anguis. According to Linnæus none of the ſpecies of this genus are poiſonous.

ANGULAR, ſomething that relates to, or hath angles. Angular objects at a diſtance appear round; the little inequalities diſappearing at a much leſs diſtance than the bulk of the body. Angular motion is a compound kind of motion, wherein the moveable both ſlides and revolves at the ſame time. Such is the motion of the wheel of a coach or other vehicle.

ANGULAR *motion*, in aſtronomy, is the increaſe of the diſtance between any two planets, revolving round any body as the common centre of their motion. The quantity of this motion is expreſſed by two right lines, drawn from the ſaid centre to the revolving bodies; which will open wider, and conſequently the angle will grow greater, as the revolving bodies part farther and farther from one another.

ANGURIA, the water-melon; a genus of the diandria order, belonging to the monœcia claſs of plants. The eſſential characters are theſe: the *male* calyx is quinqueſid, and the corolla quinquepetalous: the *female* calyx and corolla the ſame: the pericarpium is a pome beneath, with two cells: the ſeeds are numerous. For the moſt approved methods of cultivating melons, ſee the treatiſe on GARDENING, article KITCHEN-GARDEN, Months January, February, March, May, and June.

ANIMAL, in natural hiſtory, an organized and living body, which is alſo endowed with ſenſation: thus, minerals are ſaid to grow or increaſe, plants to grow and live, but animals alone to have ſenſation.

It is this property of ſenſation alone that can be deemed the eſſential characteriſtic of an animal; and by which the animal and vegetable kingdoms ſeem to be ſo eſſentially ſeparated, that we cannot even imagine the leaſt approximation of the one to the other. Thoſe naturaliſts, indeed, who have ſuppoſed the diſtinction between animals and vegetables to conſiſt in any thing elſe than what we have already mentioned, have found themſelves greatly embarraſſed; and have generally agreed, that it was extremely difficult, if not impoſſible, to ſettle the boundaries between the animal and vegetable kingdoms. But this difficulty will be eaſily ſeen to ariſe from their taking the characteriſtic marks of the animal kingdom, from ſomething that was evidently common to both. Thus Boerhaave attempted to diſtinguiſh an animal from a vegetable, by the former having a mouth, which the latter has not: but here, as the mouth of an animal is only the inſtrument by which nouriſhment is conveyed to its body, it is evident that this can be no eſſential diſtinction, becauſe vegetables alſo require nouriſhment, and have inſtruments proper for conveying it into their bodies; and where the end is the ſame, a difference in the means can never be eſſential. The fixing the difference in an animal's having a gula, ſtomach, and inteſtines, as is done by Dr. Tyſon, is as little to the purpoſe.

The power of moving from one place to another, hath by many been thought to conſtitute their difference; and indeed, in moſt caſes, it is the obvious mark by which we diſtinguiſh an animal from a vegetable: but Lord Kames hath given ſeveral very curious inſtances of the locomotive power of plants; ſome of which, as he ſays, would do honour to an animal.—"Upon the ſlighteſt touch, the ſenſitive plant ſhrinks back and folds up its leaves, ſimilar to a ſnail; which on the ſlighteſt touch retires within its ſhell. A new ſpecies of the ſenſitive plant hath been lately diſcovered. If a fly perch upon one of its flower-leaves, it cloſes inſtantly, and cruſhes the inſect to death. There is not an article in botany more admirable than a contrivance, viſible in many plants, to take advantage of good weather, and to protect themſelves againſt bad. They open and cloſe their flowers and leaves in different circumſtances: ſome cloſe before ſunſet, ſome after: ſome open to receive rain, ſome cloſe to avoid it. The petals of many flowers expand in the ſun; but contract at night, or on the approach of rain. After the ſeeds are fecundated, the petals no longer contract. All the trefoils may ſerve as a barometer to the huſbandman; they always contract their leaves on an impending ſtorm. Some plants follow the ſun, others turn from it. Many plants, on the ſun's receſs, vary the poſition of their leaves, which is ſtyled the *ſleep of plants*. A ſingular plant was lately diſcovered in Bengal. Its leaves are in continual motion all day long; but when night approaches, they fall down from an erect poſture to reſt.

"A plant has a power of directing its roots for procuring food. The red whortle-berry, a low evergreen plant, grows naturally on the tops of our higheſt hills, among ſtones and gravel. This ſhrub was planted in an edging to a rich border, under a fruit-wall. In two or three years, it over-ran the adjoining deep-laid gravel-walk; and ſeemed to fly from the border, in which not a ſingle runner appeared. An effort to come at food in a bad ſituation, is extremely remarkable in the following inſtance. Among the ruins of Newabbey, formerly a monaſtery in Galloway, there grows on the top of a wall a plane-tree about 20 feet high. Straitened for nouriſhment in that barren ſituation, it ſeveral years ago directed roots down the ſide of the wall, till they reached the ground ten feet below; and now the nouriſhment it afforded to thoſe roots during the time of their deſcending is amply repaid, having every year ſince that time made vigorous ſhoots. From the top of the wall to the ſurface of the earth, theſe roots have not thrown out a ſingle fibre; but are now united in a ſingle root.

"Plants, when forced from their natural poſition, are endowed with a power to reſtore themſelves. A hop-plant, twiſting round a ſtick, directs its courſe from ſouth to weſt, as the ſun does. Untwiſt it, and tie it in the oppoſite direction: it dies. Leave it looſe in the wrong direction: it recovers its natural direction in a ſingle night. Twiſt a branch of a tree ſo as to invert its leaves, and fix it in that poſition: if left in any degree looſe, it untwiſts itſelf gradually, till the leaves be reſtored to their natural poſition. What better can an animal do for its welfare? A root of a tree meeting with a ditch in its progreſs, is laid open to the air. What follows? It alters its courſe like a rational being, dips into the ground, ſurrounds the ditch, riſes on the oppoſite ſide to its wonted diſtance from the ſurface, and then proceeds in its original direction. Lay a wet ſponge near a root laid open to the air; the root will direct its courſe to the ſponge. Change the place of the ſponge; the root varies its direction. Thruſt a pole into the ground at a moderate diſtance from a ſcendent plant; the plant directs its courſe to the pole, lays hold of it, and riſes on it to its natural height. A honeyſuckle proceeds in

its courſe, till it be too long for ſupporting its weight; and then ſtrengthens itſelf by ſhooting into a ſpiral. If it meet with another plant of the ſame kind, they coaleſce for mutual ſupport; the one ſerewing to the right, the other to the left. If a honeyſuckle twig meets with a dead branch, it ſerews from the right to the left. The claſpers of briony ſhoot into a ſpiral, and lay hold of whatever comes in their way for ſupport. If, after completing a ſpiral of three rounds, they meet with nothing, they try again by altering their courſe."

By comparing theſe and other inſtances of ſeeming voluntary motion in plants, with that ſhare of life wherewith ſome of the inferior kinds of animals are endowed, we can ſcarce heſitate at aſcribing the ſuperiority to the former; that is, putting ſenſation out of the queſtion. Muſcles, for inſtance, are fixed to one place as much as plants are; nor have they any power of motion, beſides that of opening and ſhutting their ſhells: and in this reſpect they have no ſuperiority over the motion of the ſenſitive plant; nor doth their action diſcover more ſagacity, or even ſo much, as the roots of the plane-tree mentioned by Lord Kames.

Mr. Buffon, who ſeems to be deſirous of confounding the animal and vegetable kingdoms, denies ſenſation to be any eſſential diſtinction. "Senſation (ſays he) more eſſentially diſtinguiſhes animals from vegetables; but ſenſation is a complex idea, and requires ſome explication. For if ſenſation implied no more than motion conſequent upon a ſtroke or an impulſe, the ſenſitive plant enjoys this power. But if, by ſenſation, we mean the faculty of perceiving and comparing ideas, it is uncertain whether brute animals are endowed with it. If it ſhould be allowed to dogs, elephants, &c. whoſe actions ſeem to proceed from motives ſimilar to thoſe by which men are actuated, it muſt be denied to many ſpecies of animals, particularly to thoſe which appear not to poſſeſs the faculty of progreſſive motion. If the ſenſation of an oyſter, for example, differed only in degree from that of a dog, why do we not aſcribe the ſame ſenſation to vegetables, though in a degree ſtill inferior? This diſtinction, therefore, between the animal and vegetable, is neither ſufficiently general nor determined.

"From this inveſtigation we are led to conclude, that there is no abſolute and eſſential diſtinction between the animal and vegetable kingdoms; but that nature proceeds, by imperceptible degrees, from the moſt perfect to the moſt imperfect animal, and from that to the vegetables; and the freſh-water polypus may be regarded as the laſt of animals and the firſt of plants." It were to be wiſhed, that philoſophers would on ſome occaſions conſider, that a ſubject may be dark as well on account of their inability to ſee, as when it really affords no light. Our author boldly concludes, that there is no eſſential difference between a plant and an animal, becauſe we aſcribe ſenſation to an oyſter, and none to the ſenſitive plant; but we ought to remember, that though we cannot perceive a diſtinction, it may nevertheleſs exiſt. Before Mr. Buffon, therefore, had concluded in this manner, he ought to have proved that ſome vegetables were endowed with ſenſation.

It is no doubt, however, as much incumbent on thoſe who take the contrary ſide of the queſtion, to prove that vegetables are not endowed with ſenſation, as it was incumbent on Mr. Buffon to have proved that they are. But a little attention will ſhow us, that the difficulty here proceeds entirely from our inability to ſee the principle of ſenſation. We perceive this principle in ourſelves, but no man can perceive it in another. Why then does every individual of mankind conclude that his neighbour has the ſame ſenſations with himſelf? It can only be from analogy. Every man perceives his neighbour formed in a manner ſimilar to himſelf; he acts in a ſimilar manner on ſimilar occaſions, &c. Juſt ſo it is with brute animals. It is no more doubtful that they have ſenſations, than that we have them ourſelves. If a man is wounded with a knife, for inſtance, he expreſſes a ſenſe of pain, and endeavours to avoid a repetition of the injury. Wound a dog in the ſame manner, he will alſo expreſs a ſenſe of pain; and, if you offer to ſtrike him again, will endeavour to eſcape, before he feels the ſtroke. To conclude here, that the action of the dog proceeded from a principle different from that of the man, would be abſurd and unphiloſophical to the laſt degree.

We muſt further take notice, that there are ſenſations eſſentially diſtinct from one another; and in proportion as an animal is endowed with more or fewer of theſe different ſpecies, it is more or leſs perfect as an animal: but, as long as one of them remains, it makes not the leaſt approach to the vegetable kingdom; and, when they are all taken away, is ſo far from becoming a vegetable, that it is only a maſs of dead matter. The ſenſes of a perfect animal, for inſtance, are five in number. Take away one of them, ſuppoſe ſight; he becomes then a leſs perfect animal, but is as unlike a vegetable as before. Suppoſe him next deprived of hearing; his reſemblance to a vegetable would be as little as before; becauſe a vegetable can neither feel, taſte, nor ſmell, and we ſuppoſe him ſtill to enjoy theſe three ſenſes. Let us, laſtly, ſuppoſe him endowed only with the ſenſe of feeling, which, however, ſeems to include that of taſte, and he is no more a vegetable than formerly, but only an imperfect animal. If this ſenſe is then taken away, we connect him not with the vegetable kingdom, but with what Mr. Buffon calls *brute-matter*. It is to this kingdom, and not to the vegetable, that animals plainly approximate as they deſcend. Indeed, to ſuppoſe an approximation between the vegetable and animal kingdoms, is very abſurd: for, at that rate, the moſt imperfect animal ought to be the moſt perfect plant; but we obſerve no ſuch thing. All animals, from the higheſt to the loweſt, are poſſeſſed of vegetable life; and that, as far as we can perceive, in an equal degree, whether the animal-life is perfect or imperfect: nor doth there ſeem to be the ſmalleſt connection between the higheſt degree of vegetation and the loweſt degree of ſenſation. Though all animals, therefore, are poſſeſſed of vegetable life, theſe two ſeem to be as perfectly diſtinct and incommenſurate to one another as any two things we can poſſibly imagine.

The power of vegetation, for inſtance, is as perfect in an onion or leek, as in a dog, an elephant, or a man: and yet, though you threaten a leek or an onion ever ſo much, it pays no regard to your words, as a dog would do; nor, though you wound it, does it avoid a ſecond ſtroke. It is this principle of ſelf-preſervation in all animals, which, being the moſt powerful one in their nature, is generally taken, and with very good reaſon, as the true characteriſtic of animal-life. This principle is undoubtedly a conſequence of ſenſation; and as it is never obſerved to take place in vegetables, we have a right to ſay that the foundation of it, namely ſenſation, belongs not to them. There is no animal, which makes any motion in conſequence of external impulſe where danger is threatened, but what puts itſelf in a poſture of defence; but no vegetable whatever does ſo. A muſcle, when it is touched, immediately ſhuts its ſhell; and as this action puts it in a ſtate of defence, we conclude that it proceeded from the principle of ſelf-preſervation. When the ſenſitive plant contracts from a touch, it is no more in a ſtate of defence than before; for whatever would have deſtroyed it in its expanded ſtate, will alſo do it in its contracted ſtate. We conclude, therefore, that the motion of the ſenſitive plant proceeds only from a certain property called by phyſicians *irritability:* and which, though our bodies poſſeſs it in an eminent degree, is a characteriſtic neither of animal nor vegetable life, but belongs to us in common with brute matter. It is certain, that an electrified ſilk-thread ſhews a much greater variety of motions than any ſenſitive plant. If a bit of ſilk-thread is dropped on an electrified metal-plate, it immediately erects itſelf; ſpreads out the ſmall fibres like arms; and, if not detained, will fly off. If a finger is brought near it, the thread ſeems greedily to catch at it. If a candle approaches, it claps cloſe to the plate, as if afraid of it.—Why do we not conclude that the thread in this caſe is really afraid of the candle? For this plain reaſon, That its ſeeming flight is not to get away from the candle, but to get towards the electrified metal; and, if allowed to remain there, will ſuffer itſelf to be burnt without offering to ſtir.—The ſenſitive plant, in like manner, after it has contracted, will ſuffer itſelf to be cut in pieces, without making the leaſt effort to eſcape. The caſe is not ſo with the meaneſt animal. An hedge-hog, when alarmed, draws its body together, and expands its prickles, thereby putting itſelf in a poſture of defence. Throw it into water; and the ſame principle of ſelf-preſervation prompts it to expand its body and ſwim. A ſnail, when touched, withdraws itſelf into its ſhell; but if a little quicklime is ſprinkled upon it, ſo that its ſhell is no longer a place of ſafety, it is thrown into agonies, and endeavours to avail itſelf of its locomotive power in order to eſcape the danger. In muſcles and oyſters, indeed, we cannot obſerve this principle of ſelf preſervation ſo ſtrongly, as nature has deprived them of the power of progreſſive motion: but, as we obſerve them conſtantly to uſe the means which nature has given them for ſelf-preſervation, we can have no reaſon to think that they are deſtitute of that principle upon which it is founded.

But there is no need of arguments drawn from the inferior creation. We ourſelves are poſſeſſed both of the animal and vegetable life, and certainly muſt know whether there is any connection between vegetation and ſenſation or not. We are conſcious that we exiſt; that we hear, ſee, &c. but of our vegetation we are abſolutely inconſcious. We feel a pleaſure for inſtance, in gratifying the calls of hunger and thirſt; but of the proceſs by which our aliment is formed into chyle, the chyle mixed with the blood, the circulation of that fluid, and the ſeparation of all the humours from it, we are altogether ignorant. If we then, who are more perfect than other vegetables, are utterly inſenſible of our own vegetable life, why ſhould we imagine that the leſs perfect vegetables are ſenſible of it?

To illuſtrate our reaſoning here by an example: The direction of the roots of the plane-tree mentioned by Lord Kames, ſhews as much ſagacity, if we are to look only to the outward action, as can be obſerved in any motion of the moſt perfect animal whatever; nevertheleſs, we have not the leaſt ſuſpicion, either that the tree ſaw the ground at a diſtance, or that it was informed of its being there by the reſt of its roots. If a wound is made in the body of a man, and a loſs of ſubſtance is to be repaired, the ſame ſagacity will be obſerved in the arrange-

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ment of the fibres, not only as if they were animated, but they will diſpoſe of themſelves ſeemingly with a degree of wiſdom far ſuperior to what we have any idea of; yet this is done without our having the leaſt knowledge either how it is done, or of its being done at all. We have therefore in ourſelves a demonſtration, that vegetable life acts without knowing what it does: and if vegetables are ignorant of their moſt ſagacious actions, why ſhould we ſuſpect that they have a ſenſation, let it be ever ſo obſcure, of any of their inferior ones, ſuch as contracting from a touch, turning towards the ſun, or advancing to meet a pole?

Thus we may eaſily give Mr. Buffon a reaſon why we aſcribe ſenſation to an oyſter, and none to a vegetable; namely, becauſe we perceive the vegetable do nothing but what is alſo performed in our own bodies, without our having the leaſt ſenſation of it; whereas an oyſter puts itſelf in a defenſive poſture on the approach of danger: and this being an action ſimilar to our own upon a like occaſion, we conclude that it proceeds from the ſame principle of ſenſation. Here it may alſo be obſerved, that though the inferior animals are deficient in the number, they are by no means ſo in the acuteneſs of their ſenſations; on the contrary, though a muſcle or an oyſter is probably endowed with no other ſenſe than that of feeling, yet this ſenſe is ſo exquiſite, that it will contract upon the ſlighteſt touch, ſuch as we would be altogether inſenſible of.

As to that power of contractility, or irritability, which is obſerved in ſome plants; our ſolids have it, when deprived both of vegetable and animal life: for a muſcle, cut out of a living body, will continue to contract, if it is irritated by pricking it, after it has neither ſenſation nor vegetation.

A very good moral reaſon may alſo be adduced why we do not believe vegetables to be endowed with ſenſation. Had they been ſo, we muſt ſuppoſe them to ſuffer pain when they are cut or deſtroyed; and, if ſo, what an unhappy ſtate muſt they be in, who have not the leaſt power to avoid the injuries daily offered them? In fact, the goodneſs of the Deity is very conſpicuous in not giving to vegetables the ſame ſenſations as to animals; and, as he hath given them no means of defence, though we had not been told it by himſelf, we might have known that he gave them for food to animals; and, in this caſe, to have endowed them with ſenſation would have been a piece of cruelty. Though animals without number prey upon one another, yet all of them have ſome means of defence; from whence we may juſtly conclude, that their mutual deſtruction was not an original appointment of the Creator, but what he foreſaw would happen in a courſe of time, and which he therefore gave every one of them ſome means of guarding againſt. It may no doubt be here objected, that the giving ſome means of ſelf-defence to every animal cannot be reckoned a ſufficient proof that it was not the original deſign of the Creator that they ſhould be deſtroyed, ſeeing theſe means are not always effectual for their preſervation. This objection, however, cannot be completely obviated without a ſolution of the queſtion concerning the origin of evil among the works of a perfectly good Being. But whatever difficulty there may be in ſolving this queſtion, it is certain, that as ſome means of ſelf-defence is given to every animal, it has been the original deſign of the Creator, that in all caſes one ſpecies of animals ſhould not be deſtroyed at the pleaſure of any other ſpecies; and as no means of ſelf-defence is given to any vegetable, it is plain that they have been deſtined for a prey to every ſpecies of animals that had acceſs to them. Philoſophers have inſiſted much on the neceſſity of one animal's devouring another, that there might be room ſufficient for all; but this, ſo far from being a ſyſtem worthy of the Divine wiſdom, ſeems to us to be a reflection upon it, as if the Author of nature could not have found means to preſerve the life of one part of his creatures, without the deſtruction and miſery of the reſt.

Naturaliſts mention a certain power, totally different from that of attraction or repulſion, by which the food of a plant, after it was attracted or otherwiſe brought to it, was aſſimilated to its ſubſtance. For further particulars concerning this ſubject, ſee the Syſtem of AGRICULTURE, Section II. under the head FOOD OF PLANTS. This power, diſtinguiſhed by the name of *tranſmutation*, belongs in a more eminent degree to animals. The alimentary ſubſtance is changed into two kinds of matter. (1.) An excrementitious one, which paſſes off through the inteſtines; and (2.) A fluid, which is the direct pabulum of the animal. Different ſubſtances, however, are not equally changeable by this proceſs. The human ſtomach is not capable of acting upon any animal ſubſtance till it has loſt its vital principle: the ſtomachs of ſome animals cannot act upon creatures of their own ſpecies: ſome have an apparatus for grinding their food after it is ſwallowed, &c. and there are no animals but what are ſubject to death by taking certain ſubſtances into their ſtomach. Some ſubſtances alſo, though they reſiſt the action of the ſtomach, and paſs unchanged into the ſyſtem, produce no bad effects. Thus, madder will turn the bones of animals red; rhubarb will communicate its purgative nature to the milk, and its deep yellow colour to the urine. All theſe changes, however, ſeem to belong to the vegetative part of our ſyſtem: for as every one of them are performed without our knowledge of the manner how; and not only ſo, but while we are abſolutely unconſcious of their being done; we can have no reaſon to ſuppoſe, that the *animal* life, properly ſo called, is at all connected with them, any farther than as they are at preſent the means of preſerving the creature alive, and making the connection betwixt the principle of life and this viſible creation.

The animal kingdom, among naturaliſts, forms the firſt of the three diviſions in Natural Hiſtory, called Zoology; the ſecond being called Botany, or the vegetable kingdom; and the third Mineralogy, or the mineral kingdom. The animal kingdom is divided into ſix claſſes, viz. 1. Mammalia, 2. Ornithology, 3. Ichthyology, 4. Entomology, 5. Amphibiology, 6. Vermeology. The reſpective claſſes compriſe ſuch a number of animals, that few naturaliſts are acquainted with the whole of the ſix claſſes; contenting themſelves, generally, with a minute inveſtigation of one out of the ſix; for which reaſon the animal kingdom is divided into the above ſix ſyſtems, which the reader, by referring to in this work, will find an enumeration of all the orders and genera that belong to each ſyſtem: and as the genera are enumerated in the ſyſtem, it will ſerve as an index to thoſe parts of the alphabet, where he will find a deſcription of every animal belonging to each genus.

For the claſſification of the ſeveral animals which compoſe this extenſive kingdom of nature, with the reſpective characters of each claſs, ſee the article ZOOLOGY; and for curious remarks and obſervations on the animal kingdom in general, reſpecting propagation, preſervation, uſe, &c. ſee the Treatiſe on NATURAL HISTORY, Sect. IV. throughout.

ANIMAL, uſed adjectively, denotes any thing belonging to, or partaking of, the nature of animals. Thus, animal actions, thoſe that are peculiar to animals; ſuch are ſenſation and muſcular motion.

ANIMALS conſiſt of ſolids, or firm parts, as fleſh, bones, membranes, &c. and fluids, as blood, &c. Of an intermediate kind, may perhaps be reckoned fat, &c. The ſolids are mere earth, bound together by ſome oily humour, and accordingly they are reducible by fire into ſuch earth again. Thus a bone, being perfectly purged of all its moiſture by calcination, is found a mere earth, which the leaſt force will crumble into duſt, for want of the natural gluten: yet the ſame bone, by immerging it in water or oil, becomes firm and ſtrong again; and more ſo in oil than in water. And thus cupels are made of animal earth, which will ſuſtain the utmoſt effect of fire. The fluid parts of animals are the cruder as they are leſs diſtant from the lacteals, and abſorbent veſſels. Thus chyle is little elſe but a vegetable juice: but in its farther progreſs, it gradually lays aſide its vegetable characters, till after a number of circulations it becomes a perfect animal juice under the denomination of blood, from whence the humours are all derived. Animal ſubſtances have been diſtinguiſhed from thoſe of vegetables by two circumſtances: the firſt, that when burnt they are found perfectly inſipid; all animal ſalts being volatile, and flying off with heat: the contrary of which is found in vegetables, which conſtantly retain ſome fixed ſalt in all their aſhes. The ſecond, that no pure acid is contained in any animal juice; nor can any acid ſalt be extracted from the ſame; the contrary of which is found in all vegetables. See ACID.

ANIMAL-*Flower*, in vermeology, a name given to ſeveral ſpecies of animals belonging to the genus of actinia. They have likewiſe been diſtinguiſhed by the names of *urtica marina*, or *ſea-nettle*, from their ſuppoſed property of ſtinging; and *ſea-anemone*, from their claws or tentacles being diſpoſed in regular circles, and tinged with a variety of bright lively colours, reſembling the petals of ſome of our moſt beautiful flowers. As to one ſpecies, particularly mentioned by Abbe Diequemarre, (Phil. Tranſ. for 1778, art. 37.) the pureſt white, carmine, and ultramarine, are ſaid to be ſcarce ſufficient to expreſs their brilliancy. The bodies of ſome of them are hemiſpherical, of others cylindrical, and of others ſhaped like a fig. Their ſubſtance likewiſe differs; ſome are ſtiff and gelatinous, others fleſhy and muſcular; but all of them are capable of altering their figure when they extend their bodies and claws in ſearch of food. They are found in many of the rocky coaſts of the Weſt India iſlands, and likewiſe on ſome parts of the coaſt of England.

They have only one opening, which is in the centre of the uppermoſt part of the animal; round this are placed rows of fleſhy claws; this opening is the mouth of the animal, and is capable of great extenſion. The animals themſelves, though exceedingly voracious, will bear long faſting. They may be preſerved alive a whole year, or perhaps longer, in a veſſel of ſea-water, without any viſible food; but, when food is preſented, one of them will ſucceſſively devour two muſcles in their ſhells, or even ſwallow a whole crab as large as a hen's egg. In a day or two the crab-ſhell is voided at the mouth, perfectly cleared of all the meat. The muſcle-ſhells are likewiſe diſcharged whole, with the two ſhells joined together, but entirely empty, ſo that not the leaſt particle of fiſh is to be perceived on opening them. An anemone of one ſpecies will even ſwallow an individual of another ſpecies; but, after retaining it ten or twelve hours, will throw it up alive and uninjured,

jured. Through this opening alſo it produces its young ones alive, already furniſhed with little claws, which, as ſoon as they fix themſelves, they begin to extend in ſearch of food.

One of the extremities of the ſea-anemone reſembles, as we have ſaid, the outward leaves of that flower; while its limbs are not unlike the ſhag or inner part of it. By the other extremity it fixes itſelf, as by a ſucker, to the rocks or ſtones lying in the ſand; but it is not totally deprived of the power of progreſſive motion, as it can ſhift its ſituation, though very ſlowly.

ANIMAL *ſpirits* are a fine ſubtle juice or humour in animal bodies; ſuppoſed by many to be the great inſtrument of muſcular motion, ſenſation, &c. The ancients diſtinguiſhed ſpirits into three kinds, viz. *animal*, *vital*, and *vegetative*: but the moderns have reduced them to one ſort, viz. *animal*; about the nature of which, and the matter whence they are formed, great diſputes have ariſen among anatomiſts, though their very exiſtence has never been fairly proved. In the Hiſtory of the Royal Academy of Sciences at Paris, an. 1759, there is an ingenious memoir on this ſubject by M. Bertin. He undertakes to prove that the nervous fluid, or animal ſpirits, circulate; that if they depart from the brain, they return to it by the nerves. In ſhort, he propoſes to form the courſe of this fluid into a ſyſtem of circulation, leſs demonſtrable, indeed, to the ſenſes than that of the circulation of the blood, but in other reſpects, grounded on equally ſolid reaſons. As it is hard to define what could never yet be brought under the judgment of our ſenſes, all that we ſhall here offer concerning them, is, that they muſt needs be extremely ſubtile bodies, which eſcape all manner of examination by the ſenſes, though ever ſo well aſſiſted; and pervade the tracts of the nerves, which yet have no diſcovery of cavity or perforation; nor could ever by any experiment be collected; yet are conſtantly moving in vaſt quantities, as they muſt of neceſſity be, to perform all thoſe mighty operations which are aſcribed to them. However the antiquity of the opinion claims ſome reverence. By the help of theſe ſpirits we are furniſhed with a vaſt number of precarious ſolutions of great phenomena; and without them we muſt leave a great chaſm in the philoſophical hiſtory of animal bodies; but after all, the phenomena that would in this caſe be unexplained, are, it may be, to us inexplicable. They are ſuppoſed to be ſeparated in the brain, from the ſubtileſt parts of the blood; and thence carried, by the nerves, to all parts of the body, for the performance of all animal and vital functions. See the Syſtem of ANATOMY, Part V. Sect. II. and Plate XII.

ANIMALCULE, in general, ſignifies a little animal; and thus the term might be applied to every animal which is conſiderably inferior in ſize to ourſelves. It hath been cuſtomary, however, to diſtinguiſh by the name of *animalcules* only ſuch animals as are of a ſize ſo diminutive, that their true figure cannot be diſcerned without the aſſiſtance of glaſſes; and more eſpecially it is applied to ſuch as are altogether inviſible to the naked eye, and cannot even be perceived to exiſt but by the aſſiſtance of microſcopes.

By the help of magnifying glaſſes, we are brought into a kind of new world; and numberleſs animals are diſcovered, which from their minuteneſs muſt otherwiſe for ever have eſcaped our obſervation: and how many kinds of theſe inviſibles there may be, is ſtill unknown; as they are diſcerned of all ſizes, from thoſe which are barely inviſible to the naked eye, to ſuch as reſiſt the action of the microſcope, as the fixed ſtars do that of the teleſcope, and with the beſt magnifiers hitherto invented appear only as ſo many moving points.

The ſmalleſt living creatures our inſtruments can ſhow are thoſe that inhabit the waters: for though poſſibly animalcules equally minute, or perhaps more ſo, may fly in the air, or creep upon the earth, it is ſcarce poſſible to bring ſuch under our examination; but water being tranſparent, and confining the creatures in it, we are able, by applying a drop of it to our glaſſes, to diſcover, to a certain degree of ſmallneſs, all that it contains. For a deſcription of the moſt curious of theſe animalcules, extracted from the accounts of the moſt accurate microſcopical obſervers, ſee the Article MICROSCOPIC OBJECTS. For repreſentation, ſee Plate I. and II.

ANIMATE, ANIMATED, ſomething endued with life, or a living ſoul. In mechanics, *animate power* is uſed to denote a man or brute; in contradiſtinction to *inanimate power*, as ſprings, weights, &c. Naturaliſts and philoſophers vary extremely in aſſigning the characters, ſubjects, and ſpecies of animate bodies. Some include ſtocks and ſtones in this rank; others exclude brutes themſelves. Some of the philoſophers have held all nature to be animated; that the ſun, the earth, the planets, rivers, trees, ſtones, &c. are ſo many animals; others, that the whole ſyſtem is only one huge animal, informed with a ſoul, or *anima mundi*. Plato, in Timæo. Morhoff. Polyh. Phil. lib. ii. p. i. cap. 11.

ANIMATED is alſo uſed to denote a thing impregnated with vermin or *animalcules*. In this ſenſe the whole earth may ſeem to be animated; ſince in every part of it we meet with an infinite number of animals, either viſible or inviſible: they are found in air, water, earth, plants, and even in the hardeſt ſtones; and there is perhaps no animal known, which does not breed numbers of others in the different parts of its body.

ANIMATION ſignifies the informing an animal body with a ſoul. The different hypotheſes of phyſicians and philoſophers, concerning the time of animation, have had their influence on the penal laws made againſt artificial abortions; it having been made capital to procure miſcarriage in the one ſtate, while in the other it was only deemed a venial crime. The emperor Charles V. by a conſtitution publiſhed in 1532, put the matter on another footing; inſtead of the diſtinction of an animated and unanimated fœtus, he introduced that of a vital and non-vital fœtus, as a thing of more obvious and eaſy deciſion, and not depending on any ſyſtem either of creation, traduction, or infuſion. Accordingly a fœtus is ſaid, in a legal ſenſe, to be animated, when it is perceived to ſtir in the womb, which uſually happens about the middle of the term of geſtation.

ANISE-SEED, a medicinal ſeed, produced by an umbelliferous plant of the ſame name, common in ſome gardens. The outer thin ſkin of the ſeeds of this plant contains an eſſential oil; and the kernel itſelf contains an inodorous expreſſible oil. It can only operate as a mere reſinous ſubſtance, and may therefore be, not improperly, ſupplied by cheaper reſins The plant is a ſpecies of *pimpinella*, or *burnet ſaxifrage*. It is a ſmall tender plant, producing one ſtalk, ſeldom ariſing above two feet high. It flowers and ſeeds in July, the root dying every year after it has yielded ſeed. It is cultivated in Germany; but the beſt ſeed, which is a ſmaller ſort, comes from Spain. The ſeed only is uſed, being one of the four greater hot ſeeds. *Aniſe-ſeed* is carminative, expelling wind out of the ſtomach and bowels both given at the mouth and in clyſters. It is frequently put into children's victuals for the gripes and wind. It is very uſeful againſt cold affections of the lungs, difficulty of breathing, and aſthma. Some commend it much to be taken frequently by nurſes to increaſe their milk. It is often uſed as a corrector of the ſtronger purgative medicines. The oil diſtilled from the ſeed is uſed for the ſame purpoſes; and is often applied outwardly in carminative and anodyne liniments; particularly for the pleuriſy, and other pains in the ſide.

ANNALS, in matters of literature, a ſpecies of hiſtory, which relates events in the chronological order wherein they happened. They differ from perfect hiſtory in this, that annals are but a bare relation of what paſſes every year, as a journal is of what paſſes every day; whereas hiſtory relates not only the tranſactions themſelves, but alſo the cauſes, motives, and ſprings of actions. Annals require nothing but brevity; hiſtory demands ornament. Cicero informs us of the origin of annals. To preſerve the memory of events, the *Pontifex Maximus*, ſays he, wrote what paſſed each year, and expoſed it on tables in his own houſe, where every one was at liberty to read: this they called *annales maximi*; and hence the writers who imitated this ſimple method of narrating facts were called *analiſts*.

ANNEALING, by the workmen called *nealing*, is particularly uſed in making glaſs: it conſiſts in placing the bottles, &c. whilſt hot, in a kind of oven or furnace, where they are ſuffered to cool gradually; they would otherwiſe be too brittle for uſe. Metals are rendered hard and brittle by hammering: they are therefore made red hot, in order to recover their malleability; and this is called *nealing*.

The difference between unannealed and annealed glaſs, with reſpect to brittleneſs, is very remarkable. When an unannealed glaſs-veſſel is broken, it often flies into a ſmall powder, with a violence ſeemingly very unproportioned to the ſtroke it has received. In general, it is in greater danger of breaking from a very ſlight ſtroke than from one of ſome conſiderable force. One of thoſe veſſels will often reſiſt the effects of a piſtol-bullet dropt into it from the height of two or three feet; yet a grain of ſand falling into it, will make it burſt into ſmall fragments. This takes place ſometimes immediately on dropping the ſand into it: but often the veſſel will ſtand for ſeveral minutes after, ſeemingly ſecure; and then, without any new injury, it will fly to pieces. If the veſſel be very thin, it does not break in this manner, but ſeems to poſſeſs all the properties of annealed glaſs.

The ſame phenomena are ſtill more ſtrikingly ſeen in glaſs drops or tears. They are globular at one end and taper to a ſmall tail at the other. They are the drops which fall from the melted maſs of glaſs on the rods on which the bottles are made. They drop into the tubs of water which are uſed in the work; the greater part of them burſt immediately in the water. When thoſe that remain entire are examined, they diſcover all the properties of unannealed glaſs in the higheſt degree. They will bear a ſmart ſtroke on the thick end without breaking; but if the ſmall tail be broken, they burſt into ſmall powder with a loud exploſion. They appear to burſt with more violence, and the powder is ſmaller in an exhauſted receiver than in the open air. When they are annealed, they loſe thoſe properties.

By the proceſs of annealing, the glaſs is kept for ſome time in a ſtate approaching to fluidity; the heat increaſes the bulk of the cryſtallized part, and renders it ſo ſoft, that the internal parts have the opportunity of expanding and forming a regular cryſtallization.

A ſimilar proceſs is now uſed for rendering kettles and other veſſels of caſt-iron leſs brittle: of it the ſame explanation may be given. The greater number of metals diminiſh in bulk when they paſs from a fluid to a ſolid ſtate; iron, on the contrary, expands.

When caſt-iron is broken, it has the appearance of being compoſed of grain; forged or bar iron appears to conſiſt of plates. Forged iron has long been procured, by placing a maſs of caſt-iron under large hammers, and making it undergo violent and repeated compreſſion. A proceſs is now uſed for converting caſt-iron into forged, by heat alone. The caſt-iron is placed in an air-furnace, and kept for ſeveral hours in a degree of heat, by which it is brought near to a fluid ſtate. It is then allowed to cool gradually, and is found to be converted into forged-iron. This proceſs is conducted under a patent; although, if Reaumur's experiments upon caſt-iron be conſulted, it will appear not to be a new diſcovery.

By theſe experiments, it is aſcertained, that if caſt-iron be expoſed for any length of time to a heat conſiderably below its melting point, the texture and properties are not changed: but if it be kept in a heat near the melting point, the ſurface ſoon becomes lamellated like forged-iron; and the lamellated ſtructure extends farther into the maſs in proportion to the length of time in which it is expoſed to that degree of heat. When it is continued for a ſufficient time, and then allowed to cool gradually, it is found to poſſeſs the lamellated ſtructure throughout.

Caſt-iron, then, is brittle, becauſe it has not had the opportunity of cryſtallizing regularly. When it is expoſed to cold while fluid, the ſurface becoming ſolid, prevents the inner parts from expanding and arranging themſelves into regular cryſtals. When caſt-iron is brought near to the melting point, and continued for a ſufficient length of time in that degree of heat, the particles have the opportunity of arranging themſelves into that form of cryſtals by which forged-iron is diſtinguiſhed, and by which it poſſeſſes coheſion and all its properties.

There appears, therefore, to be no other eſſential difference between forged and caſt iron, except what ariſes from the cryſtallization. Caſt-iron is indeed often not ſufficiently purified from other ſubſtances which are mixed with the calx. It appears alſo to contain a conſiderable quantity of calx unreduced; for during the proceſs for converting it into forged iron by heat alone, a pale flame riſes from the metal till near the end of the proceſs. This is owing to fixed air which the heat forces off from the calx. The expulſion of this air reduces the calx, and thereby frees the metal from that injurious mixture.

That this explanation of the annealing of iron is probable, appears alſo from the well-known fact of forged-iron being incomparably more difficult of fuſion than caſt-iron. A piece of forged-iron requires a very violent heat to melt it; but when it is reduced to a ſmall powder, it melts in a much lower degree of heat. Iron diminiſhes in bulk when it paſſes into a fluid ſtate, while moſt other metals increaſe in volume. The expanſion which heat occaſions in bringing them to their melting-point, will be favourable to their fluidity, by gradually bringing the particles to the ſame ſtate of ſeparation in which they are when the maſs is fluid; but the expanſion of iron by heat removes it farther from that ſtate, and keeps it in the ſtate which is favourable to the continuance of it in a cryſtallized form. It will not melt till the heat expand it ſo much that the coheſion of cryſtallization be overcome. When it is reduced to a minute powder before it be expoſed to the heat, it melts ſooner. The cryſtals having been deſtroyed, that coheſion has no effect in preventing it from paſſing into a ſtate of fluidity.

Upon the ſame principles may be explained the almoſt peculiar property of welding poſſeſſed by iron, and the converſion of forged iron into ſteel.

ANNIHILATION, the act of reducing any created being into nothing. Chriſtians, Heathens, Jews, Siameſe, Perſians, divines, philoſophers, &c. have their peculiar ſyſtems, ſentiments, conjectures, not to ſay dreams, concerning annihilation; and we find great diſputes among them about the reality, the poſſibility, the means, meaſures, prevention, ends, &c. of annihilation. We ſhall therefore ſubjoin the following opinions, ſubmitting their propriety to the judgement of our readers.

The firſt notions of the production of a thing from, or reduction of it to, nothing, Dr. Burnet ſhows, aroſe from the Chriſtian theology; the words *creation* and *annihilation*, in the ſenſe now given to them, having been equally unknown to the Hebrews, the Greeks, and the Latins.

The ancient philoſophers in effect denied all annihilation as well as creation, reſolving all the changes in the world into new modifications, without ſuppoſing the production of any thing new, or deſtruction of the old. By daily experience, they ſaw compounds diſſolved; and that in their diſſolution nothing periſhed but their union or connection of parts: when in death the body and ſoul were ſeparated, the man they held was gone, but that the ſpirit remained in its original the great ſoul of the world, and the body in its earth from whence it came; theſe were again wrought by nature into new compoſitions, and entered new ſtates of being which had no relation to the former.

The Perſian bramins hold, that after a certain period of time, conſiſting of 71 joogs, God not only annihilates the whole univerſe, but every thing elſe, angels, ſouls, ſpirits, and all, by which he returns to the ſame ſtate he was in before the creation; but that, having breathed a while, he goes to work again, and a new creation ariſes, to ſubſiſt 71 joogs more, and then to be annihilated in its turn. Thus they hold there have been almoſt an infinite number of worlds; but how many joogs are elapſed ſince the laſt creation, they cannot certainly tell; only in an almanac written in the Sanſcript language in 1670, the world is ſaid to be then 3,892,771 years old from the laſt creation.

The Siameſe heaven is exactly the hell of ſome Socinians and other Chriſtian writers; who, ſhocked with the horrible proſpect of eternal torments, have taken refuge in the ſyſtem of annihilation. This ſyſtem ſeems countenanced by Scripture; for that the words *death*, *deſtruction*, and *periſhing*, whereby the puniſhment of the wicked is moſt frequently expreſſed in Scripture, do moſt properly import annihilation and an utter end of being. To this Tillotſon anſwers, that theſe words, as well as thoſe correſponding to them in other languages, are often uſed, both in Scripture and other writings, to ſignify a ſtate of great miſery and ſuffering, without the utter extinction of the miſerable. Thus God is often ſaid in Scripture to bring *deſtruction* on a nation, when he ſends judgements upon them, but without exterminating or making an end of them. So, in other languages, it is frequent, by *periſhing*, to expreſs a perſon's being made miſerable; as in that known paſſage in Tiberius's letter to the Roman ſenate: *Ita me dii, deæque omnes, pejus perdant, quam hodie perire me ſentio.* As to the word *death*, a ſtate of miſery which is as bad or worſe than death, may properly enough be called by that name; and thus the puniſhment of wicked men after the day of judgement is in the book of Revelations frequently called the *ſecond death*.

Some Chriſtian writers allow a long time of the moſt terrible torments of ſinners; and after that ſuppoſe that there ſhall be an utter end of their being. Of this opinion Irenæus appears to have been; who, according to M. du Pin, taught that the ſouls, at leaſt of the wicked, would not ſubſiſt eternally; but that, after having undergone their torments for a certain period, they would at laſt ceaſe to be at all. But Tillemont, Petit, Didier, and others, endeavour to defend Irenæus from this imputation, as being too favourable to the wicked.

It has been much diſputed among divines, whether, at the conſummation of all things, this *earth* is to be annihilated, or only purified, and fitted for the habitation of ſome new order of beings. Gerard in his Common Places, and Hakewil in his Apology, contend earneſtly for a total abolition or annihilation. Ray, Calmet, and others think the ſyſtem of renovation or reſtitution more probable, and more conſonant to Scripture, reaſon, and antiquity. The fathers who have treated on the queſtion are divided; ſome holding that the univerſe ſhall not be annihilated, but only its external face changed; others aſſerting, that the ſubſtance of it ſhall be deſtroyed.

According to ſome writers Exiſtence is a ſtate of violence: all things are continually endeavouring to return to their primitive nothing; it requires no power at all: it will do itſelf; nay, what is more, it requires an infinite power to prevent it.

Many authors conſider preſervation as a continual reproduction of a thing, which, ſubſiſting no longer of itſelf, would every moment return into nothing. Gaſſendi on the contrary aſſerts, that the world may indeed be annihilated by the ſame power which firſt created it, but that to continue it there is no occaſion for any power of preſervation.

ANNOTTO, in commerce, a kind of red dye, brought from the Weſt Indies. This is otherwiſe denominated anate and attole. It is procured from a red flower, produced by a ſhrub, which grows ſeven or eight feet high. This flower being thrown into tubs and ciſterns, for the purpoſe, is treated much after the manner of indigo; and the red maſs is extracted by this infuſion and fermentation from the pellicles of the tree.

The annotto is now only prepared by the Spaniards. The Engliſh had formerly a manufacture at St. Angelo, now ruined. The drug is prefered by the dyers to indigo, and ſold one fourth dearer. The double Glouceſter cheeſe is coloured with this dye, not with marygolds. To water it gives only a pale browniſh yellow colour, and is very little ſoluble in that liquid. It readily diſſolves in ſpirit of wine, and gives a bright orange colour; hence it is uſeful as an ingredient in varniſhes and lacquers. Wool and ſilk boiled in a ſolution of it, by alkaline ſalts in water, acquire a deep, but not a durable orange dye; for though it is not changed by alum or acids, it is diſcharged by ſoaps, and deſtroyed by expoſure to the air. It is ſaid to be an antidote to the poiſonous juice of manihot, or caſſada. See more of this artificial preparation, and the manner of making it, in Dr. Lewis's Commercium Phil. Techn. p. 224, &c. or Neumann's Works, p. 433, &c.

A NEW SYSTEM of ANNUITIES.

WHEN a ſum of money is to be paid annually to any perſon for a term of years, or for life, it is called an Annuity. The differences between a rent and an Annuity, in law, are, 1ſt. That every rent is conſidered as ariſing from, and going out of the land; but an Annuity charges only the granter or his heirs that have aſſets by deſcent; 2dly, That for the recovery of an annuity, no action lies, but only the writ of annuity againſt the granter, his heirs, or ſucceſſors; but of rent, the ſame actions lie as do of land: and 3dly, That an annuity is never taken for aſſets, becauſe it is no freehold in law, nor can be put in execution upon a ſtatute merchant, ſtatute ſtaple, or elegit, as a rent may be. It is however frequently ſo ordered, that payments of this ſort, are to be made quarterly, or half yearly, in which caſes there ſeems ſome degree of impropriety in the term Annuity; for the expreſſion, "a Quarterly Annuity," is certainly a ſoleciſm.

The calculation or doctrine of Annuities is diſtinguiſhed into two parts; namely, Annuities certain, and Annuities contingent; the former commencing and expiring with ſome given term of years; the latter either commencing or expiring on the deceaſe of ſome perſon or perſons concerned, or being dependent on ſuch perſon or perſons ſurviving a certain age, &c. We ſhall treat of them both in their diſtinct order.

CHAP. I. ANNUITIES CERTAIN.

PROBLEM I. To find what an annuity unpaid for a given term of years amounts to at a given rate of intereſt.

REMARK. When it is a real caſe that an annuity has actually been unpaid for a certain number of years, the perſon entitled thereto cannot legally demand more than the amount at ſimple intereſt; to find which, obſerve this rule.

Let the rate of intereſt for 1l. the annuity, and the time, be multiplied together, and let ½ this product be multiplied by the time, leſs 1, ſo will the reſult be the intereſt depending, to which add the product of the annuity by the time, and the ſum will be the amount.

N.B. In this rule the time is ſuppoſed to be complete years. If the time, however, in any caſe conſiſts of years and parts of a year, the amount for whole years muſt be calculated according to this method, and a proportional part of the annuity, according to the rule of three (allowing diſcount) muſt be taken for the remainder.

EXAMP. What will an annuity of 50l. amount to at the end of eight years, at the rate of 5 per cent. per annum, ſimple intereſt. Here, intereſt being at 5 per cent. the rate for 1l. is .05; and .05×50×8=20; and the half thereof, 10, multiplied by 8—1 (7)=70l. the intereſt; to which add 50×8, (400) and the ſum is 470; the amount required.

N.B. Compound intereſt being wholly unequitable, it is never admitted, neither indeed ought it to be in annuity-calculations, except in caſes ſimilar to the above, where the legiſlature for certain reaſons has ſo appointed it.

SCHOLIUM. If the payments are half yearly, or quarterly, then, in applying the above rule, the double or quadruple of the time muſt be uſed in lieu of the time, and the quarterly or half yearly payment, muſt be uſed inſtead of the annuity.

PROBLEM II. The ſame caſe given as above to find the amount at compound intereſt.

RULE. Multiply the amount of 1l. for one year, as often into itſelf as there are years, leſs 1; or which is the ſame, raiſe it to the power whoſe index is equal to the number of years; from the reſult ſubtract 1, and divide the remainder by the intereſt of 1l. for a year; then multiply the quotient by the annuity, and the product will be the amount required.

EXAMP. What is the amount of an annuity of 50l. for three years, at 5 per cent. compound intereſt. Here the amount of 1l. for one year is 1.05, and this multiplied twice into itſelf, (viz. cubed) the reſult=1.157625; and this, leſs 1,=.157625; which, divided by .05, the quotient is 3.1525, and this multiplied by 50, the product is 157.625l. or 157l. 12s. 6d. the anſwer ſought.

SCHOLIUM. If the payments are half yearly or quarterly, take the amount and intereſt of 1l. for half or quarter of a year and uſe them in the above rule, inſtead of the amount and intereſt for a year; alſo take the double or quadruple of the time, in lieu of the time; and the rule will hold good.

N. B. The amount of 1l. for half a year at compound intereſt, is equal to the ſquare root of the amount for a year; and the amount for a quarter of a year is equal to the ſquare root of the amount for half a year. The amount of 1l. leſs 1, is equal to the intereſt.

The amount of 1l. for ¼ and ½ a year reſpectively.

	3 per Cent.	3½ per C.	4 per Cent	4½ per C.	5 per Cent
½ year	1.007417	1.008637	1.009853	1.011065	1.012272
¼ year	1.014889	1.017349	1.019804	1.022252	1.024695

PROBLEM III. To find the preſent value of an annuity to continue a given time, at a given rate per cent.

RULE. Multiply the amount of 1l. for a year, as often into itſelf as there are years, leſs 1, (or which is the ſame, involve it to the power denoted by the time); by this reſult divide 1, and ſubtract the quotient from 1; divide the remainder by the intereſt of 1l. for a year; then multiply this laſt quotient by the annuity, and the product will be the preſent value.

EXAMP. What is the preſent worth of an annuity of 40l. to continue 5 years, diſcounting at 5 per cent. per annum, compound intereſt. Here 1.05 involved to the 5 power=1.27628, by which dividing 1, there is .78353, which ſubtracted from 1, leaves .21647; and this divided by .05, gives 4.3294, which multiplied by 40, we have 173.1761.=173l. 3s. 6d. *fere*,= the preſent worth.

N. B. If the payments are half yearly or quarterly, take the time and the amount, and intereſt of 1l. as directed in the laſt articles, and the rule will hold good.

COROLLORY. The preſent value of an annuity for a given term, but not to commence till certain years hence, is had by finding, firſt, the preſent value of the annuity for the given term, and then the preſent worth of that ſum according to the number of years which is to elapſe before the annuity commences.

PROBLEM IV. An annuity, the amount thereof for a certain term, and the rate of intereſt being given, to find the time.

RULE. Multiply the amount by the intereſt of 1l. for a year, and divide the product by the annuity. To the quotient add 1, then divide the logarithm of this ſum, by the logarithm of the amount of 1l. for a year, and the quotient will be the time required.

EXAMP. In what time will an annuity of 100l. amount to 315l. 5s. at 5 per cent. per annum compound intereſt. Here 315.25×.05=15.7625, which divided by 100, the quotient is .157625, to which adding 1, the ſum is 1.157625; and the logarithm thereof is .0635679. Alſo the logarithm of 1.05 is .0211893; by which, dividing .0635679, the quotient is 3, the true number of years required.

SCHOLIUM. This method, as well as that in the following problem, always ſuppoſes that the perſon is intitled to a proportional part of the next annual payment, anſwerable to the parts of a year, which may happen to be over and above the complete years, diſcount being allowed for the remainder of the year.

PROBLEM V. An annuity, the preſent worth thereof, and the rate of intereſt being given, to find the time.

RULE. Multiply the preſent worth by the intereſt of 1l. for a year, and ſubtract the product from the annuity; take the logarithm of the remainder, and ſubtract it from the logarithm of the annuity; and divide this remainder by the logarithm of the amount of 1l. for a year, and the quotient will be the time required. It will be needleſs to give an example, as thoſe who underſtand the laſt problem will find no difficulty in this.

PROBLEM VI. To find the value of a freehold eſtate, or of an annuity to continue for ever at compound intereſt.

RULE. Divide 100l. by the rate of intereſt per cent. or, which is the ſame, divide 1l. by the intereſt of 1l. for a year; and the quotient will be the value of an annuity of 1l. to continue for ever; or of an eſtate, whoſe annual rent is 1l. or, in other terms, it will be the number of years purchaſe which ſuch annuity or eſtate is worth; and that being multiplied by the annuity or annual rent, will give the whole value required.

EXAMP. What is the value of an annuity of 100l. to continue for ever at 5 per cent. compound intereſt? Here 1l. divided by .05; or 100l. divided by 5, gives a quotient of 25, the number of years purchaſe; and this multiplied by 100l. gives 2500l. the value required,

N. B. The number of years purchaſe of an eſtate, or of an annuity to continue for ever, (which in this caſe is 25) is called the perpetuity thereof.

PROBLEM VII. Given the amount or preſent value of an annuity or certain annual payments, to determine therefrom what would be the amount or preſent value, provided the ſame were paid in equal half yearly or quarterly payments, or in equal portions, at any other intervals, whereof one is an aliquot part of a year.

RULE. Multiply the given amount, or preſent value, by the intereſt of 1l. for a year, and divide the product by twice the intereſt of 1l. for half a year, or four times the intereſt of 1l. for a quarter of a year, (or, in general, by m times the intereſt of 1l. for $\frac{1}{m}$th of a year) and the quotient in each caſe will be the amount or preſent worth required.

COR. I. The amount of an annuity of 1l. for n years (ſuppoſing the firſt payment not due till a year hence) is equal to the intereſt of 1l. for n years divided by the intereſt of 1l. for a year.

COR. II. The preſent value of ſuch an annuity for n years, is equal to the diſcount of 1l. for n years divided by the ſaid diviſor, or intereſt for 1l. for a year.

COR. III. The intereſt of 1l. for n years, divided by m times the intereſt of 1l. for $\frac{1}{m}$ of a year, is equal to the amount of 1l. Annuity for n years, when the ſame is paid in equal portions at every $\frac{1}{m}$ of a year.

COR. IV. Alſo if the diſcount of 1l. due n years hence, be divided by the ſame diviſor, the quotient will be the preſent value of ſuch annuity on the ſame terms.

N. B. The intereſt of 1l. for any aliquot part of a year is found

found thus: Divide the logarithm of the amount of 1l. for a year, at the given rate of intereſt, by the number denoting the aliquot part, and the quotient will be the logarithm of the amount of 1l. for ſuch part of a year, then the number anſwerable thereto, is the amount itſelf. Alſo the amount, leſs 1, is the intereſt.

With regard to the foregoing rule, the time is ſuppoſed to be years complete, but if otherwiſe, the concluſion can ſcarce ever err the hundredth part of a year's purchaſe, and therefore it may juſtly be applied in all caſes of life annuities, the ſubject not being capable of greater accuracy. The caſes, however, which reſpect the two laſt corollories, do not come under ſo cloſe a reſtriction; for when the payments are made at every $\frac{1}{m}{}^{th}$ part of a year, the time in them is limitable only to ſuch part of a year, or a complete number of payments, viz. it may be any fraction of a year expreſſed by $\frac{1}{m}$, $\frac{2}{m}$, $\frac{3}{m}$, $\frac{4}{m}$, &c. to $\frac{m-1}{m}$.

SCHOLIUM I. Another ſtill ſhorter method may be uſed for reducing the value of yearly to that of half yearly payments, viz. Multiply half the amount or preſent value of the yearly payments by the intereſt of 1l. for half a year. Add the product to the ſaid amount, or preſent value, and it will be the anſwer required. Alſo, If half the half-yearly value thus found be multiplied by the intereſt of 1l. for a quarter of a year, and the product be added to the half-yearly value, it will give the quarterly value.

The former method, however, is preferable on account of its generality, and being in all caſes well adapted to practice.

SCHOLIUM II. If the given time be ſuch as to fall between two payments, the amount or preſent value muſt be found for the time comprehending the complete payments, let the time between each be what it may; then, when the amount is to be found, the preſent worth of ſuch proportional part of the next payment as is anſwerable to the time which is over and above the laſt payment, muſt be found, by diſcounting for the interval which the given time falls ſhort of the next payment. Alſo the amount of the former amount muſt be ſought for the interval which is over and above the laſt payment; ſo will the ſum of this amount and the laſt mentioned preſent worth, be the true amount required. But if the preſent value is required, then the preſent worth of the ſaid proportional part of the next payment muſt be found, (by diſcounting for the whole given time) and added to the preſent value of the complete payments, and the ſum will be the anſwer required.

SCHOLIUM III. Where compound intereſt is concerned, all the caſes will be beſt wrought by logarithms, as that method ſaves a deal of trouble; multiplication and diviſion being thereby performed by the addition and ſubtraction of only two numbers, and involution by a ſhort multiplication, as will be ſhewn under the proper head. But as this work may fall into the hands of thoſe who are not well acquainted with the nature of them, or who, perhaps, have not accurate tables thereof, I ſhall add two ſmall tables, which in moſt caſes will very well ſupply the want of them.

TABLE I.

THE AMOUNT OF AN ANNUITY OF ONE POUND.

Y.	3 per Cent	3½ per Cent.	4 per Cent.	4½ per Cent.	5 per Cent
1	1.000000	1.000000	1.000000	1.000000	1.000000
2	2.030000	2.035000	2.040000	2.045000	2.050000
3	3.090900	3.106225	3.121600	3.137025	3.152500
4	4.183627	4.214943	4 246464	4.278191	4.310125
5	5.309136	5.362466	5.416323	5.470710	5.525631
6	6.468410	6.550152	6.632975	6.716892	6.801913
7	7.662462	7.779408	7 898294	8.019152	8.142008
8	8.892336	9.051687	9.214226	9.380014	9.549109
9	10.159106	10.368496	10.582795	10.802114	11.026564
10	11.463879	11.731393	12.006107	12.288209	12.577893
11	12.807796	13.141992	13.486351	13.841179	14.206787
12	14.192030	14.601962	15.025805	15.464032	15.917127
13	15.617790	16.113030	16.626838	17.159913	17.712983
14	17.086324	17.676986	18.291911	18.932109	19.598632
15	18.598914	19.295681	20 023588	20.784054	21.578564
16	20.156881	20.971030	21.824531	22.719337	23.657492
17	21.761588	22.705016	23.697512	24.741707	25.840366
18	23.414435	24.499691	25.645413	26.855084	28.132385
19	25.116868	26.357181	27.671229	29.063562	30.539004
20	26.870374	28.279682	29.778079	31.371423	33.065954
21	28.676486	30.269471	31.969202	33.783137	35.719252
22	30.536780	32.328902	34.247970	36.303378	38.505214
23	32.452884	34.460414	36.617889	38.937030	41.430475
24	34.426470	36.666528	39 082604	41.689196	44.501999
25	36.459264	38.949857	41.645908	44.565210	47.727099
26	38.553042	41.313102	44.311745	47.570645	51.113454
27	40.709634	43.759060	47.084214	50.711324	54.669126
28	42.930923	46.290627	49.967583	53.993333	58.402583
29	45.218850	48.910799	52.966286	57.423033	62.322712
30	47.575416	51.622677	56.084938	61.007070	66.438848

TABLE I. IN CONTINUATION.

Y.	3 per Cent.	3½ per Cent.	4 per Cent.	4½ per Cent.	5 per Cent.
31	50.002678	54.429471	59.328335	64.752388	70.760790
32	52.502759	57.334502	62.701469	68.666245	75.298829
33	55.077841	60.341210	66.209527	72.756226	80.063771
34	57.730177	63.453152	69.857909	77.0302 56	85.066959
35	60.462082	66.674013	73.652225	81.496618	90.320307
36	63.275944	70.007603	77.598314	86.163966	95.836323
37	66.174223	73.457869	81.702246	91.041344	101.628139
38	69 159449	77.028895	85.970336	96.138205	107.709546
39	72.234233	80.724906	90.409150	101.464424	114.095023
40	75.401260	84.550278	95.025516	107.030323	120.799774
41	78.663298	88.509537	99.826536	112.846688	127.839763
42	82.023196	92.607371	104.819598	118.924789	135.231751
43	85.483892	96.848629	110.012382	125.276404	142.993339
44	89.048409	101.238331	115.412877	131.913842	151.143006
45	92.719861	105.781673	121.029392	138.849965	159.700156

TABLE II.

THE PRESENT VALUE OF AN ANNUITY OF ONE POUND.

Y	3 per Cent.	3½ per Cent.	4 per Cent.	4½ per Cent.	5 per Cent.
1	.970874	.966184	.961538	.956938	.952381
2	1.913470	1.899694	1.886095	1.872668	1.859410
3	2.828611	2.801637	2.775091	2.748964	2.723248
4	3.717098	3.673079	3.629895	3.587526	3.545951
5	4.579707	4.515052	4.451822	4.389977	4.329477
6	5.417191	5.328553	5.242137	5.157872	5.075692
7	6.230283	6.114544	6.002055	5.892701	5.786373
8	7.019692	6.873956	6.732745	6.595886	6.463213
9	7.786109	7.607687	7.435332	7.268790	7.107822
10	8.530203	8.316605	8.110896	7.912718	7.721735
11	9.252624	9.001551	8.760477	8.528917	8.306414
12	9.954004	9.663334	9.385074	9.118581	8.863252
13	10.634955	10.302738	9.985648	9.682852	9.393573
14	11.296073	10.920520	10.563123	10.222825	9.898641
15	11.937935	11.517411	11 118387	10.739546	10.379658
16	12.561102	12.094117	11.652296	11.234015	10.837770
17	13.166118	12.651321	12.165669	11.707191	11.274066
18	13.753513	13.189682	12.659297	12.159992	11.689587
19	14.323799	13.709837	13.133939	12 593294	12.085321
20	14.877475	14.212403	13.590320	13.007936	12.462210
21	15.415024	14.697974	14.029160	13.404724	12.821153
22	15.936917	15.167125	14.451115	13.784425	13.163003
23	16.443608	15.620410	14.856842	14.147775	13.488574
24	16.935542	16.058368	15.246963	14.495478	13.798642
25	17.413148	16.481515	15.622080	14.828209	14.093945
26	17.876842	16.890352	15.982769	15.146611	14.375185
27	18.327031	17.285365	16.329586	15.451303	14.643034
28	18.764108	17.667019	16.663063	15.742874	14.898127
29	19.188455	18.035767	16.983715	16.021889	15.141074
30	19.600441	18.392045	17.292033	16.288889	15.372451
31	20.000428	18.736276	17.588494	16.544391	15.592811
32	20.388766	19.068865	17.873552	16.788891	15.802677
33	20.765792	19.390208	18.147646	17.022862	16.002549
34	21.131837	19.700684	18.411198	17.246758	16.192904
35	21.487220	20.000661	18.664613	17.461012	16.374194
36	21.832252	20.290494	18.908282	17.666041	16.546852
37	22.167235	20.570525	19.142579	17.862240	16.711287
38	22.492462	20.841087	19.367864	18.049990	16.867893
39	22.808215	21.102501	19.584485	18.229656	17.017041
40	23.114772	21.355072	19.792774	18.401584	17.159086
41	23 412401	21.599104	19.993052	18.566109	17 294308
42	23.701359	21.834883	20.185627	18.723550	17.423208
43	23.981902	22.062689	20.370795	18.874210	17.545912
44	24.254274	22.282791	20.548841	19.018383	17.662773
45	24.518713	22.495450	20.720040	19.156347	17.774070

USE OF THE TABLES.

By Table the 1ſt, Problem the 2d may be reſolved; for the tabular number anſwering to the number of years and rate per cent. multiplied by the annuity will give the amount. In the example, the given number of years are three, and the intereſt 5 per cent. The tabular number is 3.1525, which multiplied by 50, the annuity, the product is 157.625l. the ſame as before.

By Table 2d, the 3d Problem is reſolved. Thus the tabular number anſwering to five years and 5 per cent. is 4.329477 which multiplied by 40, the annuity, gives 173.179l. nearly the ſame as before.

Alſo by means of table I. the amount of any ſum of money for a given number of years, at compound intereſt, according to any of the rates per cent. may be found by multiplying the given ſum by the difference between the tabular number for the given number of years, and the next greater tabular number in the ſame column.

EXAMP. Let it be required to find the amount of 50l. at the expiration of ſeven years, at five per cent. per annum, compound intereſt. Here the tabular number for ſeven years at five per cent. is 8.142008, and the next greater (or that for eight years) is 9.549109. Their difference is 1.407101, which multiplied by 50=70.355051.=70l. 7s. 1¼d. *fere*, the amount required.

In like manner the preſent worth of a ſum of money due certain years hence, may be found by Table 2d, by multiplying the given ſum by the difference between the tabular number anſwering

anſwering to the given number of years, and the next leſs tabular number in the ſame column.

EXAMP. What is the preſent worth of 120l. due nine years hence, at 5 per cent. per annum compound intereſt? Here the tabular number againſt nine years at 5 per cent. is 7.107822, and the next leſs (or that for eight years) is 6.463213; their difference is .644609; and this multiplied by 120=77.353081. =77l. 7s. 0¼d. *fere*, the value required.

Alſo if the amount or preſent worth of an annuity be given, and it be required to find the time, it will be found by dividing the ſame by the annuity, and looking for the quotient, or the next leſs number (in the table of amounts or preſent worths) under the proper rate per cent. For the number of years in the firſt column will be the time required. But if it is required to determine the time to parts of a year, take from table 2d. the preſent worth of 1l. due one year hence, and add the ſame to the next leſs number. Then take the logarithm thereof, and ſubtract the ſame from the ſum of the logarithms of the ſaid next leſs number, and the quotient above mentioned. Divide the remainder by the logarithm of the amount of 1l. for a year, and the quotient will be the time required.

Likewiſe, if it be required to find the amount or preſent value of an annuity for a time greater than is ſpecified in the table, divide the propoſed time into two periods, and take the amount or preſent value for one period, and find the amount or preſent value of that ſum for the remaining period; alſo find the amount or preſent value of the annuity for the remaining time, then add the two amounts or preſent values together, and the ſum will be the anſwer. If the time be above 90 years, then divide it into 3 or more parts, and proceed in the ſame way to find the value of each part, and take the ſum of the whole.

CHAP. II. ANNUITIES CONTINGENT.

THE calculations for life annuities depend ſolely on the doctrine of probabilities, which tho' to ſome it may appear without the limits of human inveſtigation, yet the theory has been ſo far eſtabliſhed by the practice, as to render it indiſputable.

It is by all allowed that the Supreme Being cannot be impreſſed with an idea of probability, ſince all things that are or ſhall be, are alike comprehended by Him, who is the Alpha and Omega. With Him, therefore, all things are certain, and all are directed by His infinite wiſdom to their proper ends, ſo that the notion of contingency, when applied to the Creator and Lord of the univerſe, is wholly abſurd. But to us who are ſhut up to the future, and can only form our judgements according to the preſent appearance of things, the idea of probability forces itſelf on our intellects. Thus we cannot but expect an approaching ſtorm, when we ſee the clouds black with tempeſt; and on the contrary, when there is a ſettled ſerenity in the atmoſphere, we have the ſtrongeſt expectations of a continuation of fair weather. In like manner, a phyſician forms his judgement from the ſeveral indications of a diſorder; and, in general, the happening of a future event appears more or leſs probable, according as there are more or fewer marks of its approach.

Wherefore, without preſuming on the Divine order, we may certainly form our eſtimations on lives, if our concluſions are fairly deduced from obſervation, and the more eſpecially ſo, as ſociety and various occurrences in life often render them neceſſary. Thus a perſon has as undoubted a right to ſell a life eſtate, as any other, and this calls for a proper and equitable valuation; for who would give as much for a life eſtate on an age of 60, as for one on an age of 20 or 30, provided both the parties were equally healthful? To determine upon an average the proper values of each, with other things of the like nature, is the buſineſs of which I ſhall now treat. It appeared requiſite to make theſe obſervations, becauſe calculations of this ſort have been frequently ridiculed, from a want of giving the ſubject a proper inveſtigation.

Calculations for life annuities are deduced from compariſons on the bills of mortality for all ages, the only method that can in ſuch caſes be depended on: but, before we proceed, it will be proper to give the following

DEFINITIONS:

I. The probability of life is greater or leſs according as there appears more or fewer chances for a perſon's living or dying at any given ſtage of life, and is denoted by a fraction, whoſe numerator is the chances of living, and denominator the ſum of the chances both of living and dying. Thus, if it be obſerved that out of 500 perſons of one age, only 380 of them are in being at the end of two years, in that caſe the probability of any one's ſurviving 2 years, is $\frac{380}{380+120}=\frac{380}{500}=\frac{38}{50}=\frac{19}{25}$, and the odds in that caſe are 19 to 6 that a perſon of that particular age ſhall be living two years hence. The probability of dying is a like fraction, whoſe numerator is the chances of dying. In the preſent caſe the probability of dying is $\frac{120}{500}=\frac{6}{25}$; and the odds are 19 to 6 that the perſon does not die in 2 years. The ſum of the probabilities of living and dying is =1, which is expreſſive of a certainty.

II. The extremity of life is that period beyond which there is no probability of ſurviving. In the Northampton tables this period is 97 years.

III. The complement of life, is the number of years which any perſon's age wants of the full extremity. Thus the complement of an age of 90 is 7.

IV. The expectation of life is the number of years which is due to the life of a perſon of a certain age upon an equality of chance, or it is the number of years purchaſe, which an annuity for life, ſecured upon land without intereſt, is worth in ready money. This in ſingle lives is always equal to the ſum of all the probabilities of ſurviving to the extremity of life.

V. The number of years purchaſe, in annuities, eſtates, &c. at any rate of intereſt, is that number which, if multiplied, by the annuity or annual rent, is equal to the preſent value thereof, according to ſuch rate of intereſt, or it is the preſent value of an annuity or annual rent of 1l. according to the given rate of intereſt.

VI. Reverſion of a life annuity, is where two or more lives are in joint poſſeſſion, and the expectation depends upon the probability of one particular life ſurviving the reſt.

TABLE III.

Shewing the probabilities of Life at all ages, as deduced by Mr. Simpſon, from ten years obſervation on the bills of mortality in London.

Age.	Perſons living.	Decre. of Life.	Age.	Perſons living.	Decre. of Life.	Age.	Perſons living.	Decre. of Life.	Age.	Perſons living.	Decre. of Life.
0	1000	320	27	321	6	54	135	6			
1	680	133	28	315	7	55	129	6			
2	547	51	29	308	7	56	123	6			
3	496	27	30	301	7	57	117	5			
4	469	17	31	294	7	58	112	5			
5	452	12	32	287	7	59	107	5			
6	440	10	33	280	7	60	102	5			
7	430	8	34	273	7	61	97	5			
8	422	7	35	266	7	62	92	5			
9	415	5	36	259	7	63	87	5			
10	410	5	37	252	7	64	82	5			
11	405	5	38	245	8	65	77	5			
12	400	5	39	237	8	66	72	5			
13	395	5	40	229	7	67	67	5			
14	390	5	41	222	8	68	62	4			
15	385	5	42	214	8	69	58	4			
16	380	5	43	206	7	70	54	4			
17	375	5	44	199	7	71	50	4			
18	370	5	45	192	7	72	46	4			
19	365	5	46	185	7	73	42	3			
20	360	5	47	178	7	74	39	3			
21	355	5	48	171	6	75	36	3			
22	350	5	49	165	6	76	33	3			
23	345	6	50	159	6	77	30	3			
24	339	6	51	153	6	78	27	2			
25	333	6	52	147	6	79	25	2			
26	327	6	53	141	6	80	23				

TABLE IV.

Shewing the probabilities of Life at all ages, deduced from forty-ſix years obſervation on the bills of mortality at Northampton, viz. from 1735 to 1780.

Age.	Perſons living.	Decre. of Life.	Age.	Perſons living.	Decre. of Life.	Age.	Perſons living.	Decre. of Life.
0	11650	1894	33	4160	75	67	1472	80
1	9756	1106	34	4085	75	68	1392	80
2	8650	1367	35	4010	75	69	1312	80
3	7283	502	36	3935	75	70	1232	80
4	6781	335	37	3860	75	71	1152	80
5	6446	197	38	3785	75	72	1072	80
6	6249	184	39	3710	75	73	992	80
7	6065	140	40	3635	76	74	912	80
8	5925	110	41	3559	77	75	832	80
9	5815	80	42	3482	78	76	752	77
10	5735	60	43	3404	78	77	675	73
11	5675	52	44	3326	78	78	602	68
12	5623	50	45	3248	78	79	534	65
13	5573	50	46	3170	78	80	469	63
14	5523	50	47	3092	78	81	406	60
15	5473	50	48	3014	78	82	346	57
16	5423	50	49	2936	79	83	289	55
17	5373	53	50	2857	81	84	234	48
18	5320	58	51	2776	82	85	186	41
19	5262	63	52	2694	82	86	145	34
20	5199	67	53	2612	82	87	111	28
21	5132	72	54	2530	82	88	83	21
22	5060	75	55	2448	82	89	62	16
23	4985	75	56	2366	82	90	46	12
24	4910	75	57	2284	82	91	34	10
25	4835	75	58	2202	82	92	24	8
26	4760	75	59	2120	82	93	16	7
27	4685	75	60	2038	82	94	9	5
28	4610	75	61	1956	82	95	4	3
29	4535	75	62	1874	81	96	1	1
30	4460	75	63	1793	81	Total	299198	11650
31	4385	75	64	1712	80			
32	4310	75	65	1632	80			
33	4235	75	66	1552	80			

TABLE V.

Shewing the expectation of Life at every age, according to the bills of mortality for London and Northampton.

Age.	Expectation. London.	Expectation. Northamp	Age.	Expectation. London.	Expectation. Northamp	Age.	Expectation. London.	Expectation. Northamp
0	19.5	25.18	33	22.8	26.72	65	11.0	10.88
1	27.5	32.74	34	22.4	26.20	66	10.6	10.42
2	32.5	37.79	35	22.0	25.68	67	10.3	9.96
3	34.5	39.55	36	21.6	25.16	68	9.9	9.50
4	36.1	40.58	37	21.2	24.64	69	9.6	9.05
5	36.5	40.84	38	20.8	24.12	70	9.3	8.60
6	36.5	41.07	39	20.4	23.60	71	8.9	8.17
7	36.3	41.03	40	20.1	23.08	72	8.6	7.74
8	36.1	40.79	41	19.7	22.56	73	8.3	7.33
9	35.7	40.36	42	19.3	22.04	74	8.0	6.92
10	35.3	39.78	43	19.0	21.54	75	7.7	6.54
11	34.8	39.14	44	18.6	21.03	76	7.3	6.16
12	34.2	38.49	45	18.3	20.52	77	6.9	5.83
13	33.6	37.83	46	17.9	20.02	78	6.5	5.48
14	33.0	37 17	47	17.5	19.51	79	6.0	5.11
15	32.4	36 51	48	17.2	19.00	80	5.5	4.75
16	31.8	35.85	49	16.8	18.49	81		4.41
17	31.2	35.20	50	16.5	17.99	82		4.09
18	30.6	34.58	51	16.1	17.50	83		3.80
19	30.0	33.99	52	15.7	17.02	84		3.58
20	29.4	33.43	53	15.4	16.54	85		3.37
21	28.8	32.90	54	15.0	16.06	86		3.19
22	28.2	32 39	55	14.7	15.58	87		3.01
23	27.7	31.88	56	14.3	15.10	88		2.86
24	27.1	31.36	57	13.9	14 63	89		2.66
25	26.6	30.85	58	13.6	14 15	90		2.41
26	26.1	30.33	59	13.2	13.68	91		2.09
27	25.6	29.82	60	12.9	13.21	92		1.75
28	25.1	29.30	61	12.5	12.78	93		1.37
29	24.6	28.79	62	12.1	12.28	94		1.06
30	24.1	28 27	63	11.7	11.81	95		0.75
31	23.6	27.76	64	11.3	11.35	96		0.50
32	23.1	27.24						

TABLE VI.

Shewing the value of an annuity on a ſingle life, according to the probabilities of life at London and Northampton, from the age of ſix to ſeventy-five years.

Age.	Years purchaſe at 3 per Cent.		Years purchaſe at 4 per Cent.		Years purchaſe at 5 per Cent.	
	London.	Northamp.	London	Northamp.	London.	Northamp.
6	18.8	20.73	16.2	17.48	14.1	15.04
7	18.9	20.85	16.3	17.61	14.2	15.17
8	19.0	20.89	16.4	17.66	14.3	15.23
9	19.0	20.81	16.4	17.62	14.3	15.21
10	19.0	20.66	16.4	17.52	14.3	15.14
11	19.0	20.48	16.4	17.39	14.3	15.04
12	18.9	20.28	16.3	17.25	14.2	14.94
13	18.7	20.08	16.2	17.10	14.1	14.83
14	18.5	19.87	16.0	16.95	14.0	14.71
15	18.3	19.66	15.8	16.79	13.9	14.59
16	18.1	19.44	15.6	16.62	13.7	14.46
17	17.9	19.22	15.4	16.46	13.5	14.33
18	17.6	19 01	15.2	16.31	13.4	14.22
19	17.4	18.82	15.0	16.17	13.2	14.11
20	17.2	18.64	14.8	16.03	13.0	14.01
21	17.0	18.47	14.7	15.91	12.9	13.92
22	16.8	18.31	14.5	15.80	12.7	13.83
23	16.5	18.15	14.3	15.68	12.6	13.75
24	16.3	17 98	14.1	15.56	12.4	13.66
25	16.1	17.81	14.0	15.44	12.3	13.57
26	15.9	17.64	13.8	15.31	12.1	13.47
27	15.6	17.47	13.6	15.18	12.0	13.38
28	15.4	17.29	13.4	15.05	11.8	13.28
29	15.2	17.11	13.2	14.92	11.7	13.18
30	15.0	16.92	13.1	14.78	11.6	13.07
31	14.8	16.73	12.9	14.64	11.4	12.97
32	14.6	16.54	12.7	14.50	11.3	12.85
33	14.4	16.34	12.6	14.35	11.2	12.74
34	14.2	16.14	12.4	14.20	11.0	12.62
35	14.1	15.94	12.3	14.04	10.9	12 50
36	13.9	15.73	12.1	13.88	10.8	12.38
37	13.7	15.52	11.9	13.72	10.6	12.25
38	13.5	15.30	11.8	13.55	10.5	12.12
39	13.3	15.08	11.6	13.38	10.4	11.98
40	13.2	14.85	11.5	13.20	10.3	11.84
41	13.0	14.62	11.4	13.02	10.2	11.70
42	12.8	14.39	11.2	12.84	10.1	11.55
43	12.6	14.16	11.1	12.66	10.0	11.41
44	12.5	13.93	11.0	12.47	9.9	11.26
45	12.3	13.69	10.8	12.28	9.8	11.11
46	12.1	13.45	10.7	12.09	9.7	10.95
47	11.9	13.20	10.5	11.89	9.5	10.78
48	11.8	12.95	10.4	11.68	9.4	10 62
49	11.6	12.69	10.2	11.47	9.3	10.44
50	11.4	12.44	10.1	11.26	9.2	10.27
51	11.2	12.18	9.9	11.06	9.0	10.10
52	11.0	11.93	9.8	10.85	8.9	9.93
53	10.7	11.67	9 6	10.64	8.8	9.75
54	10.5	11.41	9.4	10.42	8.6	9.57
55	10.3	11.15	9.3	10.20	8.5	9.38
56	10.1	10.83	9.1	9.98	8.4	9.19
57	9.9	10,61	8.9	9.75	8.2	9.00
58	9.6	10,34	8.7	9.52	8 1	8.80
59	9.4	10.06	8.6	9.28	8.0	8.60
60	9.2	9.78	8.4	9.04	7.9	8.19
61	8.9	9.49	8.2	8.80	7.7	8.18
62	8.7	9.21	8.1	8.55	7.6	7.97
63	8.5	8.91	7.9	8.29	7.4	7.74
64	8.3	8.61	7.7	8.03	7.3	7.51
65	8.0	8.30	7.5	7.76	7.1	7.28
66	7.8	7.99	7.3	7.49	6.9	7.03
67	7.6	7.68	7.1	7.21	6.7	6.79
68	7.4	7.37	6.9	6.93	6.6	6.54
69	7.1	7.05	6.7	6.65	6.4	6.28
70	6.9	6.73	6.5	6.36	6.2	6.02
71	6.7	6.42	6.3	6.08	6.0	5.76
72	6.5	6.10	6.1	5.79	5.8	5.50
73	6.2	5.79	5.9	5.51	5.6	5.24
74	5.9	5.49	5.6	5.23	5.4	4.99
75	5.6	5.20	5.4	4.96	5.2	4.74

TABLE VII.

Shewing the value of an annuity on the joint continuance of two lives, according to the probabilities of life in London and Northampton.

Ages.		Value at 3 per Cent.		Value at 4 per Cent.		Value at 5 per Cent.	
		Lond	North.	Lond	North.	Lond	North.
	10	14.7	16.34	13.0	14.28	11 6	12.67
	15	14.3	15.76	12.7	13.84	11.3	12.30
	20	13.8	15.15	12.2	13.35	10.8	11 91
	25	13.1	14.68	11.6	12.00	10.2	11.63
10	30	12 3	14.15	10.9	12.59	9.7	11.30
	35	11.5	13.53	10 2	12.10	9.1	10.92
	40	10.7	12.79	9.6	11.51	8.6	10.44
	45	10.0	11.98	9.0	10 85	8.1	9.90
	50	9 3	11.04	8.4	10.08	7.6	9.26
	55	8.6	10.05	7.8	9.26	7.1	8.56

TABLE VII. In Continuation.

Ages.		Value at 3 per Cent.		Value at 4 per Cent.		Value at 5 per Cent.	
		Lond	North.	Lond	North.	Lond	North.
	60	7.8	8.95	7.2	8.31	6.6	7.75
10	65	6.9	7.72	6.5	7.24	6.1	6.80
	70	6.1	6.35	5.8	6.01	5.5	5.70
	75	5 3	4.96	5.1	4.72	4.9	4.52
	15	13.9	15.23	12.3	13.41	11.0	11.96
	20	13.3	14.66	11.8	12.56	10.5	11.58
	25	12.6	14.23	11.2	12.63	10.1	11.32
	30	11.9	13.73	10.6	12.25	9.5	11.02
	35	11.2	13.15	10.0	11.79	9.0	10.66
	40	10.4	12.46	9.4	11.23	8.5	10.21
15	4.	9.6	11.69	8.8	10.61	8.0	9.69
	50	8.9	10.80	8.2	9.87	7 5	9.08
	55	8.2	9.85	7.6	9.08	7.0	8.40
	60	7.5	8.79	7.0	8.17	6.5	7.62
	65	6.8	7.60	6.4	7.13	6.0	6.71
	70	6.0	6.26	5.7	5.93	5.4	5.63
	75	5.2	4.91	5.0	4.70	4.8	4.50
	20	12.8	14.13	11.3	12.54	10.1	11.23
	25	12.2	13.74	10.8	12.23	9.7	10.99
	30	11.6	13.29	10.3	11.87	9.2	10.71
	35	10.9	12.74	9.8	11.45	8.8	10.36
	40	10.2	12.10	9 2	10 92	8.4	9.94
20	45	9.5	11.37	8.6	10.33	7.9	9.45
	50	8.8	10.52	8.0	9.63	7.4	8.86
	55	8.1	9.62	7.5	8.87	6.9	8.21
	60	7.4	8.60	6.9	8.00	6.4	7.46
	65	6.7	7.44	6.3	6.99	5.9	6.58
	70	6.0	6.15	5.7	5.83	5.4	5.53
	75	5.2	4.83	5.0	4.62	4.8	4.42
	25	11.8	13.38	10.5	11.94	9.4	10.76
	30	11.3	12.97	10.1	11.62	9.0	10.50
	35	10.7	12.46	9.6	11.22	8.6	10.18
	40	10.0	11.85	9.1	10 73	8.2	9.77
	45	9.4	11.16	8.5	10.16	7.8	9.30
25	50	8.7	10.36	7.9	9.49	7.3	8.74
	55	8.0	9.48	7.4	8.75	6.8	8.12
	60	7.3	8.50	6.8	7.91	6.3	7.38
	65	6.6	7.37	6.2	6.92	5.8	6.52
	70	5.9	6.10	5.6	5.78	5.3	5.49
	75	5.1	4.80	4.9	4.59	4.7	4.40
	30	10.8	12.59	9 6	11.31	8.6	10.26
	35	10.3	12.13	9.2	10.95	8.3	9.95
	40	9.7	11.57	8.8	10.49	8 0	9.58
	45	9.1	10.92	8.3	9 96	7.6	9.14
30	50	8.5	10.16	7.8	9.32	7.2	8.60
	55	7.9	9.33	7.3	8.61	6.7	8.00
	60	7.2	8.38	6.7	7.80	6.2	7.29
	65	6.4	7.29	6.1	6.84	5.7	6.45
	70	5.8	6.04	5.5	5.73	5.2	5.44
	75	5.1	4.76	4 9	4.56	4.7	4 37
	35	9.9	11.72	8.8	10.61	8.0	9.68
	40	9.4	11.21	8.5	10 20	7.7	9.33
	45	8.9	10.62	8.1	9.71	7.4	8.91
	50	8.3	9.91	7.6	9.11	7.0	8.42
35	55	7.7	9.13	7.1	8.45	6.6	7.84
	60	7.1	8.23	6.5	7.70	6.1	7.17
	65	6.4	7.18	6.0	6.73	5.6	6.36
	70	5.7	5.97	5 4	5.66	5.1	5.38
	75	5.0	4.72	4.8	4.51	4.6	4.31
	40	9.1	10.76	8.1	9.82	7.3	9.02
	45	8.7	10.44	7.8	9.55	7.1	8.79
	50	8.2	9.59	7.4	8.83	6.8	8.18
	55	7.6	8.87	6.9	8.22	6.4	7.65
40	60	7.0	8.03	6.4	7.49	6.0	7.02
	65	6.4	7.03	5.9	6.61	5.5	6 24
	70	5.7	5.87	5.4	5.57	5.1	5.30
	75	5.0	4.66	4.8	4.46	4.6	4.27
	45	8.3	9.78	7.4	8.99	6.7	8.31
	50	7.9	9.20	7.1	8.50	6.5	7.89
	55	7.4	8.56	6.7	7.95	6.2	7.41
45	60	6.8	7.78	6.3	7.27	5.8	6.82
	65	6.3	6.85	5.8	6.45	5.4	6 09
	70	5.6	5.75	5.3	5.46	5.0	5.20
	75	4.9	4.58	4.7	4.39	4.5	4.21
	50	7.6	8.71	6.8	8.08	6.2	7.52
	55	7.2	8.15	6.5	7.59	6.0	7.10
	60	6.7	7.46	6.1	6.99	5.7	6.57
50	65	6.2	6.61	5.7	6.24	5.3	5.90
	70	5.5	5.58	5.2	5.31	4.9	5.05
	75	4.8	4.47	4.6	4.28	4.4	4.11
	55	6.9	7.68	6.2	7.18	5.7	6.74
	60	6.5	7.09	5.9	6.66	5.5	6.27
55	65	6.0	6.33	5.6	5.99	5.2	5.67
	70	5.4	5.39	5.1	5.13	4.8	4.89
	75	4.7	4.35	4.5	4 17	4.3	4.01
	60	6.1	6.61	5.6	6.23	5.2	5.89
60	65	5.7	5.97	5.3	5.66	4.9	5.37
	70	5.2	5.14	4.9	4.90	4.6	4.68
	75	4.6	4.19	4.4	4.02	4.2	3.87
	65	5.4	5.47	5.0	5.20	4.7	4.96
65	70	4.9	4.78	4.6	4 57	4.4	4.38
	75	4.4	3.96	4.2	3.81	4.0	3.67
70	70	4.6	4.26	4.4	4.09	4.2	3.93
	75	4.2	3.60	4.0	3.47	3.9	3.35
75	75	3.8	3.11	3.7	3.02	3.6	2.92

USE OF THE TABLES.

The 1ſt and 2d Tables exhibit the probabilities of life at all ages in London and Northampton, according to the bills of mortality; that for London I have taken from the ſelect exerciſes of the late ingenious Mr. Thomas Simpſon, F. R. S. together with ſuch of the following tables as are dependent thereon, it being proved, from recent obſervations, that they are ſtill the moſt correct of any extant.

The other, with the reſt of the tables for Northampton, are extracted from the laſt Treatiſe of Dr. Price, a work in itſelf truly valuable. I was the more induced to give thoſe tables, becauſe Northampton, though a pretty large town, is healthfully ſituated, and conſequently they may be taken as a ſtandard for country lives.

Of the 1ſt and 2d Tables, the 1ſt column is the age, the 2d the number of perſons living at any age, and the third column is the annual decrement, or the number of deaths happening each year. Thus in the Northampton Table, out of 11650 births, there are but 4310 perſons who ſurvive the age of 31, and only one perſon who attains the age of 96. In the London table, out of 1000 perſons born, there are but 400 living at the age of 12, and only 25 arrive at the age of 79. Hence, according to the London Table, the probability of living to the age of 40 is $\frac{400}{1000}$ or $\frac{4}{10}$, and the probability of the contrary is $\frac{1000-400}{1000}=\frac{600}{1000}=\frac{6}{10}$, and conſequently the odds that a new born child does not attain to that age is 6 to 4. Again, in the London Table, out of 280 perſons of 33 years of age, but 141 arrive at the age of 53; the probability is $\frac{141}{280}$, or $\frac{1}{2}$ nearly, ſo that there is an equal wager that a perſon of good health, aged 33, ſhall live 20 years. Theſe things premiſed I ſhall proceed to the ſolution of problems relative to lives, &c.

PROBLEM I. To find the period or term of years which a perſon of a given age has any aſſigned probability of ſurviving. Rule. Take from the table the number of perſons anſwerable to the given age, multiply the ſame by the given probability, and ſeek the reſult in the ſecond column of the table, and againſt it, in the firſt column, is the age limiting the term of years required.

Examp. If the probability that a perſon aged 40 ſhall live a certain term of years is $\frac{1}{2}$, or which is the ſame, if the odds in his favour are juſt 1 to 1; required the number of years? Here (by the Northampton Table) the number of perſons at that age is 3635; and $3635\times\frac{1}{2}=\frac{1000}{2}=1817\frac{1}{2}$. I look in the table for 2726, and find it falls between the age of 51 and 52. And, by taking a proportional part, according to the differences, the exact age is 51.606 years; hence the required term is 11.606 years.

Schol. If the term expire before the 8th or 9th year of age, the decrements of life being ſo exceeding irregular within that period, the time over and above the complete years cannot be determined accurately, for the proportioning of the differences will not hold good.

PROBLEM II. To find what is the probability that any number of perſons of given ages ſhall all ſurvive a certain term of years.

Rule. Find (from the table) as has been before illuſtrated, the probability of each perſon's ſurviving the term; then the product of all theſe probabilities will be the probability ſought.

Examp. What is the probability that three inhabitants of London, whoſe ages are 40, 50, 60, reſpectively, ſhall be all living 10 years hence?

Firſt, that one of the age of 40 ſhall live 10 years, the probability is $\frac{102}{159}$, that one of 50 lives 10 years, is $\frac{102}{159}$, and that one of 60 ſurvives that term, is $\frac{54}{102}$. The product of theſe is $\frac{159\times102\times54}{229+159\times102}=\frac{54}{229}=\frac{3}{13}$ nearly; and conſequently the odds are 10 to 3 that they are not all living 10 years hence.

Schol. If it is required to know the probability of certain perſons being alive, and alſo of others being dead at the end of any given term, then the reſpective probabilities of living and dying muſt be multiplied together, and the product will be the probability ſought.

PROBLEM III. If a perſon of a given age has a certain ſum of money due at ſo many years hence, provided he lives ſo long, it is required to determine the preſent value thereof, or what it is worth in caſe it ſhould be ſold.

Rule. Find the preſent worth of the ſum for the given number of years, as though the time

time were certain; then multiply the same by the probability of the person's living till that time, and the product will be the answer.

EXAMP. A person aged 70 years is to receive 10l. if he lives till 75. What is the present value thereof according to the London bills of mortality, supposing interest to be at 4 per cent. per annum? Here the present value of 10l. due 5 years hence is 8.2193, and the probability of one of 70 years old living 5 years is $\frac{10}{14} = \frac{5}{7}$; and $8.2193 \times \frac{5}{7} = 5.4795l. = 5l.\ 9s.\ 7d.$ the answer.

SCHOL. If several sums of money were due, in like manner, at different periods, the present value of the whole would be obtained by finding the value of each separate sum, and adding the whole together. By a similar mode of proceeding the value of an annuity upon any single life may be found, as also upon any number of joint lives, by multiplying the probability of their all continuing in being till the end of each distinct year taken separately, and during the complement of the oldest life, by the present value of 1l. discounted from the expiration of each such year, according to the given rate of interest, then the sum of the whole will give the value sought. But in practice, the proceeding in this way, year by year, to the utmost period of life, would be intolerable labour, and on this account it is that I have added tables whereby this and other cases of still greater difficulty may be solved with facility and dispatch. I shall not, therefore, insist further on the theory from the doctrines of chance, but proceed to the direct application of the tables in the most useful cases, which, as it is a subject of general utility, wherein even the nation itself is concerned, I am persuaded that the extending of it rather beyond the bounds which we had prescribed will be highly agreeable to the reader. It is our wish and aim to be sufficiently copious on every interesting matter, and to expunge as much as possible whatever appears to be otherwise.

PROBLEM IV. To find the value of an annuity during the life of a person of a given age, at any proposed rate of interest.

RULE. In Table VI. look for the age in the 1st column, and against it, under the proper interest, is the number of years purchase, or, which is the same, the present value of an annuity of 1l. during such life. Multiply this by the annuity, and the product is the answer.

EXAMP. Suppose the age be 50, the rate of interest 3 per cent. and the annuity 80l. Here against age 50, and under 3 per cent. we have 11.6, according to the London bills, and 12.69, as by the bills of Northampton, which, multiplied by 80, there is 928l. for the value of a London life, and 953l. or 953l. 16s. for the value of a Northampton life.

PROBLEM V. To determine the value of an annuity granted for a given term of years, upon the contingency of its ceasing on the falling of a proposed life, before the expiration of the said given Term.

RULE. Take the value of the whole life from the table. Also take the value of another life whose age is greater than the former by the given term of years; and find the present value thereof by discounting at the given rate of interest for the said given term: then take such part of that value as is denoted by the probability of the person's surviving the said term: subtract the same from the value of the whole life, and the remainder will be the answer.

EXAMP. Let the age be 10, the term of years 15, and the rate of interest 5 per cent per annum. Here the value of an age of 10 by the London table is 14.3; the value of an age of 25 is 12.3; and the present value of 1l. to be received at the end of 15 years is .481; then $12.3 \times .481 = 5.9$ = present value of an annuity to be granted to an age of 25, fifteen years hence. Also the probability that one of the age of 10 is surviving 15 years hence is $\frac{11}{14} = \frac{100}{127}$ nearly, and $5.9 \times \frac{100}{127} = \frac{590}{127}$ 4.8 = the value of a life annuity to be granted 15 years hence upon an age of 25, on the contingency that one, whose present age is 10, will be then surviving. And $14.3 - 4.8 = 9.5$, = the number of years purchase which an annuity on proposed conditions is worth.

PROBLEM VI. To find the value of an annuity for life, to commence after a given term of years, provided a person of a certain age shall live till then.

RULE. Find the value of an annuity for an age greater by the given term than the proposed age, and multiply the same by the probability of the person's surviving the said term; then find the present worth thereof, discounting for the given term of years according to the proposed rate of interest, and it will be the value sought.

EXAMP. What is the value of an annuity for the life of a person of 10 years of age, but not to commence till 15 years hence, supposing the interest 5 per cent. per annum. Here the value of a life of 25 years is (by the London tables) 12.3 the probability of an age of 10 living 15 years, is $\frac{11}{14}$; this multiplied by 12.3, the product is $\frac{12.3 \times 333}{410} = \frac{12.3 \times 999}{1230.} = \frac{999}{100} = 9.99$ or 10, nearly; the present value of 1l. due 15 years hence = .481, and $.481 \times 10 = 4.81$ = the number of years purchase of the proposed annuity.

SCHOL. If the value thus found be subtracted from the value of the life of 10 years, the remainder will be the value of an annuity granted during the 15 years, on proviso that such life shall continue so long, but to cease on the failure thereof, if the same shall happen before the expiration of that term. This will hold in all similar cases.

PROBLEM VII. To find the value of an annuity during the joint lives of two persons of given ages.

RULE. In table VII. column 1st. look for the age of the younger (or that nearest to it) and find in column 2d. the age of the elder, against which, under the given rate of interest, you will have the number of years purchase.

EXAMP. Let the ages be 25 and 30 respectively, and the rate of interest 3 per cent. Here it is manifest at sight that the value, according to the London bills, is 11.3 years purchase, and, according to the Northampton bills, 12.97 years purchase.

SCHOL. If the ages had been 25 and 33, the value must have been determined by taking proportional parts. Thus, for London, the value for 25 and 30 is as before 11.3, and for 25 and 35 it is 10.7, the decrement is .6; then as 5 (or 35—30) : .6 :: 3 (or 33—30) : .3; which subtracted from 11.3, the remainder is 11, for the value sought.

Again, if the ages were 28 and 33. Here, by the foregoing, the value for the ages 25 and 33 is 11; and by proceeding in the same manner the value for 30 and 38 will be found = 10.5; the difference is .5. And as 5 (or 30—25) : 5 :: 3 (or 28—25) : .3 which subtracted from 11, the remainder is 10.7 = the number of years purchase for the joint lives of two persons, whose ages are 28 and 33. And thus by proportioning the differences may the value for any other ages within the limits of the table be determined.

PROBLEM VIII. To find the value of an annuity granted during the longest of two lives.

RULE. Find the value of each life separately, and also the value of the joint lives; then, from the sum of the two single lives, subtract the joint life, and the remainder will be the number of years purchase for an annuity granted during the life of the longer liver of two persons.

EXAMP. Let the given ages be 15 and 40 years, and the rate of interest 4 per cent. Here, the value of a life, whose age is 15 years (by the London tables) is 15.8; and of a life, whose age is 40 years, it is 11.5. Also the value of the joint lives is 9.4. Then $15.8 + 11.5 - 9.4 = 17.9$, the value required.

PROBLEM IX. To find the value of an annuity during the joint lives of three persons.

RULE. Find the value of the joint lives of any two, and find the age of a single life, equivalent to that value. Then find the value of the joint lives of the remaining person, and a person whose age is the age of such single life, and it will be the answer sought.

EXAMP. Let the ages be 20, 35, and 45, respectively; and interest at 4 per cent. Here take the value of the joint lives of any two, suppose 20 and 35, which, by the London table, is 9.8; and the age which answers to this in the table of single lives is 52. Also the value of the joint lives, whose ages are 45 and 52, is 6.4 = the number of years purchase for an annuity, on the joint lives of three persons, whose ages are as above specified, and interest at 4 per cent.

SCHOL. If the value of the joint lives of four persons is required; find the age answering to the value of any three; then in the table of joint lives, with the age so found, and the remaining age, take out the corresponding value, and it will be the answer sought. If the value of the joint lives of five persons is required, seek an age answerable to four, and proceed as above; and so on for any other number of lives.

PROBLEM X. To find the value of an annuity on the longest life of three or more persons.

RULE. Find an age answerable to the value of the longest life of any two, which substitute in lieu of the two, and then find the value of the longest life of it and another, and it will be the value of the longest life among three lives. If there are four or more lives, substitute the age corresponding to this value in lieu of the three lives, and find the value of the longest life of this age, and the other remaining age, and it will be the value of the longest of four lives. Proceed in the same manner for five or more lives, regard being had to the rate of interest.

Having given Examples in the former Problems sufficient to shew the use of the Tables, it will be unnecessary to give more, the rules being plain and easy. I shall, however, add a few other Problems with proper directions, and then conclude the subject.

PROBLEM XI. To find the value of an annuity for as long as any two or three certain persons shall be alive.

RULE. From the sum of the values of the joint lives of every two (viz. of A B, A C, and B C) subtract twice the value of the joint lives of the three, (viz. A B C) and the remainder will be the number of years purchase required.

PROBLEM XII. To find the value of a reversion of an assigned life after a given term of years.

RULE. From the value of the proposed life subtract the value of an annuity for the given term of years, on the contingency

gency of its ceasing upon the extinction of the aforesaid life (found by Prob. V.) and the remainder will be the answer.

PROBLEM XIII. To find the value of the reversion of an annuity for the remainder of a given term of years, after an assigned life.

RULE. From the value of an annuity certain for the given term, subtract the value of the annuity for the said term, on the contingency of its ceasing upon the failing of the proposed life, and the remainder will be the value of the reversion.

PROBLEM XIV. To find the value of the reversion of one life after another.

RULE. From the value of the life in expectation subtract the value of the two joint lives, and the remainder will be the value of the reversion.

PROBLEM XV. To find the value of the reversion of two lives after one.

RULE. From the value of the longest of the three lives subtract the value of the life in possession, and the remainder will be the value of the reversion.

PROBLEM XVI. To find the value of the reversion of one life after two joint lives.

RULE. From the value of the life in expectation, subtract the value of the three joint lives, and the remainder will be the answer.

PROBLEM XVII. To find the value of the reversion of one life after two.

RULE. From the value of the three lives (found by Problem X.) subtract the value of the two lives in possession, and the remainder will be the value of the reversion.

PROBLEM XVIII. To find the value of the reversion of two joint lives after one.

RULE. From the value of the two joint lives in expectation, subtract the value of the three joint lives, and the remainder will be the value of the reversion.

PROBLEM XIX. Two persons A and B have a joint annuity, which, after the decease of either of them, is to belong entirely to the survivor for life. To find the value of the right of each in that annuity.

RULE. From the value of the life of A or B subtract half the value of the two joint lives, the remainder will be the value of the right of A or B accordingly.

PROBLEM XX. D, and his heirs, as soon as any two of three joint lives, A, B and C, become extinct, are to enter upon an annuity, and to enjoy the same during the life of the survivor; required the present value of the expectation.

RULE. To the sum of the single lives A, B, and C, add thrice the value of the three joint lives, deducting therefrom twice the sum of the values of each pair of joint lives; viz. of A and B; A and C, and B and C, and the remainder will be the answer.

PROBLEM XXI. A given annuity after the decease of A, is to be divided equally between B and C, during their joint lives, and then is to go entirely to the last survivor for life, it is required to find the value of B's expectation.

RULE. From the value of the reversion of the life of B, after the life of A (found by Problem XIV) subtract half the value of the reversion of the joint lives, B and C, after the life of A (found by Problem XVIII) and the remainder will be the value of B's expectation.

PROBLEM XXII. A, B and C, enjoy an annuity equally amongst them, which, upon the decease of any one, is to be equally enjoyed by the survivors during their joint lives, and then the last survivor is to have the whole during his life. To find the value of the right of any one, as A, in the said annuity.

RULE. From the value of the life of A, take half the sum of the values of the joint lives, A and B, and the joint lives A and C, then to the remainder add $\frac{1}{3}$ of the value of the three joint lives, and the sum will be the answer.

PROBLEM XXIII. A enjoys an annuity for life, and is to have the nomination of a successor, who is likewise to enjoy the annuity, for his life: it is proposed to find the present value of the two successive lives.

RULE. Multiply the value of the life of A, by the value of the life put in at his decease; divide the product by the perpetuity (found by Prob. VI. Chap. I.) and subtract the quotient from the sum of the said values, and the remainder will be the answer.

PROBLEM XXIV. To find the present value of any number of lives in succession.

RULE. Multiply the value of each life, without regard to the order of succession, by the interest of 1l. for a year, and subtract each product from unity; multiply all the remainders continually together, and subtract this product also from unity: then the last remainder multiplied by the perpetuity, will be the value of all the successive lives.

OR, find (by table II.) the number of years answering to the value of each of the given lives; find also by *the same table*, the value of an annuity *certain*, for the whole of all these years added together, and it will be the answer sought.

PROBLEM XXV. A given sum of money is to be received (as a legacy) on the decease of B, who is now of a given age: what is the value thereof in present money?

RULE. Subtract the value of the life of B from the perpetuity. Then, by the rule of three, as the perpetuity is to the remainder so is the proposed sum to its present value in money.

PROBLEM XXVI. A given sum is to be received on the extinction of the 1st. 2d. or 3d. of three assigned lives; to find the present value of the expectation.

RULE. Find (by Prob. IX, X, or XI.) the value of an annuity granted upon the assigned lives, on condition of its ceasing on the falling of the 1st. 2d. or 3d. of those lives, according to the case proposed; subtract the value from the perpetuity, and then proceed according to the proportion given in the last Problem.

PROBLEM XXVII. A given sum is to be received as a legacy, on the decease of B, in case that A is then extinct; it is required to find the present value thereof, allowing for this contingency.

RULE. From the value of an annuity, in land, *certain*, for as many years as are expressed by the complement of B's age, subtract the value of the oldest life; and then it will be, as the complement of the youngest life is to the remainder, so is the proposed sum, to its present value.

SCHOL. The tables in this chapter are founded on the principle of yearly payments, and withal suppose that nothing is to be paid to the heir, or executor, &c. of the annuitant for the time from the last yearly payment to his decease, which, I believe, is frequently otherwise, and therefore to correct the value found by the tables so as to answer to any particular case, the following directions must be observed.

I. If it is required to have the yearly value such as to include the latest moment of life; then find the present worth of an annuity of 1l. (by Table II.) for a number of years equal to twice the expectation found (by Table V.) divide the same by twice that number (or four times the expectation) and add the quotient to the value found in Table VI. and it will be the proper value agreeable to the above condition.

II. If the value, according to half yearly or quarterly payments, on such consideration, is required, then, from the correct yearly value found as above, deduce the half yearly or quarterly values, by Problem VII. of Chapter I. and the result will be the answer.

III. If the half yearly or quarterly values are to be found on this supposition, that nothing is to be paid for the time between the last half yearly or quarterly payment and the death of the annuitant, then take the half or fourth (as the case shall be) of the correction found by the first direction for the yearly payments, and subtract the same from the value obtained by the 3d direction, and the remainder will be the answer.

EXAMP. Let the age be 36, then the expectation is 25 nearly, the double thereof = 50 years, and the value of an annuity of 1l. for that time at 4 per cent. is 21.4, which being divided by 100 makes .214, the correction to be added to 13.88, the value from the Northampton table of an age of 36; and consequently the true value, supposing a proportional part of the annuity to be paid up to the time of the annuitant's death, is 14.09.

Also $\frac{14.09 \times .04}{.0398} = 14.23$, the value for half-yearly payments; and $\frac{14.09 \times .04}{.0394} = 14.3$, the value for quarterly payments on the same principle.

But if nothing is to be allowed for the interval between the last half yearly or quarterly payment, and the time of death, then $14.23 - \frac{.214}{2}$ (or .107) = 14.123 and $14.3 - \frac{.214}{4}$ (or .05) = 14.25 must be deducted for the half yearly and quarterly values.

I flatter myself with the pleasing expectation that this System will be acceptable to the numerous readers of this work, as it is of an interesting nature, and requisite to be known by every person of property. I am the more emboldened in this expectation, as I have introduced the whole doctrine of Annuities with brevity, novelty, and accuracy; avoiding the errors of other writers, and incorporating what is not to be met with in any publication on this subject.

Many of the problems I have taken from the select exercises of the late ingenious Thomas Simpson, F.R.S. a work both scarce and valuable. Other tables of Mr. Simpson and Dr. Price, which appeared superfluous, I have expunged; and have advanced correct methods for solving the same problems for which they were intended, by means of those tables that are here given, so that brevity and comprehensiveness are observed through the whole.

In the printing of the tables, I have paid a most particular attention to the correcting of the press, a matter of the utmost import in calculations. And, indeed, my care in this particular, has been such, that I dare, with confidence, affirm, that the tables introduced this System are more correct than in Dr. Price's last edition, as I have here rectified some typographical faults which appear in his treatise.

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ANNUITIES, *borrowing upon*; one of the methods employed by government for raiſing ſupplies. Of this there are two methods; that of borrowing upon annuities for terms of years, and that of borrowing upon annuities for lives. During the reigns of king William and queen Anne, large ſums were frequently borrowed upon annuities for terms of years, which were ſometimes longer and ſometimes ſhorter. In 1693, an act was paſſed for borrowing one million upon an annuity of 14 per cent, or of 140,000l. a year for 16 years. In 1691, an act was paſſed for borrowing a million upon annuities for lives, upon terms which in the preſent times would appear very advantageous. But the ſubſcription was not filled up. In the following year the deficiency was made good by borrowing upon annuities for lives at 14 per cent. or at little more than ſeven years purchaſe. In 1693, the perſons who had purchaſed thoſe annuities were allowed to exchange them for others of 96 years, upon paying into the exchequer 63 pounds in the hundred; that is, the difference between 14 per cent. for life, and 14 per cent. for 96 years, was ſold for 63 pounds, or for four and a half years purchaſe. Such was the ſuppoſed inſtability of government, that even theſe terms procured few purchaſers. In the reign of queen Anne, money was upon different occaſions borrowed both upon annuities for lives and upon annuities for terms of 32, of 89, of 98, and of 99 years. In 1719, the proprietors of the annuities for 32 years were induced to accept in lieu of them South Sea ſtock to the amount of eleven and a half years purchaſe of the annuities, together with an additional quantity of ſtock equal to the arrears which happened then to be due upon them. In 1720, the greater part of the other annuities for terms of years both long and ſhort were ſubſcribed into the ſame fund. The long annuities at that time amounted to 666,89 1l. 8s. 8½d. a year. On the 5th of January, 1775, the remainder of them, or what was not ſubſcribed at that time, amounted only to 136,453l. 12s. 8d.

During the two wars which began in 1739 and in 1755, little money was borrowed either upon annuities for terms of years, or upon thoſe for lives. An annuity for 98 or 99 years, however, is worth nearly as much money as a perpetuity, and ſhould, therefore, one might think, be a fund for borrowing nearly as much, But thoſe who, in order to make family ſettlements, and to provide for remote futurity, buy into the publick ſtocks, would not care to purchaſe into one of which the value was continually diminiſhing; and ſuch people make a very conſiderable proportion both of the proprietors and purchaſers of ſtock. An annuity for a long term of years, therefore, though its intrinſic value may be very nearly the ſame with that of a perpetual annuity, will not find nearly the ſame number of purchaſers. The ſubſcribers to a new loan, who mean generally to ſell their ſubſcription as ſoon as poſſible, prefer greatly a perpetual annuity redeemable by parliament, to an irredeemable annuity for a long term of years of only equal amount. The value of the former may be ſuppoſed always the ſame, or very nearly the ſame; and it makes, therefore, a more convenient tranſferable ſtock than the latter.

During the two laſt mentioned wars, annuities, either for terms of years or for lives, were ſeldom granted but as premiums to the ſubſcribers to a new loan, over and above the redeemable annuity or intereſt upon the credit of which the loan was ſuppoſed to be made. They were granted, not as the proper fund upon which the money was borrowed; but as an additional encouragement to the lender.

Annuities for lives have occaſionally been granted in two different ways; either upon ſeparate lives, or upon lots of lives, which are called *Tontines*, from the name of their inventor. When annuities are granted upon ſeparate lives, the death of every individual annuitant diſburthens the public revenue ſo far as it was affected by his annuity. When annuities are granted upon tontines, the liberation of the public revenue does not commence till the death of all the annuitants comprehended in one lot, which may ſometimes conſiſt of twenty or thirty perſons, of whom the ſurvivors ſucceed to the annuities of all thoſe who die before them; the laſt ſurvivor ſucceeding to the annuities of the whole lot. Upon the ſame revenue more money can always be raiſed by tontines than by annuities for ſeparate lives. An annuity, with a right of ſurvivorſhip, is really worth more than an equal annuity for a ſeparate life, and from the confidence which every man naturally has in his own good fortune, the principle upon which is founded the ſucceſs of all lotteries, ſuch an annuity generally ſells for ſomething more than it is worth. In countries where it is uſual for government to raiſe money by granting annuities, tontines are upon this account generally preferred to annuities for ſeparate lives. The expedient which will raiſe moſt money, is almoſt always preferred to that which is likely to bring about in the ſpeedieſt manner the liberation of the public revenue.

In Britain, the ſeat of government being in the greateſt mercantile city in the world, the merchants are generally the people who advance money to government. By advancing it they do not mean to diminiſh; but, on the contrary, to increaſe their mercantile capitals; and unleſs they expected to ſell with ſome profit their ſhare in the ſubſcription for a new loan, they never would ſubſcribe. But if by advancing their money they were to purchaſe, inſtead of perpetual annuities, annuities for lives only, whether their own or thoſe of other people, they would not always be ſo likely to ſell them with a profit. Annuities upon their own lives they would always ſell with loſs; becauſe no man will give for an annuity upon the life of another whoſe age and ſtate are nearly the ſame with his own, the ſame price which he would give for one upon his own. An annuity upon the life of a third perſon, indeed, is, no doubt, of equal value to the buyer and the ſeller; but its real value begins to diminiſh from the moment it is granted, and continues to do ſo more and more as long as it ſubſiſts. It can never, therefore, make ſo convenient a tranſferable ſtock as a perpetual annuity, of which the real value may be ſuppoſed always the ſame, or very nearly the ſame.

In France, before the revolution, merchants did not make ſo great a proportion of the people who advance money to government, as thoſe concerned in the finances; the farmers general, the receivers of the taxes which were not in farm, the court bankers, &c. made the greater part of thoſe who advanced their money in all public exigencies. Such people were commonly men of mean birth, but of great wealth, and frequently of great pride. They were too proud to marry their equals, and women of quality diſdained to marry them. They frequently reſolved therefore, to live bachelors; and having neither any families of their own, nor much regard for thoſe of their relations, whom they were not always very fond of acknowledging, they deſired only to live in ſplendor during their own time, and were not unwilling that their fortune ſhould end with themſelves. The number of rich people, beſides, who were either averſe to marry, or whoſe condition of life rendered it either improper or inconvenient to do ſo, was much greater in France than in England. To ſuch people, who had little or no care for poſterity, nothing could be more convenient than to exchange their capital for a revenue, which is to laſt juſt as long, and no longer than they wiſh it to do.

ANNULET, *little ring*, in heraldry, is a difference or mark of diſtinction, which the fifth brother of any family ought to bear in his coat of arms. See the SYSTEM, Sect. VI. Art. 2.

ANNULETS, in architecture, are ſmall ſquare members, in the Doric capital, placed under the quarter round. They are alſo called filſets.

ANNULET is alſo uſed for a narrow flat moulding, common to other parts of a column; viz. the baſes, &c. as well as the capital; ſo called becauſe it encompaſſes the column around.—In which ſenſe annulet is frequently uſed for baguette, or little aſtragal. See the SYSTEM, and Plate VI. Fig. II.

ANNUNCIATION, the tidings which the angel Gabriel brought to the Holy Virgin, of the myſtery of the incarnation.

ANNUNCIATION is alſo the name of a feaſt, celebrated annually on the 25th of March, commonly called Lady-day, in commemoration of that wonderful event. The Jews alſo give the title Annunciation to part of the ceremony of their paſſover; viz. that, wherein they explain the origin and occaſion of that ſolemnity. This explanation they call *Haggada*, q. d. the Annunciation.

ANODYNE, (from *a* privative, and ὀδυνη, *doleo*; or *a* neg. and ὀδυνη, *pain*); a term applied to medicines which eaſe pain, and procure ſleep. They are divided into three ſorts, viz. 1. paregorics, or ſuch as aſſuage pain; 2. hypnotics, or ſuch as relieve by procuring ſleep; 3. narcotics, or ſuch as eaſe the patient by ſtupifying him. Opiates and narcotics deſtroy ſenſation. Some hypnotics and paregorics, as nitre, camphor, &c. procure eaſe and ſleep by removing the offending cauſe. Camphor is ſaid to be the beſt anodyne in nervous caſes and at the decline of fevers. The doſes of theſe medicines are generally regulated by the pulſe. Anodynes, ſhould not be given without great caution, nor on a full ſtomach, nor in dropſies. Hemlock procures eaſe and ſleep, without cauſing that head-ach next morning, uſually complained of after taking opium. If the pulſe be ſtrong, a larger doſe is ſafe; if weak, a leſs doſe muſt be given. We have alſo compound medicines in the ſhops prepared with this intention, and called by this name. Such is the anodyne balſam, made of Caſtile ſoap, camphor, ſaffron, and ſpirit of wine, digeſted in a ſand-heat. It is recommended not only for procuring eaſe in the moſt racking extremities of pain, but alſo for aſſiſting in diſcharging the peccant matters that occaſioned it. This balſam is much the ſame with the modern opodeldoc. A ready way of preparing any uſeful, ſafe, and efficacious anodyne, is as follows: take half an ounce of opium, diſſolve it in a gentle heat in three ounces of water, ſtrain the ſolution, and evaporate it to a dry ſubſtance. Grind this to powder in a glaſs mortar with thrice the quantity of loaf ſugar, and you have an excellent preparation of opium, to be given three or four grains for a doſe. By diſſolving the opium thus in water, we get rid, not only of its groſs and foul parts, but alſo of its reſinous, which are found much more pernicious than the reſt; and by dividing its parts afterwards with ſugar, the medicine is rendered more uniform, reſoluble, and miſcible with animal fluids. But however opium is prepared, it ſtill muſt be acknowledged that it retains qualities that make it little leſs than a poiſon in

a very large dose; whence it were much to be wished something could be found that would be more innocent, and yet answer the same purpose. And this camphor and nitre will do on many though not on all occasions.

ANOMALOUS, *irregular*, something that deviates from the ordinary rule and method of other things of the same kind.

ANOMALOUS *verbs*, in grammar, are such as are irregular in their conjugations; deviating from the rules or formulas observed by others. There are anomalous verbs, or irregular inflexions of verbs, in all languages. In the English, all the irregularity in our anomalous verbs lies in the formation of the preter tense, and passive participle. See the SYSTEM, Part II. Chap. III. No. 5.

ANOMALY, in astronomy, is the distance of a planet from the aphelion or apogee; or it is an irregularity in the motion of a planet, whereby it deviates from aphelion or apogee. See the SYSTEM, Sect. XII.

ANOMIA, in vermeology, a genus belonging to the order of vermes testacea. The shell is bivalve, and the valves are unequal. One valve is perforated near the hinge; affixed by that perforation to some other body. There are 25 species of the anomia; of which only two are natives of the British seas. For the generic and specific characters of the shell as forming a branch of Conchology, see the SYSTEM, Order II. Genus 15. The fossile species of the anomia genus are uncommonly numerous in this island, in our chalk-pits and limestone-quarries; and, in Gloucestershire, they are as common on the ploughed lands as pebbles in other places.

ANOREXIA, *anorexy*, (from a neg. and ὀρεξις, appetite): a want of appetite, or a loathing of food. The disorder is either original or symptomatic. When it is original, its causes are, bad diet, too free drinking, voraciousness, &c. in which cases, a vomit or two of ipecacuanha may be taken; and temperance, a light but cordial nourishing diet, and daily exercise, persisted in, will generally effect a recovery. But it is more frequently a symptom of some other disorder; and then the cure depends on the removal of the original one.

ANSERES comprehends the third order of birds in the Linnæan system of Ornithology. For the characteristic description of this order, see the SYSTEM, Sect. IV.

ANT, the English name of the genus formica. For description of this extraordinary genus of insects, see the article FORMICA: for the several species, and for the classification, see the System of ENTOMOLOGY. Neumann observes, that ants may be made use of for obtaining skeletons of small animals, such as mice, frogs, &c. exquisitely beautiful and perfect; far surpassing any thing that can be executed by artificial anatomy. The subject is for this purpose to be included in a wooden box, and properly distended, to prevent the parts from collapsing, or being crushed together by the earth. The box is to be penetrated with a number of holes, through which the ants will presently find their way.

ANT-*eater*, the English name of the genus Myrmecophaga. For a description of this genus and the species appertaining to it, see the Article MYRMECOPHAGA, and for the classification, see the System of MAMMALIA.

ANT-*eggs*, a name commonly given to a kind of little white balls found in the banks or nests of ants, ordinarily supposed to be the ova of this insect.

Late naturalists have observed, that these are not properly the ants eggs, but the young brood themselves in their first state; they are so many little vermiculi wrapped up in a film or skin, composed of a sort of silk, which they spin out of themselves as silk-worms and caterpillars do. At first they are hardly observed to stir; but, after a few days continuance, they exhibit a feeble motion of flexion and extension; and begin to look yellowish and hairy, shaped like small maggots, in which shape they grow up till they are almost as large as ants. When they pass their metamorphosis, and appear in their proper shape, they have a small black speck on them close to the anus of the included ant, which M. Lewenhoeck probably enough imagines to be the feces voided by it. Dr. Ed. King opened several of these vulgarly reputed eggs; in some of which he found only a maggot in the circumstances as above described; while in another the maggot had begun to put on the shape of an ant about the head, having two little yellow specks, where the eyes were to be. In others, a further progress was observed, the included maggots being furnished with every thing to complete the shape of an ant, but wholly transparent, the eyes only excepted, which were as black as bugles. Lastly, in others, he took out every way perfect and complete ants, which immediately crept about among the rest. These supposed ants eggs are brought up every morning in summer, near the top of the bank, where they are lodged all the warm part of the day, within reach of the sun's influence. At night, or if it be cool, or like to rain, they carry them down to a greater depth; so that you may dig a foot depth e'er you come at them. The true ants eggs are the white substance which, upon opening their banks, appears to the eye like the scatterings of fine white sugar, or salt, but very soft and tender. Examined by a microscope, it is found to consist of several pure, white appearances, in distinct membranes, all figured like the lesser sorts of birds eggs, and as clear as a fishes bladder. The same substance is found in the bodies of the ants themselves. On this spawn, when emitted, they lie in multitudes, to brood, till in some time it is turned into little vermicles as small as mites, commonly called *ants-eggs*.

ANT-*hills*, are little hillocks of earth, which the ants throw up for their habitation and the breeding of their young. They are a very great mischief to dry pastures, not only by wasting so much land as they cover, but by hindering the scythe in mowing the grass, and yielding a poor hungry food pernicious to cattle. The manner of destroying them is to cut them into four parts from the top, and then dig into them so deep as to take out the core below, so that, when the turf is laid down again, it may lie somewhat lower than the level of the rest of the land; and this will prevent the ants from returning to the same place, which otherwise they would certainly do. The earth that is taken out must be scattered to as great a distance every way as may be, otherwise they will collect it together and make another hill just by. The proper time for doing this is winter: and if the places be left open, the frost and rains of that time of the year will destroy the rest: but in this case care must be taken that they are covered up early enough in the spring, otherwise they will be less fertile in grass than the other places. In Hertfordshire they use a particular kind of spade for this purpose. It is very sharp, and formed at the top into the shape of a crescent, so that the whole edge makes up more than three-fourths of a circle; this cuts in every part, and does the business very quickly and effectually. Others use the same instruments that they do for mole-hills. Human dung is a better remedy than all these, as is proved by experiment; for it will kill great numbers of them, and drive all the rest away, if only a small quantity of it be put into their hills. Ants are likewise destroyed by scattering a good quantity of unslaked lime about their hills. Some make use of quicksilver, as a general poison to insects. For further directions, see the System of AGRICULTURE, Sect. XVIII.

ANTS, *acid of*, an acid produced by distilling millions of these insects, either without or with the addition of water. It resembles vinegar in many respects; but differs from it in forming crystals with magnesia, iron, and zinc. Its attractions are not yet determined, but are supposed to coincide with those of vinegar.

ANTAPHRODISIAC, an epithet given to medicines which diminish the feed, and extinguish the stimula or incitements to venery.

ANTARCTIC *pole* denotes the southern pole, or end of the earth's axis. The word is compound of ἀντι, *contra*, and ἀρκτος, *ursa*, *bear*; as being opposite to the arctic pole. The stars near the antarctic pole never appear above our horizon.

ANTARCTIC *circle* is one of the lesser circles of the sphere, parallel to the equator, at the distance of 23 deg. 30 min. from the south pole. It takes its name from its being opposite to another circle, parallel likewise to the equator, and at the same distance from the north pole, called the arctic circle. For further description of this and the preceding article, see the Treatise on the GLOBES and Plate annexed.

ANTECEDENT, in general, something that precedes or goes before another, in respect of time.

ANTECEDENT, in grammar, the word which a relative refers to. See the System, under the article PRONOUN, Part II. Chap. III. No. 3.

ANTECEDENT, in logic, denotes the first proposition of an enthymeme, or of an argument which only consists of two members. In opposition to this, the latter is called the consequent. Thus, in the argument, *cogito, ergo sum*, I think, and therefore I exist; *cogito* is the antecedent; being thus called, because it precedes the *ergo*, or the *copula* of the argument. See the SYSTEM, Part II. Sect. II. III. and IV.

ANTECEDENT *of a ratio*, in mathematics, denotes the first term, or that which is compared with the other. Thus, if the ratio be $a : b$, or of a to b, a is said to be the antecedent.

ANTECEDENT *signs*, in medicine, are such symptoms of disorder as appear before a distemper is so formed as to be reducible to any particular class, or proper denomination.

ANTECEDENTS, in rhetoric, are such things as being once allowed, others necessarily or very probably follow. This is one of the sixteen topics or common places enumerated by Cicero and Quintillian.

ANTEDILUVIANS, a general name for all mankind who lived before the flood, and so includes the whole of the human race from Adam to Noah and his family. As Moses has not set down the particular time of any transaction before the flood, except only the years of the fathers age wherein the several descendants of Adam in the line of Seth were begotten, and the length of their several lives, it has been the business of chronologers to endeavour to fix the years of the lives and deaths of those patriarchs, and the distance of time from the creation to the deluge. In this there could be little difficulty were there no varieties in the several copies we now have of Moses's writings; which are, the Hebrew, the Samaritan, and the Greek version of the Septuagint: but as these differ very considerably from one another, learned men are much divided in their opinions

opinions concerning the chronology of the firſt ages of the world; ſome preferring one copy and ſome another.

Dr. Burnet and Dr. Woodward differ very widely concerning the antediluvian world; the former imagines its face and appearance to have been ſmooth, equable, and in all reſpects different from what we now find it to be. The latter, on the contrary, endeavours to prove, that the face of the terraqueous globe before the deluge was the ſame as it is now, viz. unequal, diſtinguiſhed into mountains, and dales, and having likewiſe a ſea, lakes, and rivers; that this ſea was ſalt, as ours is; was ſubject to tides; and poſſeſſed nearly the ſame ſpace and extent that it does now; and that the antediluvian world was ſtocked with animals, vegetables, minerals, &c. that it had the ſame poſition, in reſpect of the ſun, which ours now hath, its axis not being perpendicular, but inclined, as at preſent, to the plane of the ecliptic; conſequently that there were then the ſame ſucceſſion of weather, and the ſame viciſſitudes of ſeaſons, as now.

As to the cuſtoms, policy, and other general circumſtances of the Antediluvians, we can only form conjectures. The only thing we know as to their religious rites is, that they offered ſacrifices, and that very early, both of the fruits of the earth, and of animals: but whether the blood and fleſh of the animals, or only their milk and wool, were offered, is a diſputed point.—Of their arts and ſciences, we have not much more to ſay. The Antediluvians ſeem to have ſpent their time rather in luxury and wantonneſs, to which the abundant fertility of the firſt earth invited them, than in diſcoveries or improvements, which probably they ſtood much leſs in need of than their ſucceſſors. The art of working metals was found out by the laſt generation of Cain's line; and muſic, which they might be ſuppoſed to practiſe for their pleaſure, was not brought to any perfection, if invented, before the ſame generation. Some authors have ſuppoſed aſtronomy to have been cultivated by the Antediluvians, though this is probably owing to a miſtake of Joſephus: but it is to be preſumed, the progreſs they made therein, or in any other ſcience, was not extraordinary; it being even very doubtful whether letters were ſo much as known before the flood.

As to their politics and civil conſtitutions, we have not ſo much as any circumſtances whereon to build conjecture. It is probable, the patriarchal form of government, which certainly was the firſt, was ſet aſide when tyranny and oppreſſion began to take place, and much ſooner among the race of Cain than that of Seth. It ſeems alſo, that their communities were but few, and conſiſted of vaſtly larger numbers of people than any formed ſince the flood; or rather, it is a queſtion, whether, after the union of the two great families of Seth and Cain, there were any diſtinction of civil ſocieties, or diverſity of regular governments, at all. It is more likely, that all mankind then made but one great nation, though living in a kind of anarchy, divided into ſeveral diſorderly aſſociations; which, as it was almoſt the natural conſequence of their having, in all probability, but one common language, ſo it was a circumſtance which greatly contributed to that general corruption, which otherwiſe perhaps could not have ſo univerſally overſpread the Antediluvian world. And for this reaſon chiefly, as it ſeems, ſo ſoon as the poſterity of Noah were ſufficiently increaſed, a plurality of tongues was miraculouſly introduced, in order to divide them into diſtinct ſocieties, and thereby prevent any ſuch total depravation for the future. See CONFUSION OF TONGUES.

Of the condition of the Antediluvians, Mr. Whitehurſt, in his *Inquiry into the original ſtate and formation of the earth*, has given us the following picture: "Under a mild and ſerene ſky, and when the ſpontaneous productions of the earth were more than ſufficient for the calls of nature without art or labour, mankind had no need of any other protection from the inclemency of the ſeaſons, nor of barns for winter's ſtore, than the benevolent Author of nature had plentifully provided for them. Conſequently, in a ſtate of nature like this, there was no temptation to acts of violence, injuſtice, fraud, &c. every one having plenty and enough, each equally partook of the numerous bleſſings thus amply provided for him. Power and property being equally diffuſed, men lived together in perfect peace and harmony, without law, and without fear; therefore it may be truly ſaid of the Antediluvians, that they ſlept away their time in ſweet repoſe on the ever-verdant turf. Such apparently was the ſtate of nature in the firſt ages of the world, or from the creation to the firſt convulſion in nature, whereby the world was not only univerſally deluged, but reduced to a heap of ruins." But our ingenious author, whoſe *Inquiry* is not profeſſedly repugnant to revelation, ſeems here to have loſt himſelf in a pleaſing reverie. At leaſt he has forgot to inform us, For what purpoſe, under ſuch circumſtances, he ſuppoſes the deluge to have been ſent upon the earth: and, How we are to underſtand the account given by Moſes, who repreſents the Antediluvians, not as an innocent race, quietly repoſing on the ever-verdant turf; but as a corrupt generation, by whom "the earth was filled with violence."

One of the moſt extraordinary circumſtances which occurs in the antediluvian hiſtory, is the vaſt length of human lives in thoſe firſt ages, in compariſon with our own. Few perſons now arrive to eighty or an hundred years; whereas, before the flood, they frequently lived to near a thouſand: a diſproportion almoſt incredible, though ſupported by the joint teſtimonies of ſacred and prophane writers. Some, to reconcile the matter with probability, have imagined that the ages of thoſe firſt men might poſſibly be computed, not by ſolar years, but months; an expedient which reduces the length of their lives rather to a ſhorter period than our own. But for this there is not the leaſt foundation; beſides the many abſurdities that would thence follow, ſuch as their begetting children at about ſix years of age, as ſome of them in that caſe muſt have done, and the contraction of the whole interval between the creation and the deluge to conſiderably leſs than two hundred years, even according to the larger computation of the Septuagint.

Again: Joſephus the Jewiſh hiſtorian, and ſome Chriſtian divines, are of opinion, that before the flood, and ſome time after, mankind in general did not live to ſuch a remarkable age, but only a few beloved of God, ſuch as the patriarchs mentioned by Moſes. They reaſon in this manner: Though the hiſtorian records the names of ſome men whoſe longevity was ſingular, yet that is no proof that the reſt of mankind attained to the ſame period of life, more than that every man was then of a gigantic ſtature becauſe he ſays *in thoſe days there were giants upon the earth*. Beſides, had the whole of the Antediluvians lived ſo very long, and increaſed in numbers in proportion to their age, before the flood of Noah, the earth could not have contained its inhabitants, even ſuppoſing no part of it had been ſea. And had animals lived as long, and multiplied in the ſame manner as they have done afterwards, they would have conſumed the whole produce of the globe, and the ſtronger would have extinguiſhed many ſpecies of the weaker. Hence they conclude, that, for wiſe and good ends, God extended only the lives of the patriarchs, and a few beſide, to ſuch an extraordinary length.

But moſt writers maintain the longevity of mankind in general in the early world, not only upon the authority of ſacred, but likewiſe of profane hiſtory. And for ſuch a conſtitution, the moral reaſons are abundantly obvious. When the earth was wholly unpeopled, except by one pair, it was neceſſary to endow men with a ſtronger frame, and to allow them a longer continuance upon earth for peopling it with inhabitants. In the infant ſtate of every mechanical art, relating to tillage, building, clothing, &c. it would require many years experience to invent proper tools and inſtruments to eaſe men of their labour, and by multiplied eſſays and experiments to bring their inventions to any degree of maturity and perfection. Every part of their work muſt have been exceedingly arduous from ſuch a penury and coarſeneſs of tools, and muſt have required longer time and more ſtrength of body than afterwards, when mechanical knowledge was introduced into the world. If parents at this period had not continued long with their children, to have taught them the arts of providing for themſelves, and have defended them from the attacks of wild beaſts, and from other injuries to which they were expoſed, many families would have been totally extinguiſhed. But one of the beſt and moſt valuable ends which longevity would anſwer was, the tranſmitting of knowledge, particularly of religious knowledge, to mankind. And thus, before writing was invented, or any ſuch eaſy and durable mode of conveyance was found out, a very few men ſerved for many generations to inſtruct their poſterity, who would not be at a loſs to conſult living and authentic records.

The natural cauſes of this longevity are variouſly aſſigned. Some have imputed it to the ſobriety of the Antediluvians, and the ſimplicity of their diet; alledging that they had none of thoſe provocations to gluttony, which wit and vice have ſince invented. Temperance might undoubtedly have ſome effect, but not poſſibly to ſuch a degree. There have been many temperate and abſtemious perſons in later ages, who yet ſeldom have exceeded the uſual period.—Others have thought, that the long lives of thoſe inhabitants of the old world proceeded from the ſtrength of their ſtamina, or firſt principles of their bodily conſtitutions: which might, indeed, be a concurrent, but not the ſole and adequate cauſe of their longevity; for Shem, who was born before the deluge, and had all the virtue of the antediluvian conſtitution, fell three hundred years ſhort of the age of his forefathers, becauſe the greateſt part of his life was paſſed after the flood. Others have imputed the longevity of the Antediluvians to the excellency of their fruits, and ſome peculiar virtue in the herbs and plants of thoſe days. But to this ſuppoſition it has been objected, that as the earth was curſed immediately after the fall, its productions we may ſuppoſe gradually decreaſed in their virtue and goodneſs till the flood; and yet we do not ſee the length of mens lives decreaſed conſiderably, if at all, during that interval. Waving this objection, as the import of the curſe is variouſly interpreted, it appears certain that the productions of the earth were at firſt, and probably continued till after the deluge, of a different nature from what they were in future times.

It has been further ſuppoſed, that a principal cauſe of the longevity under conſideration was the wholeſome conſtitution

of

of the Antediluvian air, which, after the deluge, became corrupted and unwholeſome, breaking, by degrees, the priſtine craſis of the body, and ſhortening men's lives, in a very few ages, to near the preſent ſtandard. The temperature of the air and ſeaſons before that cataſtrophe are upon very probable grounds ſuppoſed to have been conſtantly uniform and mild: the burning heats of ſummer and the ſeverities of winter's cold were not then come forth, but ſpring and autumn reigned perpetually together: And indeed, the circumſtance above all others moſt conducive to the prolongation of human life in the poſtdiluvian world appears to be an equal and benign temperature of climate (ſee the article LONGEVITY;) whence it ſeems reaſonable to infer, that the ſame cauſe might have produced the ſame effect in the Antediluvian world.

The Antediluvian world was, in all probability, ſtocked with a much greater number of inhabitants than the preſent earth either actually does, or perhaps is capable of containing or ſupplying. This ſeems naturally to follow from the great length of their lives, which exceeding the preſent ſtandard of life in the proportion, at leaſt, of ten to one, the Antediluvians muſt accordingly in any long ſpace of time double themſelves, at leaſt in about the tenth part of the time in which mankind do now double themſelves. It has been ſuppoſed that they began to beget children as early, and left off as late, in proportion, as men do now; and that the ſeveral children of the ſame father ſucceeded as quickly one after another as they uſually do at this day; and as many generations, which are but ſucceſſive with us, were contempary before the flood, the number of people living on the earth at once would be by that means ſufficiently increaſed to anſwer any defect which might ariſe from other circumſtances not conſidered. So that, if we make a computation on theſe principles, we ſhall find, that there was a conſiderable number of people in the world at the death of Abel, though their father Adam was not then 130 years old; and that the number of mankind before the deluge would eaſily amount to above one hundred thouſand millions (even according to the Samaritan chronology), that is, to twenty times as many as our preſent earth has, in all probability, now upon it, or can well be ſuppoſed capable of maintaining in its preſent conſtitution.

ANTELOPE, a ſpecies belonging to the genus capra. For a deſcription of the genus and the ſpecies which appertain to it, ſee the Article CAPRA, and for the claſſification, ſee the Syſtem of MAMMALIA.

ANTENNÆ, in entomology, ſlender bodies with which nature has furniſhed the heads of inſects, being the ſame with what are called horns or feelers. See that Syſtem, under the head SCIENTIFIC DESCRIPTION.

ANTEPILEPTIC, in medicine, denotes a quality in bodies, whereby they reſiſt or oppoſe the epilepſy and convulſive motions. The chief antepileptics from the vegetable kingdom are, the roots of peony, valerian, the flowers of the lime-tree, muſſetue of the oak, hazel, and lime. The animal kindom affords a great number of antepileptics, either real or imaginary. Such are the elks claws, caſtoreum, divers parts of the deer, ſwallows hearts, the human cranium, blood, ſecundines, &c. the hippomanes, lizards, frogs and mole's liver and ſpine, lions and peacocks dung, earthworms, &c. The mineral kingdom affords hyacynths and ſmaragds prepared, alſo tincture of luna.

ANTHEMIS, *camomile*: A genus of the polygamia ſuperflua order, belonging to the ſyngeneſia claſs of plants. Of this genus Linnæus enumerates 17 ſpecies, of which the moſt remarkable are the two following. The nobilis or common camomile, and the pyrethrum or pellitory of Spain. Theſe two ſpecies are uſed in medicine. The firſt have a ſtrong, not ungrateful, aromatic ſmell, and a very bitter naufeous taſte. They are accounted carminative, aperient, emollient, and in ſome meaſure anodyne; and ſtand recommended in flatulent colics, for promoting the uterine purgations, in ſpaſmodic pains, and the pains of childbed-women: ſometimes they have been employed in intermittent fevers, and the nephritis. Theſe flowers are frequently alſo uſed externally in diſcutient and antiſeptic fomentations, and in emollient glyſters. They enter the *decoctum pro enemate* and *decoctum pro fomento* of our pharmacopœias. An eſſential oil was formerly directed to be prepared from them, but it is now omitted. A ſimple watery infuſion of them taken in a tepid ſtate, is at preſent frequently employed to promote the operation of emetics. The root of the pyrethrum is the only part endowed with medical virtue. It has no ſenſible ſmell; its taſte is very hot and acrid, but leſs ſo than that of arum or dracunculus; the juice expreſſed from it has ſcarce any acrimony, nor is the root itſelf ſo pungent when freſh as after it has been dried. Water, aſſiſted by heat, extracts ſome ſhare of its taſte, rectified ſpirit the whole; neither of them elevate any thing in diſtillation. The principal uſe of pyrethrum in the preſent practice is as a maſticatory, for promoting the ſalival flux, and evacuating viſcid humours from the head and neighbouring parts; by this means it often relieves the tooth-ach, ſome kinds of pains of the head, and lethargic complaints.

ANTHERA, among botaniſts, that part of the ſtamen which is fixed on the top of the filamentum, within the corolla: it contains the pollen or fine duſt, which, when mature, it emits for the impregnation of the plant, according to Linnæus. See the Syſtem of BOTANY, Sect. III.

ANTHROPOPHAGI, (of ἄνθρωπος a *man*, and φαγω to *eat*), *men-eaters*. That there have been, in almoſt all ages of the world, nations who have followed this barbarous practice, we have abundance of teſtimonies. The Cyclops, the Leſtrygons, and Scylla, are all repreſented in Homer as *anthropophagi*, or man-eaters; and the female phantoms, Circe and the Syrens, firſt bewitched with a ſhew of pleaſure, and then deſtroyed. This, like the other parts of Homer's poetry, had a foundation in the manner of the times preceding his own. It was ſtill, in many places, the age ſpoken of by Orpheus,

When men devour'd each other like the beaſts,
Gorging on human fleſh.—

When America was diſcovered, this practice was found to be almoſt univerſal, inſomuch that ſeveral authors have ſuppoſed it to be occaſioned through a want of other food, or through the indolence of the people to ſeek for it; though others aſcribe its origin to a ſpirit of revenge. It appears pretty certain from Dr. Hawkeſworth's Account of the Voyages to the South Seas, that the inhabitants of the iſland of New Zealand, a country unfurniſhed with the neceſſaries of life, eat the bodies of their enemies. It appears alſo to be very probable, that both the wars and anthropophagy of theſe ſavages take their riſe and owe their continuance to irreſiſtible neceſſity, and the dreadful alternative of deſtroying each other by violence or of periſhing by hunger. See vol. iii. p. 447, & ſeq. and vol. ii. p. 389, &c. Mr. Marſden alſo informs us that this horrible cuſtom is practiſed by the Battas, a people in the iſland of Sumatra. "They do not eat human fleſh (ſays he) as a means of ſatisfying the cravings of nature, owing to a deficiency of other food; nor is it ſought after as a gluttonous delicacy, as it would ſeem among the New Zealanders. The Battas eat it as a ſpecies of ceremony; as a mode of ſhowing their deteſtation of crimes, by an ignominious puniſhment; and as a horrid indication of revenge and inſult to their unfortunate enemies. The objects of this barbarous repaſt are the priſoners taken in war, and offenders convicted and condemned for capital crimes. Perſons of the former deſcription may be ranſomed or exchanged, for which they often wait a conſiderable time; and the latter ſuffer only when their friends cannot redeem them by the cuſtomary fine of twenty beenchangs, or eighty dollars. Theſe are tried by the people of the tribe where the fact was committed, but cannot be executed till their own particular raja or chief has been acquainted with the ſentence; who, when he acknowledges the juſtice of the intended puniſhment, ſends a cloth to cover the delinquent's head, together with a large diſh of ſalt and lemons. The unhappy object, whether priſoner of war or malefactor, is then tied to a ſtake: the people aſſembled throw their lances at him from a certain diſtance; and when mortally wounded, they run up to him, as if in a tranſport of paſſion; cut pieces from the body with their knives; dip them in the diſh of ſalt and lemon juice; ſlightly broil them over a fire prepared for the purpoſe; and ſwallow the morſels with a degree of ſavage enthuſiaſm. Sometimes (I preſume according to the degree of their animoſity and reſentment) the whole is devoured; and inſtances have been known, where, with barbarity ſtill aggravated, they tear the fleſh from the carcaſe with their mouths. To ſuch a depth of depravity may man be plunged, when neither religion nor philoſophy enlighten his ſteps! All that can be ſaid in extenuation of the horror of this diabolical ceremony is, that no view appears to be entertained of torturing the ſufferers; of encreaſing or lengthening out the pangs of death; the whole fury is directed againſt the corpſe; warm indeed with the remains of life, but paſt the ſenſation of pain. I have found a difference of opinion in regard to their eating the bodies of their enemies ſlain in battle. Some perſons long reſident there, and acquainted with their proceedings, aſſert that it is not cuſtomary; but as one or two particular inſtances have been given by other people, it is juſt to conclude, that it ſometimes takes place, though not generally. It was ſuppoſed to be with this intent that raja Neabin maintained a long conflict for the body of Mr. Nairne, a moſt reſpectable gentleman and valuable ſervant of the India Company, who fell in an attack upon the campong of that chief, in the year 1773. It may be ſaid, that whether the dead body of an enemy be eaten or buried, is a matter perfectly indifferent. But whatever the practice of eating human fleſh may be in itſelf, it certainly is relatively, and in its conſequences moſt pernicious. It manifeſtly tends to eradicate a principle, which is the chief ſecurity of human life, and more frequently reſtrains the hand of the murderer, than the ſenſe of duty or the dread of puniſhment. If even this horrid practice originates from hunger, ſtill it muſt be perpetuated from revenge. Death muſt loſe much of its horror among thoſe who are accuſtomed to eat the dead; and where there is little horror at the ſight of death, there muſt be leſs repugnance to murder. See ſome further obſervations on this ſubject, equally juſt and ingenious, by Dr. Hawkeſworth, *ut ſupra*. See CANNIBAL.

ANTHRO-

ANTHROPOSCOPIA, the art of judging or diſcovering a man's character, diſpoſition, paſſions, and inclinations, from the lineaments of his body. In which ſenſe *anthroposcopia* ſeems of ſomewhat greater extent than *phythagnomy* or *metoposcopy*. Otto has publiſhed an ANTHROPOSCOPIA, *five judicium hominis de homine ex lineamentis externis*.

ANTHROPOTHYSIA, denotes the offering of human victims. The *anthropothysia* was a frequent practice among the ancients. Some have imagined that the ſacrifice of Abraham was the firſt inſtance. Many reaſonings and diſquiſitions have been founded on this ſuppoſition; by which the ſeverity of Abraham's trial is thought by ſome to have been ſomewhat exaggerated. Human ſacrifices were in uſe among the Gentiles before that time; practiſed by kings as well as by private perſons; nay by entire nations, as the Egyptians, Phœnicians, Canaanites, &c. Human ſacrifices prevail in the preſent day amongſt the inhabitants of the iſlands newly diſcovered in the South Seas, particularly at Otaheite, where Captain Cook had an opportunity of being preſent at the horrid ſolemnity. We have extracted a copious account of the ceremonies as related by that celebrated navigator, which may be ſeen under the article EATOOA; ſee alſo BANKES's GEOGRAPHY, pages 55, 56, 57.

ANTI, Αντι, is a prepoſition uſed in compoſition with ſeveral words, both in Greek, Latin, Engliſh, &c. in different ſenſes. In Engliſh, it ſometimes ſignifies before; as in *antichamber*, a place before the chamber. In which caſe it has the ſame meaning with the Latin *ante*, *before*. Sometimes, again, it ſignifies *contrary*, or *oppoſite*; and is then derived from αντι, *contra*, *againſt*. In this latter ſenſe, the word makes part of the name of various medicines, to denote ſome peculiar or ſpecific virtue in them againſt certain diſeaſes: ſuch, e. gr. are antivenereals, antiſcorbutics, antinephritics, &c. The prepoſition is frequently, however, omitted on theſe occaſions, without any alteration of the ſenſe; as in nephritics, arthritics, aſthmatics, &c.

ANTICHRIST, among eccleſiaſtical writers, denotes a great adverſary of Chriſtianity, who is to appear upon the earth towards the end of the world. We have demonſtrations, diſputations, and proofs, in great order and number, both that the pope is, and that he is not, Antichriſt. F. Calmet is very large in deſcribing the father and mother of Antichriſt, his tribe and pedigree, his wars and conqueſts, his atchievements againſt Gog, Magog, &c. Some place his capital at Conſtantinople, others at Jeruſalem, others at Moſcow, and ſome few at London; but the generality at Rome, though theſe laſt are divided. Grotius and ſome others ſuppoſe Rome Pagan to have been the ſeat of Antichriſt: moſt of the Lutheran and reformed doctors contend earneſtly for Rome Chriſtian under the papal hierarchy. In fact, the point having been maturely debated at the council of Gap, held in 1603, a reſolution was taken thereupon, to inſert an article in the confeſſion of faith, whereby the pope is formally declared to be Antichriſt. Pope Clement VIII. was ſtruck to the quick with this deciſion; and even king Henry IV. of France was not a little mortified to be thus declared, as he ſaid, an imp of Antichriſt.

We cite the following extract from the ENCYCLOPÆDIA BRITANNICA, *to ſhew the propriety of abridging voluminous works, which abound with articles obſolete, unintereſting, or uncertaining; and ſometimes, as in the preſent inſtance, include remarks which muſt not only inſult the underſtanding, but ſhock the feelings of every rational and ſenſible reader.*

M. le Clerc holds, that the rebel Jews and their leader Simon, whoſe hiſtory is given by Joſephus, are to be reputed as the true Antichriſt. Lightfoot and Vanderhart rather apply this character to the Jewiſh Sanhedrim. Hippolitus and others held that the devil himſelf was the true Antichriſt; that he was to be incarnate, and make his appearance in human ſhape before the conſummation of all things. Others among the ancients held that Antichriſt was to be born of a virgin, by ſome prolific power imparted to her by the devil. A modern writer of the female ſex, whom many hold for a ſaint, has improved on this ſentiment; maintaining that Antichriſt is to be begotten by the devil on the body of a witch by means of the ſemen of a man caught in the commiſſion of a certain crime, and conveyed, &c. Hunnius and ſome others, to ſecure Antichriſt to the pope (notwithſtanding that this latter ſeemed excluded by not being of the tribe of Dan) have broke in upon the unity of Antichriſt, and aſſert that there is to be both an eaſtern and a weſtern Antichriſt. Father Malvenda, a Jeſuit, hath publiſhed a large work entitled *Antichriſtus*, in which this ſubject is amply diſcuſſed. It conſiſts of thirteen books. In the firſt he relates all the opinions of the fathers with regard to Antichriſt. In the ſecond, he ſpeaks of the times when he ſhall appear; and ſhows, that all the fathers who ſuppoſed Antichriſt to be near at hand, judged the world was near its period. In the third, he diſcourſes of his origin and nation; and ſhows that he is to be a Jew, of the tribe of Dan: this he founds on the authority of the fathers; on the paſſage in Geneſis xlix. 17. *Dan ſhall be a ſerpent by the way*, &c. on that of Jeremy viii. 16. where it is ſaid, *The armies of Dan ſhall devour the earth:* and on Rev. vii. where St. John, enumerating all the tribes of Iſrael, makes no mention of that of Dan. In the fourth and fifth books, he treats of the ſigns of Antichriſt. In the ſixth, of his reign and wars. In the ſeventh, of his vices. In the eighth, of his doctrine and miracles. In the ninth, of his perſecutions: and in the reſt, of the coming of Enoch and Elias, the converſion of the Jews, the reign of Jeſus Chriſt, and the death of Antichriſt, after he has reigned three years and an half. See alſo *Lowman on the Revelation*. How endleſs are conjectures? Some of the Jews, we are told, actually took Cromwell for the Chriſt; while ſome others have laboured to prove him Antichriſt himſelf. Pfaffius aſſures us he ſaw a folio book in the Bodleian library, written on purpoſe to demonſtrate this latter poſition. Upon the whole, the Antichriſt mentioned by the apoſtle John, 1 Ep. ii. 18. and more particularly deſcribed in the book of Revelation, ſeems evidently to be the ſame with the *Man of Sin*, &c. characteriſed by St. Paul in his ſecond Epiſtle to the Theſſalonians. c. ii. And the entire deſcription literally applies to the exceſſes of papal power. Had the right of private judgment, ſays an excellent writer, been always adopted and maintained, Antichriſt could never have been; and when the ſacred right comes to be univerſally aſſerted, and men follow the voice of their own reaſon and conſciences, Antichriſt can be no more.

ANTIMONIALS, in medicine, denote preparations of antimony; or remedies whereof antimony is the baſis, or principal ingredient. Antimonials are chiefly of an emetic tendency; though they may be ſo qualified as to become either cathartic or diaphoretic, or even only alterative. Quincy aſſures us, that there are no medicines in pharmacy to be compared with theſe in maniacal affections; for that there are no emetics, or cathartics, of any other tribe, that are ſtrong enough for ſuch patients, unleſs in an over-doſe, which might be dangerous. An antimonial cup, made either of glaſs of antimony, or of antimony prepared of ſalt-petre, though a ſubſtance indiſſoluble by the ſtomach, will give a ſtrong cathartic, or emetic quality to any liquor poured into it, without any diminution of its own weight. Beſides thoſe numerous preparations which take their denominations from antimony, the chief of which are enumerated under that article, there are ſeveral other antimonial medicines. Such are the crocus metallorum, Poterius's cordial, the tinctura metallorum, mercurius vitæ, or powder of algarot, bezoardicum minerale, ſulphur metallorum, the Carthuſian powder, or Kermes mineral, &c. Lemery deſcribes ſeveral other preparations of this mineral.

ANTIMONY, a blackiſh mineral ſubſtance, ſtaining the hands, full of long, ſhining, needle-like ſtriæ, hard, brittle, and conſiderably heavy. It is found in different parts of Europe, as Bohemia, Saxony, Tranſylvania, Hungary, France, and England, commonly in mines by itſelf, intermixed with earth and ſtony matters. Sometimes it is blended with the richer ores of ſilver, and renders the extraction of that metal difficult by volatilizing a part of the ſilver, or in the language of the miners, *roaſting the ore*. Antimony at firſt, was of ſervice only in the compoſition of paint. Scripture deſcribes it to us as a ſort of paint, with which the women blackened their eye-brows. Jezebel, underſtanding that Jehu was to enter Samaria, painted her eyes with antimony; or, according to the Hebrew, "put her eyes in antimony." As large black eyes were thought the fineſt, thoſe of both ſexes, who were careful of their beauty, rubbed their eyes, eye-lids, and round the eyes, with a needle dipped in a box of paint made of antimony, with a deſign of blackening them.—At this day, the women of Syria, Arabia, and Babylonia, anoint and blacken themſelves about the eyes; and both men and women put black upon their eyes in the deſert, to preſerve them from the heat of the ſun and the piercing of its rays. Mr. Barrieux tells us, that the Arabian women border their eyes with a black colour made of tutty, which the Arabians call *tebel*. They draw a line of this kind of blacking without the corner of their eyes, to make them appear larger. Iſaiah, in his enumeration of the ſeveral ornaments belonging to the daughters of Sion, has not forgot the needles which they made uſe of in painting their eyes and eye-lids. Nor has this practice eſcaped the laſh of Juvenal:

Hic ſupercilium madida fuligine tinctum
Obliqua producit acu, pingitque tremulæ
Attollens oculos.

Ezekiel, diſcovering the irregularities of the Jewiſh nation under the idea of a debauched woman, ſays, that ſhe bathed and perfumed herſelf, and that ſhe anointed her eyes with antimony. Job ſhows ſufficiently how much antimony was in eſteem, by calling one of his daughters a veſſel of antimony, or a box to put paint in, *cornu ſtibii*. The author of the Book of Enoch ſays, that before the deluge the angel Azleel taught young women the art of painting themſelves. Tertullian and St. Cyprian have declaimed very warmly againſt this cuſtom of painting their eyes and eye-brows, which was much practiſed in Afric even by the men: *Inunge oculos tuos non ſtibio diaboli, ſed collyrio Chriſti*, ſays St. Cyprian. Pliny, ſpeaking of the Roman ladies, ſays, that they painted their very eyes:

Tanta eſt decoris affectatio, ut tingantur oculi quoque. Sardanapalus painted his eyes and eye-brows. Joſephus reproaches the ſeditious with the ſame, who aſſumed the name of zealots, and made themſelves maſters of the temple of Jeruſalem.

The modern uſes of antimony are very numerous and important. It is a common ingredient in ſpecula or burning concaves, ſerving to give the compoſition a finer texture. It makes a part in bell metal, and renders the ſound more clear. It is mingled with tin, to make it more hard, white, and ſounding; and with lead, in the caſting of printers letters, to render them more ſmooth and firm. It is alſo a general help in the melting of metals, and eſpecially in the caſting of cannon balls. It is likewiſe made uſe of for purifying and heightening the colour of gold. It is now univerſally allowed, that pure antimony in its crude ſtate has no noxious quality; and that though many of its preparations are moſt virulently emetic and cathartic, yet, by a ſlight alteration or addition, they loſe their virulence, and become mild in their operation.

Before the fourteenth century, antimony had no place in medicine. But, about that time, Baſil Valentine, having found a method of preparing and correcting the dangerous qualities of its ſulphur, publiſhed a book, intitled *Currus triumphalis Antimonii*, wherein he maintained it a ſure remedy for all diſeaſes—but, in ſpite of all he could ſay in its behalf, though confirmed by experience, antimony remained in general neglect upwards of an hundred years: till about the beginning of the ſixteenth century, when it was brought into vogue by Paracelſus.—The parliament of Paris, immediately upon this reſtoration, condemned the uſe of it in form; and a phyſician, named Beſnier, having been found delinquent herein, was expelled the faculty. It ſeems, a great deal of miſchief had been done by it, for want of knowing the proper ways of giving it; ſo that the arret of parliament repreſents it as a mere poiſon, incapable of being corrected by any method of preparation, and not to be taken inwardly, without the utmoſt damage.

Several learned men complained of ſo ſevere and unjuſt a prohibition; and, by a courſe of happy experiments, at length brought it into eſteem again: whence, in ſpite of all the invectives made againſt antimony by divers authors, it was at length replaced, in the year 1637, by public authority, among the number of purgative drugs; and was inſerted, accordingly, in the Pharmacopœia, publiſhed by the faculty that ſame year.

Patin did all he could to decry antimony: in his letters we find an unuſual vehemence expreſſed againſt it.—He had even compiled a large regiſter of perſons whom the phyſicians had killed by it; which he called *the Martyrology of antimony*. Antimony, in medicine, &c. is not only given in ſubſtance, but many preparations of it are uſed; which are either emetic, cathartic, diaphoretic, or ſudorific. Crude antimony in powder is found good for diſſolving viſcidities, in cutaneous diſeaſes, and, as ſome very confidently aſſert, in convulſions and epilepſies. Crude antimony is recommended in palſies, pains and numbneſs, which come on after a ſalivation, and is ſaid to have cured ſeveral who were paralytic from other cauſes. The method of giving it, is to begin with three grains, increaſing the doſe with three grains every day, to half a drachm; after which the doſe is diminiſhed three grains every day, till it comes down to the quantity of the firſt doſe. Externally, in ointments, it is commended for drying up ulcers, curing the itch, and in plaiſters for reſolving of tumors. There appears no reaſon for people's being afraid of giving crude antimony internally; experience ſhews it to be a ſafe medicine, unleſs by accident the acid of the ſtomach ſhould be ſufficient to act as a menſtruum to it. The preparations of antimony are, 1. Sulphur præcipitatum antimonii. 2. Crocus antimonii, called alſo crocus metallorum. 3. Crocus antimonii lotus. 4. Calx antimonii, called antimonium diaphoreticum. 5. Tartarum emeticum. 6. Cauſticum antimoniale. 7. Cinnabaris antimonii. 8. Regulus antimonii martialis. 9. Tinctura antimonii. 10. The Kermes mineral, or Carthuſian powder.

The virtues of antimony, in the diſeaſes of animals, are very great, and very evident on any trial. Pigs that have the meaſles are at all times recovered by it, which proves it a great purifier of the blood. Horſes who have running heels, that cannot be cured by the common methods uſed by the farriers, will generally be cured by this medicine in a little time. The manner of uſing it is this: mix one drachm with every feeding of oats which the horſe has in a morning; it is beſt put together in one place, buried under a few oats, and the horſe's head being with-held a little, and then let go juſt againſt that place, he will take it all in at a mouthful. Some horſes do not diſlike it, others obſtinately refuſe it, but to theſe it may eaſily be given in balls. The liver of antimony, crude antimony, and the crocus metallorum, are uſed as purgatives for horſes. See the Syſtem of CHEMISTRY, Part. III. Chap. I. Sect. IV.

It is generally ſuppoſed, that the vapours of antimony are poiſonous when raiſed by fire, but it appears otherwiſe from the operations Mr. Geoffroy made on it; he having once gone through ſixty calcinations of twelve ounces of antimony, without receiving any harm from it: whence it is very evident, that the common opinion of the fumes of antimony containing an arſenical ſulphur, is an erroneous one; and it may be added, that one great mark of antimony's being good, is, that it loſes a great deal of its weight in calcination. It has more ſulphur in this caſe, which the fire raiſes in a vapour, and leſs of the terreſtrial matter or ſpar, which are uſually very abundant in it. For a further account of antimony, its ores, proceſſes, preparations, uſes, &c. ſee the Syſtem of CHEMISTRY, Part III. Chap. I. Sect. IV.

Eſſence of antimony, an emetic wine made with glaſs of antimony; to which is ſometimes added a ſpicy ſtomachic. Dr. Huxham ſays, he never found any antimonial preparation better, ſafer, and more efficacious than this ſimple infuſion of the glaſs of antimony in a generous white wine, with a little ſpice to render it more grateful to the ſtomach. This medicine given to twenty or thirty drops, operates by gentle ſweats, and purges in larger doſes very mildly. The judicious phyſician, here mentioned, recommends it in obſtinate rheumatiſms.

Powder of antimony, is a mixture of two grains of emetic tartar, finely pulverized, with half a dram of any of the teſtaceous powders. This is a ſubſtitute for Dr. James's febrifuge powder; and has the ſame virtues with the antimonial wine above deſcribed, and emetic tartar.

Antimony (ſays Mr. Boyle) alone, or aſſociated with one or two other ingredients, by a variety of operations and compoſitions, might be brought to furniſh a whole apothecary's ſhop: it will anſwer the phyſician's intention, whether he wants to employ a cathartic, or an emetic, a diuretic, diaphoretic, deobſtruent, bezoardic, or cordial. All theſe preparations of antimony, how ſevere ſoever alone, may yet be ſo managed, as to operate little or nothing at all in the *primæ viæ*, nor be perceived till they are got into the ſmalleſt veſſels.—And then it is they are qualified to combat the gout, pox, evil, &c. See Neumann's Chemical Works, p. 128, &c. And Macquer's Chemical Dictionary, under Antimony.

ANTINOMIANS, in church hiſtory, denote thoſe who maintain the law of no uſe or obligation under the goſpel diſpenſation, or who hold doctrines that clearly ſuperſede the neceſſity of good works and a virtuous life. The antinomians took their origin from John Agricola about the year 1538, who taught that the law is no ways neceſſary under the goſpel; that good works do not promote our ſalvation, nor ill ones hinder it; that repentance is not to be preached from the decalogue, but only from the goſpel. This ſect ſprung up in England during the protectorate of Oliver Cromwell; and extended their ſyſtem of libertiniſm much farther than Agricola, the diſciple of Luther. Some of their teachers expreſsly maintained, that as the elect cannot fall from grace, nor forfeit the divine favour, the wicked actions they commit are not really ſinful, nor are to be conſidered as inſtances of their violation of the divine law; and that conſequently they have no occaſion either to confeſs their ſins, or to break them off by repentance. According to them, it is one of the eſſential and diſtinctive characters of the elect, that they cannot do any thing which is either diſpleaſing to God, or prohibited by the law. Luther, Rutherford, Schluſſelburg, Sedgwick, Gataker, Witſius, Bull, Williams, &c. have written refutations; Criſp, Richardſon, Saltmarſh, &c. defences of the antinomians; Wigandus, a compariſon between ancient and modern antinomians. The doctrine of Agricola was in itſelf obſcure, and perhaps repreſented worſe than it really was, by Luther, who wrote with acrimony againſt him, and firſt ſtiled him and his followers antinomians. Agricola ſtood on his own defence, and complained, that opinions were imputed to him, which he did not hold. Nicolas Amſdorf fell under the ſame odious name and imputation, and ſeems to have been treated more unfairly than even Agricola himſelf. It is rather hard to charge upon a man all the opinions that may be inferred from things that have haſtily dropped from him, when he himſelf diſavows ſuch inferences.

ANTI-PÆDO-BAPTISTS, is a diſtinguiſhing denomination given to thoſe who object to the baptiſm of infants; becauſe, they ſay, infants are incapable of being inſtructed, and of making that profeſſion of faith, which entitles them to this ordinance, and an admiſſion into church communion. See ANABAPTISTS and BAPTISTS.

ANTIPATHY, in phyſiology, is formed from the two Greek words, *ανti contrary*, and *παθος paſſion*. Literally taken, the word ſignifies *incompatibility*: but for the moſt part the term *antipathy* is not uſed to ſignify ſuch incompatibilities as are merely phyſical; it is reſerved to expreſs the averſion which an animated or ſenſitive being feels at the real or ideal preſence of particular objects. In this point of view, which is the light in which we at preſent conſider the term; *antipathy*, in common language, ſignifies "a natural horror and deteſtation, an inſuperable hatred, an involuntary averſion, which a ſenſitive being feels for ſome other object, whatever it is, though the perſon who feels this abhorrence is entirely ignorant of its cauſe, and can by no means account for it." Such is, they ſay, the natural and reciprocal hoſtility between the ſalamander and the tortoiſe; between the toad and the weaſel; or between ſheep and wolves. Such is the invincible averſion

ſion of particular perſons againſt cats, mice, ſpiders, &c. a prepoſſeſſion which is ſometimes ſo violent, as to make them faint at the ſight of theſe animals. Of theſe and a thouſand other antipathies the ancient naturaliſts, the ſchoolmen, and the vulgar, form ſo many legends; and relate them as certain facts, that they may demand an explication of them from the philoſophers. But theſe ſages begin with inveſtigating whether ſuch antipathies actually exiſt or not. To what then are thoſe antipathies, of which we have heard ſo much, reducible? Either to legendary tales; or to averſions againſt objects which we believe dangerous; or to a childiſh terror of imaginary perils; or to a diſreliſh, of which the cauſe is diſguiſed; or to a ridiculous affectation of delicacy; or to an infirmity of the ſtomach; in a word, to a real or pretended reluctance for things which are either inveſted, or ſuppoſed to be inveſted, with qualities hurtful to us. Too much care cannot be taken in preventing, or regulating, the antipathies of children; in familiariſing them with objects of every kind; in diſcovering to them, without emotion, ſuch as are dangerous; in teaching them the means of defence and ſecurity, or the methods of eſcaping their noxious influence; and, when the rational powers are matured by age, in reflecting on the nature of thoſe objects which we fear, in aſcertaining what has been told concerning their qualities, or in vigorouſly operating upon our own diſpoſitions to overcome thoſe vain repugnancies which we may feel. See SYMPATHY, which is the oppoſite of *Antipathy*.

ANTIPATHY, in ethics, hatred, averſion, repugnancy. *Hatred* is entertained againſt perſons; *averſion*, and *antipathy*, indiſcriminately againſt perſons or things; and *repugnancy*, againſt actions alone. Hatred is more voluntary than averſion, antipathy, or repugnancy. Theſe laſt have greater affinity with the animal conſtitution. The cauſes of *antipathy* are leſs known than thoſe of *averſion*. *Repugnancy* is leſs permanent than either the one or the other.—We *hate* a vicious character, we feel *averſion* to its exertions: we are affected with *antipathy* for certain perſons at firſt ſight; there are ſome affairs which we tranſact with *repugnancy*. *Hatred* calumniates; *averſion* keeps us at a diſtance from certain perſons; *antipathy* makes us deteſt them; *repugnancy* hinders us from imitating them.

ANTIPERISTALTIC, in anatomy, a motion of the inteſtines contrary to the periſtaltic motion. As the periſtaltic motion is a contraction of the fibres of two inteſtines from above downwards, the antiperiſtaltic motion is their contraction from below, upwards. Phyſicians, ancient as well as modern, have uſually had recourſe to the notion of an antiperiſtaltic motion, to account for the action of vomiting, and the phœnomena of the iliac paſſion. In behalf of the former, M. Littre alledges, that as the œſophagus, the ſtomach, and inteſtines, are but one and the ſame continued canal, every where lined with the ſame fleſhy fibres, and as it is allowed, that the inteſtines, beſides their natural or periſtaltic motion, (whereby being ſucceſſively contracted from above downwards, they expel their contents in this direction) have alſo an antiperiſtaltic or preternatural motion, whereby they contract from below upwards, and thus eject their contents; it is highly probable, that the other members of the ſame canal, viz. the ſtomach and œſophagus, are alſo ſometimes ſubject to the like antiperiſtaltic motion; and return their contents to the mouth. Hiſt. Acad. Scienc. ann. 1700. The cauſe of the antiperiſtaltic motion is uſually aſſigned to be a ſtoppage of ſome of the inteſtines, but chiefly of the ilium. Some late ingenious authors ſeem to have over-turned the whole antiperiſtaltic ſyſtem, and ſhewn this motion imaginary, as well as unneceſſary for accounting for theſe diſorders. Meſſ. Chirac and Du Verney have endeavoured to prove this in reſpect of vomiting; and M. Haguenot, and after him M. St. Andre, in the iliac paſſion. Mem. Acad. Scienc. ann. 1713. Phil. Tranſ. No. 351.

ANTIPODES, in geography, a name given to thoſe inhabitants of the globe that live diametrically oppoſite to each other. The word is Greek, and compounded of ἀντι, *oppoſite*, and πους, *a foot*; becauſe their feet are oppoſite to each other. The antipodes lie under oppoſite meridians and oppoſite parallels; in the ſame degree of latitude, but of oppoſite denominations, one being north and the other ſouth. They have nearly the ſame degree of heat and cold, days and nights of equal length, but in oppoſite ſeaſons. It is noon to one, when midnight to the other; and the longeſt day with the one, is the ſhorteſt with the other.

Plato is eſteemed the firſt who thought it poſſible that the antipodes ſubſiſted, and is looked upon as the inventor of the word. As this philoſopher apprehended the earth to be ſpherical, he had only one ſtep to make to conclude the exiſtence of the antipodes. The ancients, in general, treated this opinion with the higheſt contempt; never being able to conceive how men and trees could ſubſiſt ſuſpended in the air with their feet upwards, for ſo they apprehended they muſt be in the other hemiſphere. If we may believe Aventine, Boniface, archbiſhop of Mentz and legate of pope Zachary, in the eighth century, declared a biſhop of that time, called Virgilius, heretic, for maintaining that there was ſuch a thing as antipodes. As to the ſentiments of the primitive Chriſtians with regard to antipodes; ſome, rather than admit the concluſions of the philoſophers, abſolutely denied the whole, even the demonſtrations of the geometricians relating to the ſphericity of the earth, which is Lactantius's way, Inſtit. lib. iii. cap. 24. But they never reflected that theſe terms *upwards* and *downwards* are merely relative; and ſignify only nearer to, or farther from, the centre of the earth, the common centre to which all heavy bodies gravitate; and that, therefore, our antipodes have not their feet upwards and head downwards any more than ourſelves; becauſe they, like us, have their feet nearer the centre of the earth, and their heads farther from it. To have the head downwards and feet upwards, is to place the body in a direction of gravity tending from the feet to the head: but this cannot be ſuppoſed with regard to the antipodes; for they, like us, tend toward the centre of the earth, in a direction from head to foot. See the Treatiſe on the GLOBES, under the head USE OF THE TERRESTRIAL GLOBE, Problem XVI.

ANTIQUARY, ANTIQUARIUS, a perſon who ſtudies and ſearches after monuments and remains of the ancients; as, old medals, books, ſtatues, ſculptures, and inſcriptions: and, in general, all curious pieces that may afford any light into antiquity. In the chief cities of Greece and Italy, there were other perſons of diſtinction, called antiquaries, whoſe buſineſs it was to ſhew ſtrangers the antiquities of the place, to explain the ancient inſcriptions, and to give them all the aſſiſtance they could in this way of learning. This was, doubtleſs, a very curious and uſeful inſtitution, and might well deſerve to be re-eſtabliſhed.—Pauſanius calls theſe antiquaries, Ἐξηγηται. The Sicilians call them myſtogogi. There was an ancient college of antiquaries erected in Ireland by Ollamh Fodhla, 700 years before Chriſt, for compoſing a hiſtory of that country. And to this, ſay the Iriſh hiſtorians, it is owing, that the hiſtory and antiquities of that kingdom may be traced back beyond thoſe of moſt other nations. Foundations of this kind have often been wiſhed for, and ſometimes alſo attempted in England. Sir H. Spelman ſpeaks of a ſociety of antiquaries in his time, to whom his treatiſe of the terms, written in the year 1614, was communicated, he himſelf being one of the number. This ſociety was formed by Archbiſhop Parker, Camden, Sir Robert Cotton, Stow, and others; in 1598, R. Carew was admitted into it. Application was made to Queen Elizabeth for a charter and houſe, wherein they might hold their meetings, erect a library, and the like. But by the death of that princeſs, their application proved abortive. Her ſucceſſor, King James I. was far from favouring their deſign. In the year 1717, this ſociety was revived again, ſince which time no interruptions having happened, it is at preſent in a very flouriſhing condition; conſiſting of many learned and ingenious men, of the nobility, gentry, clergy, &c. whoſe buſineſs, as members, is to diſcover the antiquities of their own, as well as thoſe of other nations. This ſociety was incorporated by the king's charter in the year 1751, by the name of the Preſident, Council, and Fellows of the Society of Antiquaries of London; their council conſiſts of twenty-one perſons, ten of whom are annually changed: the election of members is by ballot, a certificate ſigned by three or more Fellows being previouſly exhibited for ſix ordinary ſucceſſive meetings, except in the caſe of peers, members of the privy council, and judges, who may be propoſed by a ſingle member and ballotted for the ſame day; and the choice is determined by a majority of two thirds. Every member pays an admiſſion-fee of five guineas, and two guineas a year, or an additional ſum of twenty-one guineas. They have weekly meetings on Thurſday from ſeven of the clock in the evening till nine. This ſociety began to publiſh its diſcoveries, &c. in 1770, under the title of *Archæologia*.

ANTIQUE, in a general ſenſe, ſomething that is ancient. It is chiefly uſed among architects, ſculptors, and painters; who apply it to ſuch pieces of buildings, ſculpture, painting, &c. as were made at the time when the arts were in their greateſt perfection, among the ancient Greeks and Romans; viz. from the age of Alexander to the time of the emperor Phocas, about the year of Chriſt 600, when Italy became over-run by the Goths and Vandals. In this ſenſe the word ſtands oppoſed to *modern*. Thus we ſay, an *antique* building, or a building after the *antique*; an *antique* buſt, or bas-relievo; the *antique* manner, taſte, &c. Under this is included the knowledge of ancient coins, medals, inſcriptions, buildings, ſtatues, ſculptures, MSS. veſſels, &c.

ANTIQUITIES, a term implying all teſtimonies, or authentic accounts, that have come down to us of ancient nations. Bacon calls antiquities *the wrecks of hiſtory*, or ſuch particulars as induſtrious and learned perſons have collected from genealogies, inſcriptions, monuments, coins, names, etymologies, archives, inſtruments, fragments of hiſtory, &c.

Antiquities form a very extenſive ſcience, including "an hiſtorical knowledge of the edifices, magiſtrates, offices, habiliments, manners, cuſtoms, ceremonies, worſhip, and other objects worthy of curioſity, of all the principal ancient nations of the earth." This ſcience is not a matter of mere curioſity, but is indiſpenſable to the theologian; who ought to be thoroughly acquainted with the antiquities of the Jews, to enable

enable him properly to explain numberleſs paſſages in the Old and New Teſtaments: to the lawyer; who, without the knowledge of the antiquities of Greece and Rome, can never well underſtand, and properly apply, the greateſt part of the Roman laws: to the phyſician and the philoſopher, that they may have a complete knowledge of the hiſtory and principles of the phyſic and philoſophy of the ancients: to the critic, that he may be able to underſtand and interpret ancient authors: to the orator and poet; who will be thereby enabled to ornament their writings with numberleſs images, illuſions, compariſons, &c. Antiquities are divided into ſacred and profane, into public and private, univerſal and particular, &c. It is true, that the antiquaries, (eſpecially ſuch as are infected with a ſpirit of pedantry, and the number of theſe is great) frequently carry their inquiries too far, and employ themſelves in laborious reſearches after learned trifles: but the abuſe of a ſcience ought never to make us neglect the applying it to rational and uſeful purpoſes. Many antiquaries alſo reſtrain their learned labours to the ecclairciſſement of the antiquities of Greece and Rome: but this field is far too confined, and by no means contains the whole of this ſcience, ſeeing it properly includes the antiquities of the Jews, Egyptians, Perſians, Phenicians, Carthaginians, Hetruſcans, Germans, and, in general, all thoſe principal nations mentioned in ancient hiſtory, ſo far as any accounts of them are come down to us. If to the general ſubjects above mentioned we add the particular ſtudy of antiques, of the ſtatues, baſſ-reliefs, and the precious relics of architecture, painting, camaieus, medals, &c. it is eaſy to conceive that antiquities form a ſcience very extenſive and very complicated, and with which only a very ſmall acquaintance could have been attainable by any one man, if our predeceſſors had not prepared the way for us; if they had not left us ſuch ineſtimable works as thoſe of Gronovius, Grævius, Montfaucon, Count Caylus, Winckelman, the Hebraic antiquities of D. Iken of Bemen, the Grecian antiquities of Brunnings, the Roman antiquities of Nieupoort, and eſpecially that work which is entitled *Bibliographia Antiquaria Joh. Alberti Fabricii*, profeſſor at Hamburg; &c. &c. Nor muſt we here forget that very valuable work, with which our countryman Mr. Robert Wood has lately enriched this ſcience, and which is ſo well known, and ſo juſtly eſteemed by all true connoiſſeurs, under the title of the *Ruins of Palmyra*. [For a copious account of this famous piece of antiquity, ſee PALMYRENE RUINS.] It is by this work that we are fully convinced of the grandeur and magnificence, the taſte and elegance, of the buildings of the ancients. We here ſee that the invention of theſe matters is not all owing to the Greeks, but that there were other nations who ſerved them as models. For, though many of the edifices of Palmyra are to be attributed to the emperor Aurelian, and to Odenatus and his wife Zenobia, who reigned there about the year 264, yet there are found, at the ſame place, ruins of buildings, that appear to be of far greater antiquity, and that are not leſs beautiful. The ancient Perſepolis is ſufficient to prove this aſſertion. When we duly reflect on all theſe matters, and eſpecially if we attempt to acquire any knowledge of this ſcience, we ſhall ſoon be convinced that it but ill becomes a petitmaitre to laugh at a learned antiquary.

ANTIQUITY is alſo uſed to denote the great age of a thing, or its duration from times of old. In this ſenſe we ſay, the *antiquity* of a kingdom, a cuſtom, or the like: moſt nations lay claim to an *antiquity* much greater than they can truly warrant. The preſent age may be ſaid to be the *antiquity* of the world; which was but new in what are commonly called the ancient days, according to the received *chronology*. There are great diſputes concerning the *antiquity*, or age of the world. Ariſtotle carried it even to eternity; and Parmenides, Pythagoras, and the Chaldeans, were of the ſame opinion: but the generality of philoſophers, as well as divines and hiſtorians, have always held an origin of it; though where to fix that origin, is the difficulty. The different ſyſtems of the chronology of the Greeks, the Egyptians, the Jews, the Hebrew text, and the Septuagint verſion of Scaliger, of Pezron, of Sir Iſaac Newton, &c. to ſay nothing of the Chineſe annals, leave the point infinitely embarraſſed. Some have propoſed to trace out the antiquity of the earth, by an obſervation of the ſaltneſs of the ſea; others by obſerving the elevation of the bottom of the ſea, or the growth of its ſtrata. One mark or proof of antiquity has been ſtarted by Rudbeck, which he pretends to have carried to a demonſtration; it is taken from the thickneſs of a certain black cruſt, called in the Swediſh tongue, *mat-iorden*, and *ſwart-myllan*, which covers the ſurface of the earth; being formed of a mixture of rotten graſs, and other herbs, with duſt and a kind of mud, which the melted ſnow leaves behind it. According to this antiquary, there are at leaſt 500 years requiſite to form an inch thick of this cruſt, which in many places of Sweden is found to be upwards of ſeven inches thick, where urns have been dug up full of bones and aſhes. From whence it follows, according to this author, that it is upwards of 3500 years ſince burning the dead was practiſed in Scandinavia. Recupero, the hiſtoriographer of Ætna, ſuggeſts an argument in favour of the antiquity of the earth from the ſeveral ſtrata of lava, that have iſſued at different times from this mountain. A ſtream of lava, which Diodorus Siculus relates to have burſt out in the time of the ſecond Punic war, is covered at this day only with a very ſcanty ſoil; and in digging pits and wells, ſeveral ſtrata of lava have been diſcovered with earth to a conſiderable thickneſs, over the ſurface of each ſtratum; in one inſtance ſeven diſtinct ſurfaces of this kind were pierced; and allowing 2000 years for the interval between two eruptions, the lava that compoſed the firſt or loweſt ſtratum, muſt have flowed from the mountain above 14000 years ago. Brydone's Tour, &c. vol. i. p. 131. The Chaldeans pretend to aſtronomical obſervations of 470,000, or 473,000 years; they mention the preciſe king who reigned over them at the time of the deluge, whoſe name was Xiſuthrus, and attribute to him ſeveral things which we aſcribe to Noah. But the Chineſe is eſteemed the moſt ancient monarchy in the univerſe; having cultivated the ſciences from the earlieſt ages, and ſubſiſted at leaſt theſe 4000 years with the ſame laws, manners, and uſages. Some indeed have called in queſtion the truth and authenticity of the Chineſe annals; yet we find them confirmed, at leaſt as high as 660 years before Chriſt, by the annals of Japan. At worſt the Chineſe antiquities ſtand on as good a footing as thoſe either of Greece or Rome. Their annaliſts both for order and chronology are not inferior to any of thoſe ancients ſo much admired among us; but far ſurpaſſes them in point of antiquity, and have a better title to be credited, as having written by public authority, which can be ſaid of few Greek or Roman pieces, except perhaps the Capitoline Marbles, which are not properly a hiſtory. We have no inconſiderable confirmation of the truth of the Chineſe account, from an ancient obſervation of a grand conjunction of the planets under Chuen-Hio, emperor of China, related by Martinius. That prince lived 2513 years before Chriſt. M. Kirchius has defended the obſervation againſt Caſſini, and ſhewn a conjunction muſt really have happened at the time mentioned by the Chineſe annals. Dionyſius Halicarnaſſes has traced the Roman antiquities, Joſephus the Jewiſh antiquities, Beroſus the Chaldaic antiquities, Sanconiathon the Phœnician antiquities, Manetho and Marſham the Egyptian antiquities. The Phœnician antiquities of Sanconiathon are preſerved in part by Euſebius. We have an Engliſh tranſlation of Sanconiathon, with notes by biſhop Cumberland, and a continuation from the canon of Eratoſthenes. Lond. 1720. 8vo. The Britiſh antiquities before Cæſar's invaſion are utterly dubious, not to ſay fabulous. Old chronicles ſpeak of Samothes, the ſon of Japhet, as the founder of the Britiſh monarchy; Albion, a deſcendant of Cham, invaded it three hundred years after; and about 600 years after this, Brute, grandſon of Æneas, came and took poſſeſſion of the iſland in the year of the world 3880, giving it the name which it ſtill retained when Cæſar made his attempt. This is Jeffrey of Monmouth's ſyſtem of the antiquities of the Britiſh nation, which the generality of our hiſtorians admit for want of a better. It has been defended by A. Thomſon of Queen's-college, in the preface to his Engliſh tranſlation of that writer. It muſt not be forgot that the Iriſh alſo pretend to be the moſt ancient of all nations; they trace their origin without interruption up to Japhet. But the Scots ſtill diſpute the priority with them, holding themſelves to be an elder branch of the Scythians, the firſt of men. The antiquity of religion has been often urged as a proof of the truth of it. Jews, Gentiles, Chriſtians, Proteſtants, Papiſts, have all in their turns made uſe of the argument from antiquity. It is indeed of the inartificial kind; and comes rather under the denomination of a preſumption than a proof; on the whole it ſeems to have ſerved the cauſe of error as much, if not more, than that of truth.

ANTISEPTIC, from *ανθ* and *σηπτος*, *putrid*, of *σηπω*, to *putrify*, an appellation given to ſuch ſubſtances as reſiſt putrefaction. We have ſome curious experiments in relation to antiſeptic ſubſtances by Dr. Pringle, who has aſcertained their ſeveral virtues. Thus, in order to ſettle the antiſeptic virtue of ſalts, he compared it with that of common ſea-ſalt; which being one of the weakeſt, he ſuppoſes equal to unity, and expreſſes the proportional ſtrength of the reſt by higher numbers, as in the following table.

Salts, their antiſeptic virtue.		Salts, their antiſeptic virtue.	
Sea-ſalt	1	Saline mixture	3
Sal gemmæ	1 +	Nitre	4 +
Tartar vitriolated	2	Salt of hartſhorn	4 +
Spiritus Mindereri	2	Salt of wormwood	4 +
Tartarus ſolubilis	2	Borax	12 +
Sal diureticus	2 +	Salt of amber	20 +
Crude ſal ammoniac	3	Alum	30 +

In this table the proportions are marked in integral numbers; only in ſome there is added the ſign +, to ſhew, that thoſe ſalts are poſſeſſed of a ſtronger antiſeptic virtue than the number in the table expreſſes, by ſome fractions; unleſs in the three laſt, where the ſame ſign imports, that the ſalt may be ſtronger by ſome units. Some reſinous and other ſubſtances even exceed the antiſeptic virtues of the neutral ſalts; thus myrrh, aſſa-fœtida, terra japonica, and aloes, are at leaſt twelve

twelve times more antiſeptic than ſea-ſalt. Two grains of camphor is equivalent to ſixty grains of that ſalt. An infuſion of a few grains of Virginian ſnake-root, in powder, exceeds twelve times its weight of ſea-ſalt. Chamomile flowers have nearly the ſame extraordinary quality. The Jeſuits bark has it alſo. Beſides theſe, pepper, ginger, ſaffron, contrayerva root, are twelve times more antiſeptic than ſea-ſalt. Dried ſage, rhubarb, the root of the wild valerian, mint, angelica, ground-ivy, ſena, green-tea, red-roſes, worm-wood, muſtard, and horſe-raddiſh, were likewiſe found more antiſeptic than the ſtandard. To the claſs of antiſeptic medicines may likewiſe be added fermented liquors, acids, ſpirits, and even thoſe plants called anti-acids, and erroneouſly ſuppoſed haſteners of putrefaction, particularly horſe-raddiſh. Now vegetables, poſſeſſing this virtue, are the more valuable, in that, being uſually free of acrimony, they may be taken in much greater quantities than either ſpirits, acids, reſins, or even the neutral ſalts. Antiſeptics are preſcribed in all putrid, malignant, and peſtilential caſes. It is to be remarked, however, that different kinds of them are to be given in different diſeaſes, and even in different ſtages of the ſame diſeaſe. Thus, the bark is a ſpecific in a gangrene, when the veſſels are relaxed, and the blood reſolved or diſpoſed to putrefaction; but will fail, if the veſſels are too full, or the blood be too thick. With the ſame caution is the bark to be uſed in wounds, viz. chiefly in caſes of abſorbed matter, when it infects the humours, and brings on a hectic fever. By the great antiſeptic virtue of alum, the bark, and other aſtringents, it ſhould ſeem, that aſtriction had no ſmall ſhare in the cure of putrid diſorders; and, indeed, the very nature of putrefaction conſiſts in a ſeparation or diſunion of the parts. But as aſtringents are improper to be adminiſtered in many caſes, contrayerva-root, ſnake-root, camphor, &c. may ſupply their place; which, though highly antiſeptic, have very little, or any, of an aſtringent quality. Pringle's Obſ. on the Diſeaſes of the Army. See Dr. Macbride's Eſſay on the reſpective Powers, &c. of Antiſeptics. For a further account of the nature and properties of antiſeptic or antiputreſcent ſubſtances, ſee the Syſtem of CHYMISTRY, under the ſeveral heads which refer to the principles of CHYMISTRY, in Part I. and to VEGETABLE SUBSTANCES, in Part IV.

ANTISPASMODICS, are medicines proper for the cure of ſpaſms and convulſions. Opium, balſam of Peru, and the eſſential oils of many vegetables, are the principal in this claſs of medicines. Opium excels for its immediate effects. Peruvian balſam, in many inſtances, produces more laſting benefit than opium, and ſometimes ſucceeds where opium fails. As antiſpaſmodics, the eſſential oils differ in this from opium, that they act more on a particular part than on the ſyſtem in general, and have no ſoporific effect. Some medicines remove ſpaſms by immediate contact, as aſſes milk, cream, oil of almonds; others by repelling heat, as gas, ſulphur, nitre, ſal ammoniac, &c. And where the ſtrictures are produced by inanition, and a defect of vital heat, ſpaſms are removed by thoſe medicines that reſtore the vis vitæ, ſuch as valerian, caſtor, muſk, &c.

ANTITHESIS, in rhetoric, a contraſt or oppoſition of words or ſentiments. Such is that of Cicero, in the ſecond Catilinarian: "On one ſide ſtands modeſty, on the other impudence; on one fidelity, on the other deceit; here piety, there ſacrilege; here continency, there luſt, &c." Such alſo is that of Auguſtus to ſome ſeditious young men: *Audite, juvenes, ſenem, quem juvenem ſenes audivere.* Such again is that of Seneca: *Curæ leves loquuntur, ingentes ſtupent.* And that of Virgil:

Flectere ſi nequeo ſuperos, Acheronta movebo.

St. Auguſtine, Seneca, Salvian, and many other ancient writers, ſeem greatly to affect antitheſes; but among the moderns they are generally decried. Deſmaretz repreſents them as the favourites of young writers. The following is an example of modern antitheſis:

———Though gentle, yet not dull;
Strong, without rage; without o'erflowing, full.

ANTITHESIS is ſometimes uſed for controverſy. In this ſenſe, we meet with *antithetic* method, *antithetic* diſcourſes, &c. Marcion compoſed a volume of antitheſes, or contrarieties and oppoſitions between the law and the goſpel.

ANTITRINITARIANS, thoſe who deny the Trinity, and teach, that there are not three perſons in the Godhead. Thus the Samoſatenians, who do not believe the diſtinction of perſons in God; the Arians, who deny the divinity of the Word; and the Macedonians, who deny that of the Holy Spirit, are all properly Antitrinitarians. Among the moderns, Antitrinitarians are particularly underſtood of Socinians, called alſo Unitarians. The *Bibliotheca Antitrinitariorum*, or *Antitrinitarian* Library, is a poſthumous work of Chriſtopher Sandius, an eminent Antitrinitarian; wherein he gives a life, digeſted in order of time, of all the Socinian or modern Antitrinitarian authors, with a brief account of their lives, and a catalogue of their works. See UNITARIAN.

ANTŒCI, in geography, thoſe inhabitants of the earth who live under the ſame meridian, and at the ſame diſtance from the equator; the one towards the north, and the other towards the ſouth. See the Treatiſe on the GLOBES, under the head USE OF THE TERRESTRIAL GLOBE, Problem XVI.

The word is formed of ἀντι, *contra*, and οἰκεω, *I inhabit*.—The Antœci are contradiſtinguiſhed from the Periœci. Hence the Antœci have the ſame longitude, and equal latitudes, only of a different denomination. The inhabitants of Peloponneſus are nearly Antœci to the Hottentots of the Cape of Good Hope.—Antœci are frequently confounded with Antiſcii. The Antœci have preciſely the ſame hours of the day and night, but oppoſite ſeaſons: when it is 12 o'clock in the longeſt ſummer's day with one, it is 12 o'clock of the ſhorteſt winter's day with the other; and hence the night of the one is always equal to the day of the other.

ANUS, in anatomy, the lower extremity of the inteſtinum rectum; or the orifice of the fundament.—See the SYSTEM. Muſcles of the anus are the ſphincter, levator, and ſcalptor, or latiſſimus dorſi. The anus is found to have various uſes in different animals. In the pond muſcle the ſame aperture ſerves indifferently for mouth and anus. In fowls the anus has apparently ſome concern in the action of reſpiration; there are found many veſicles extended from the bronchiæ through the abdomen to the anus of fowls; which may be the cauſe of its conſtant motion, the air having both ingreſs and egreſs there. Whence it is that they are alſo found to have an attractive power, and as ſuch are uſed by ſome to draw out the poiſon and malignity in certain diſeaſes. It may be added, that a kind of alternate ſyſtole and diaſtole is perceived, at leaſt on many occaſions, in the anus of divers quadrupeds, as cows, mares, &c. Hiſt. Acad. Scienc. 1710. The ani of fowls, applied in malignant diſtempers to draw the infection out of the body, act like cupping-glaſſes; inſomuch that the fowl has often ſtuck by its anus to the part till it died. Mr. Temple affirms he has ſeen ſeven chickens thus applied to the groin of one perſon ſeized with the plague, which all ſtuck till they died. The eighth went quickly off and lived. Phil. Tranſ. No. 86. p. 5031. and Ephem. Acad. N. C. Dec. 2. An. 9. Obſ. 138. The anus of birds and quadrupeds is generally conſtant and regular as to the place it occupies in the body; in fiſh it conſiderably differs in the various kinds, and makes one of their marks of diſtinction. See the Syſtem of COMPARATIVE ANATOMY.

Some authors ſpeak of attempts, made not without ſucceſs, for conveying nouriſhment to the human body by nutritive clyſters conveyed up the anus, where the common canal by the gula has been rendered impaſſable. Mem. Acad. Scienc. 1716. p. 237. It may be added, that we have inſtances of births or deliveries by the anus; dead fœtuſes, long detained in utero, finding no other out-let, have been frequently voided piece-meal at the anus.

Diſeaſes of the anus are a fiſtula, and the procidentia, or prolapſus ani; to which may be added the hæmorrhoids, or piles. For deſcription, cauſes, prognoſis, and cure, ſee the SYSTEM, Genus XXXI.

Affections about the anus are difficult to be cured for many reaſons. The part is endued with a very tender ſenſe, and therefore is eaſily irritated by acrimonious and auſtere medicines. Beſides, the ſuperfluities of the aliment in their paſſage, are not only acrid in themſelves, but much more ſo on account of the bilious, and ſometimes ſerous humours, which paſs along with them. Moreover, the phyſician can fix no certain times for attending his patients, who ſometimes eaſe nature this way at very inconvenient times. The humidity and heat of the place alſo, which require drying as well as cooling remedies, are no ſmall obſtacles to the cure of ulcers in thoſe parts; for aſtringents are acrid, which the place, by reaſon of its exquiſite ſenſe, is not able to bear. Wherefore ſuch medicines agree with them as are aſtringent without aſperity; of this quality are principally metals, which are neither acrimonious nor extremely rough; theſe, waſhed, anſwer the intention effectually, without mordacity. Vegetables, and draſtic purges, ſuch as the oil of caſtor, &c. are beſt; and aloes exceedingly hurtful to thoſe who are ſubject to the piles, and the procedentia ani. See PROLAPSUS ANI.

AORTA, in anatomy, the great artery proceeding from the left ventricle of the heart; from which all the other arteries either mediately or immediately proceed, and by which the whole maſs of blood is conveyed to all parts of the body. It is divided into two grand trunks, diſtinguiſhed by the terms aſcending and deſcending. See the SYSTEM.

APATHY, in a moral ſenſe, denotes an inſenſibility; or a privation of all paſſion, all emotion, or perturbation of mind. The word is formed of the privative α, and παθος, *paſſion*. The Stoics affected an entire apathy: their wiſdom was to enjoy a perfect calmneſs or tranquillity of mind, incapable of being ruffled, and above the reach of any ſenſe either of pleaſure or pain. In the firſt ages of the church, the chriſtians adopted the term apathy to expreſs a contempt of all earthly concerns; a ſtate of mortification, ſuch as the goſpel preſcribes. Clemens Alexandrinus, in particular, brought it exceedingly in vogue; thinking, hereby, to withdraw the philoſophers to chriſtianity, who aſpired after ſuch a ſublime pitch of virtue.

APE, the Engliſh name of an animal belonging to the genus Simia. For a deſcription of the genus, and the ſpecies appertaining to it, ſee the Article SIMIA. For the claſſification, ſee the Syſtem of MAMMALIA. For repreſentation, ſee Plate I.

APEPSIA, (from *a*, neg. and *πεπτω*, to *digeſt.*) Indigeſtion. Abſtemiouſneſs and exceſs are alike cauſes of indigeſtion. An over-diſtenſion of the ſtomach may in ſome meaſure injure its proper tone; and long faſting, by inducing a bad quality in the juices ſecerned into the ſtomach, renders it feeble, and generates wind. Hard drinking, and any of the cauſes of anorexy, alſo injure digeſtion. The columbo root is ſaid to be particularly uſeful when the ſtomach is languid, the appetite defective, digeſtion with difficulty carried on, or when a nauſea with flatulency attends. It is preſcribed in ſubſtance with any grateful aromatic, or infuſed in Madeira wine, now and then interpoſing gentle doſes of the tincture of rhubarb. A mixture of muſtard ſeed with the columbo root is of admirable utility in complaints of this kind; particularly where acidity and flatulence prevail much in the primæ viæ.

APERIENTS, or aperitive medicines, are ſuch as open the obſtructed paſſages of the ſmall veſſels, glands, and pores; and, by that means, promote a due circulation of the contained juices. Aperients, then, coincide with what we otherwiſe call openers, anaſtomatics, and deobſtruents. The five leſſer aperient, or opening roots, are graſs, madder, eryngo, capers, and chammoc. The greater aperient, or opening roots are ſmallage, fennel, aſparagus, parſley, and butchers-broom.

APHELION, in aſtronomy, that point of the earth's or a planet's orbit, in which it is at the greateſt diſtance from the ſun. See the SYSTEM, Sect. VII.

APHIS, in entomology, the puceron, vine-fretter, or plant-louſe; a genus of inſects belonging to the order of inſecta hemiptera. The roſtrum or beak of the aphis is inflected; the antennæ or feelers are longer than the thorax; the wings are four, and erect, or they are wanting; the feet are of the ambulatory kind; and the belly often ends in two horns, from which is ejected that moſt delicate juice called *honey-dew*. For claſſification, ſee the SYSTEM, Order II. Genus 39.

Linnæus enumerates 33 ſpecies of the aphis, all of them inhabitants of particular plants, from which their trivial names are taken; as, aphis *ribis*, *ulmi*, *roſæ*, &c. And he adds, that there ſeem to be a greater variety of plants producing aphides than there are different ſorts of this inſect. But ſome late obſervers have been able to diſtinguiſh more than double the above number of ſpecies; and it is probable that many more remain ſtill to be added, as many of the ſame kind of plants are found to ſupport two or three quite different ſorts of aphides. Thus the plum-tree has two ſorts very diſtinct from each other: one of a yelloviſh green, with a round ſhort body; the other of a blueiſh green, as it were enamelled with white, and the ſhape more oblong. On the gooſeberry-buſh and currant the ſame aphides may be found; but each of theſe is inhabited by two very different ſpecies: one being of a duſky green, with a ſhort plump body; the other of a paler green, the body more taper, and tranſverſely wrinkled. The roſe-tree, again, ſupports not leſs than three diſtinct ſpecies: the largeſt is of a deep green, having long legs of a browniſh caſt, with the joints of a very dark brown, as are alſo the horns and antennæ; a ſecond ſort is of a paler green, has much ſhorter legs, and a more flat body; the third ſort is of a pale red, its body tranſverſely wrinkled, and is moſt frequently on the ſweet-briar.

The extraordinary nature of theſe inſects have for ſome time paſt juſtly excited the wonder and attention of naturaliſts. They were long ranked among the animals which had been claſſed with the true androgynes ſpoken of by Mr. Breynius: for having never been catched copulating, it was haſtily concluded that they multiplied without copulation. This however, was but a doubt, or at beſt a mere ſurmiſe; but this ſurmiſe was believed and adopted by Mr. Reaumur; and though he ſupported it by ſome obſervations peculiar to himſelf, the queſtion remained ſtill undecided, till Mr. Bonnet ſeemed to have cleared it up in the affirmative, by taking and ſhutting up a young aphis at the inſtant of its birth, in the moſt perfect ſolitude, which yet brought forth in his ſight 95 young ones. The ſame experiment being made on one of the individuals of this family, that had been tried with its chief, the new hermit ſoon multiplied like its parent; and one of this third generation, in like manner brought up in ſolitude, proved no leſs fruitful than the former. Repeated experiments, in this reſpect as far as the fifth or ſixth generation, all uniformly preſenting the obſerver with *fecund virgins*, were communicated to the Royal Academy of Sciences; when an unforeſeen and very ſtrange ſuſpicion, imparted by Mr. Trembley to Mr. Bonnet, engaged him anew in a ſeries of ſtill more painful experiments than the foregoing. In a letter which that celebrated obſerver wrote to him from the Hague, the 27th January 1741, he thus expreſſes himſelf: "I formed, ſince the month of November, the deſign of rearing ſeveral generations of ſolitary pucerons, in order to ſee if they would all equally bring forth young. In caſes ſo remote from uſual circumſtances, it is allowed to try all ſorts of means: and I argued with myſelf, Who knows, but that one copulation might ſerve for ſeveral generations? This "*who knows*," to be ſure, was next to avouching nothing; but as it came from Mr. Trembley, it was ſufficient to perſuade Mr. Bonnet that he had not gone far enough in his inveſtigation. If the fecundity of aphides was owing to the ſecret copulation ſuggeſted by Mr. Trembley, this copulation ſerved at leaſt five or more ſucceſſive generations. Mr. Bonnet therefore reared to the amount of the tenth generation of ſolitary aphides, and had the patience to keep an account of the days and hours of the births of each generation. In ſhort, it was diſcovered, that they are really diſtinguiſhed by ſexes: That there are males and females amongſt them, whoſe amours are the leaſt equivocal of any in the world: that the males are produced only in the tenth generation, and are but few in number: that theſe, ſoon arriving at their full growth, copulate with the females: that the virtue of this copulation ſerves for ten generations; that all theſe generations, except the firſt (from the fecundated eggs), are produced viviparous; and all the individuals are females, except thoſe of the laſt generations, among whom, as we have already obſerved, ſome males make their appearance, to lay the foundations of a freſh ſeries.—Theſe circumſtances have been confirmed by other naturaliſts. In particular, we have a curious and accurate detail of them by Dr. Richardſon of Rippon, in the Philoſophical Tranſactions, Vol. xi. art. 22. an extract of which we ſhall here inſert, in order to give the reader as full an inſight into the nature of theſe ſingular inſects, as can be done by a mere detail of facts in themſelves utterly unaccountable.

"The great variety of ſpecies which occur in the inſects now under conſideration, may make an inquiry into their particular nature ſeem not a little perplexed; having them, however, ſkilfully reduced under their proper genus, the difficulty is by this means conſiderably diminiſhed. All the inſects comprehended under any diſtinct genus, we may reaſonably ſuppoſe to partake of one general nature; and, by diligently examining any of the particular ſpecies, may thence gain ſome inſight into the nature of all the reſt. With this view I have choſen, out of the various ſorts of aphides, the largeſt of thoſe found on the roſe-tree: not only as its ſize makes it the more conſpicuous, but as there are few others of ſo long a duration. This ſort, appearing early in the ſpring, continues late in the autumn; while ſeveral are limited to a much ſhorter term, in conformity to the different trees and plants from whence they drew their nouriſhment.

1. "If at the beginning of February the weather happens to be ſo warm as to make the buds of the roſe-tree ſwell and appear green; ſmall aphides are frequently to be found upon them not larger than the young ones in ſummer when produced. But there being no old ones to be found at this time of the year, which in ſummer I had obſerved to be viviparous, I was formerly not a little perplexed by ſuch appearances, and almoſt induced to give credit to the old doctrine of equivocal generation. That the ſame kind of animal ſhould at one time of the year be viviparous, and at another time oviparous, was an opinion I could then by no means entertain. This however, frequent obſervation has at laſt convinced me to be fact: having found thoſe aphides which appear early in the ſpring, to proceed from ſmall black oval eggs which were depoſited on the laſt years ſhoots in autumn: though, when it happens that the inſects make too early an appearance, I have obſerved the greateſt part to ſuffer from the ſharp weather that uſually ſucceeds, by which means the roſe-trees are ſome years in a manner freed from them.

"Thoſe which withſtand the ſeverity of the weather ſeldom come to their full growth before the month of April; at which time they uſually begin to breed, after twice caſting off their exuviæ or outward covering. It appears then that they are all females, which produce each of them a very numerous progeny, and that without having intercourſe with any male inſect. As I obſerved before, they are viviparous; and what is equally uncommon, the young ones all come into the world backwards. When they firſt come from the parent, they are enveloped by a thin membrane, having in this ſituation the appearance of an oval egg; which, I apprehend, muſt have induced Reaumur to ſuſpect that the eggs diſcovered by Bonnet were nothing more than mere aboritions. Theſe egg-like appearances adhere by one extremity to the mother; while the young ones contained in them extend the other; by that means gradually drawing the ruptured membrane over the head and body to the hind feet. During this operation, and for ſome time after, by means of ſomething glutinous, the fore part of the head adheres to the vent of the parent. Being thus ſuſpended in the air, it ſoon frees itſelf from the membrane in which it was confined, and, after its limbs are a little ſtrengthened, is ſet down on ſome tender ſhoot, and then left to provide for itſelf.

2. "In the ſpring months, there appear on the roſe-trees but two generations of aphides, including thoſe which immediately proceed from the laſt year's eggs; the warmth of the ſummer adds ſo much to their fertility, that no leſs than five generations ſucceed one another in the interval. One is produced in May, which caſts off its covering, while the months of June and July each ſupply two more, which caſt off their coverings three or four times, according to the different warmth of the

the ſeaſon. This frequent change of the outward covering is the more extraordinary, as it is the oftenſt repeated when the inſects come the ſooneſt to their growth; which I have ſometimes obſerved to happen in ten days, where warmth and plenty of nouriſhment have mutually conſpired. From which conſiderations I am thoroughly convinced that theſe various coverings are not connate with the inſect, but that they are, like the ſcarf-ſkin, ſucceſſively produced.

"Early in the month of June, ſome of the third generation which were produced about the middle of May, after caſting off their laſt covering, diſcover four erect wings, much longer than their bodies: and the ſame is obſervable in all the ſucceeding generations, which are produced during the ſummer months; without, however, diſtinguiſhing any diverſity of ſex, as is uſual in ſeveral other kinds of inſects. For ſome time before the aphides come to their full growth, it is eaſy to diſcover which of them will have wings, by a remarkable fullneſs of the breaſt, which, in the others, is hardly to be diſtinguiſhed from the body. When the laſt covering is rejected, the wings, which were before folded up in a very narrow compaſs, gradually extend themſelves in a moſt ſurpriſing manner, till their dimenſions are at laſt very conſiderable. But theſe winged ones have the peculiarity, that the number of them does not ſeem ſo much to depend on their original ſtructure, as on the quantity or quality of the nouriſhment with which they are ſupplied: it being frequently obſerved, that thoſe on a ſucculent ſhoot have few or none with wings among them, while others of the ſame generation, on a leſs tender branch, are moſt of them winged; as if only the firſt rudiments of wings were compoſed in the former, while nature thought proper to expand them in the latter, that they might be more at liberty to ſupply their wants.

"The increaſe of theſe inſects in the ſummer-time is ſo very great, that, by wounding and exhauſting the tender ſhoots, they would frequently ſuppreſs all vegetation, had they not many enemies which reſtrain them. To enumerate the variety of other inſects that in their worm and fly ſtate are conſtantly deſtroying them, would exceed the bounds of the preſent deſign: there is one, however, ſo ſingular in the manner of executing its purpoſe, that I cannot paſs by it without ſome further notice. This is a very ſmall black ichneumon fly, with a ſlender body and very long antennæ, which darts its pointed tail into the bodies of the aphides, at the ſame time depoſiting an egg in each. This egg produces a worm, which feeds upon the containing inſect till it attains its full growth; when it is uſually changed to that kind of fly from whence it came. In this, however, it is ſometimes prevented by another ſort of ſmall black fly, which wounds this worm through its pearl-like habitation; and by laying one of its eggs therein, inſtead of the former fly, produces its own likeneſs. I muſt, however, further obſerve, notwithſtanding theſe inſects have many enemies, they are not without friends; if we may conſider thoſe as ſuch who are very officious in their attendance, for the good things they expect to reap thereby. The ant and the bee are both of this kind, collecting the honey in which the aphides abound; but with this difference, that the ants are conſtant viſitors, the bee only when flowers are ſcarce. To which let me alſo add, that the ants will ſuck in the delicious nectar while the aphides are in the act of diſcharging it from the anus; but the bees only collect it from the leaves on which this honey-dew has fallen.

§. "In the autumn I find three more generations of aphides to be produced; two of which make their appearance in the month of Auguſt, and the third uſually appear before the middle of September. As the two firſt differ in no reſpect from thoſe which we meet with in ſummer, it would be waſting time to dwell any longer upon them; but the third, differing greatly from all the reſt, demands our giving it a more ſerious attention. Though all the aphides which have hitherto appeared were females, in this tenth generation are found ſeveral male inſects; not that they are by any means ſo numerous as the female, being only produced by a ſmall number of the former generation. To which I muſt further add, that I have obſerved thoſe which produce males, previouſly to have produced a number of females; which in all reſpects reſembling thoſe already deſcribed, I ſhall decline taking into any further conſideration.

"The females have at firſt altogether the ſame appearance with thoſe of the former generations; but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange colour before they come to their full growth. They differ likewiſe in another reſpect, at leaſt from thoſe which occur in the ſummer, that all theſe yellow females are without wings. The male inſects are, however, ſtill more remarkable, their outward appearance readily diſtinguiſhing them from the females of this and of all other generations. When firſt produced, they are not of a green colour like the reſt, but of a reddiſh brown; and have afterwards, when they begin to thicken about the breaſt, a dark line along the middle of the back. Theſe male inſects come to their full growth in about three weeks time, and then caſt off their laſt covering; the whole inſect being, after this operation, of a bright yellow colour, the wings only excepted. But after this they ſoon change to a darker yellow, and in a few hours to a very dark brown; if we except the body, which is ſomething lighter coloured, and has a reddiſh caſt. They are all of the winged ſort; and the wings, which are white at firſt, ſoon become tranſparent, and at length appear like very fine black gauze.

"The males no ſooner come to maturity than they copulate with the females; in which act they are readily diſcovered, as they remain in conjunction for a conſiderable time, and are not eaſily diſturbed. The commerce between them continues the whole month of October, and may be obſerved at all times of the day, though I have found it moſt frequently about noon; eſpecially when the weather is moderately warm, and the ſun overcaſt. The females, in a day or two after their intercourſe with the males, I have obſerved to lay their eggs; which they uſually do near the buds, when they are left to their own choice. Where there a number crowded together, they of courſe interfere with each other; in which caſe they will frequently depoſit their eggs on other parts of the branches, or even on the ſpines with which they are beſet."

Theſe inſects are found in great numbers not only on the ſtems and leaves, but even upon roots of many trees and plants. Thoſe trees that are moſt loaded with the inſects, as already obſerved, ſuffer greatly from them. The plant-lice thruſt their ſharp-pointed roſtrum into the ſubſtance of the leaf to draw out their ſuſtenance, which warps the ſtems and leaves, and occaſions in the latter, cavities underneath, and ſwellings above; nay, even in ſome, a kind of hollow gall filled with inſects, as is often ſeen on elm-leaves.

It appears aſtoniſhing that the ſlight puncture of ſo ſmall an animal ſhould ſo greatly diſfigure a plant: but it muſt be remembered, that plant-lice always live in numerous aſſociations, which increaſe viſibly by the prodigious fruitfulneſs of thoſe inſects; ſo that although each puncture be ſlight, yet the number of them is ſo great, ſo reiterated, that it is no longer a wonder the leaves ſhould be diſfigured. Lovers of gardening plants are extremely anxious to free and cleanſe their trees from this vermin; but their care often proves unavailing, the inſect is ſo fruitful that it ſoon produces a freſh colony. The beſt and ſureſt method of extirpating it, is to put on the trees infeſted with them ſome larvæ of the plant-louſe lion, or aphidivorous flies; for thoſe voracious larvæ deſtroy every day a great number of the inſects, and that with ſo much the more facility, as the latter remain quiet and motionleſs in the neighbourhood of theſe dangerous enemies, who range over heaps of plant-lice, which they gradually waſte and diminiſh.

APHONIA, among phyſicians, ſignifies a ſuppreſſion or total loſs of voice. It is never a primary diſeaſe; but a conſequence of many different diſorders. For the cauſes, prognoſtics and cure, ſee the Syſtem of MEDICINE, Genus 70.

APHORISM, a maxim, general rule, or principle, of a ſcience; or a brief ſentence, comprehending a great deal of matter in a few words. The word comes from ἀφορίζω, *I ſeparate*, q. d. a choice or ſelect ſentence. The term is chiefly uſed in medicine and law. We ſay, the aphoriſms of Hippocrates, of Sanctorius, of Boerhaave, &c. aphoriſms of the civil law, &c.

APHRODISIA, or APHRODISIASMUS, in medicine, denotes the uſe of venery, or the act of copulation between male and female.

APHRODISIA is alſo uſed for the age of venery, more frequently denominated puberty.

APHRODISIACS, among phyſicians, denote medicines proper to increaſe the ſeed, and promote luſt, or an inclination to venery.

APHRODITA, in vermeology, an inſect of the order of vermes mollusca. The body of the aphrodita is oval, with many ſmall tentacula or protuberances on each ſide, which ſerve as ſo many feet; the mouth is cylindrical at one end of the body, and capable of being retracted, with two briſtly tentacula. For its peculiar properties ſee VERMEOLOGY.

APHTHÆ, in medicine, little ulcers or pimples riſing in the mouth, the palate, gums, and at the root of the tongue; attended with inflammation, and a difficulty of ſwallowing. Hippocrates applied the word to ulcers in the pudenda of women, alſo to thoſe in the aſpera arteria; and Galen ſpeaks of the teſticles as ſubject to the ſame diſeaſe. Sucking children are particularly ſubject to aphthæ, when either the nurſe's milk is corrupted, or the child's ſtomach becomes unfit for digeſtion: for, in theſe caſes, the ſharp acrimonious parts of the milk riſing up, eaſily exulcerate thoſe tender and delicate parts. There are ſome aphthæ white, others red, others livid and blackiſh; the white and red ſorts are the leaſt dangerous, and the moſt eaſily cured; the livid and black often prove mortal. The black thruſh very rarely occurs; but when it does, it is always a putrid ſymptom, and not an original diſeaſe. Dr. Hunter thinks theſe white ſpecks are inflammatory exudations, and not ulcers, which appears probable from their dropping off in ſucceſſion to each other. When they happen in grown perſons, they are owing to thin, ſerous,

ſerous, and ſharp humours, turned from the ſeveral parts of the body to the mouth. External cauſes alſo frequently concur to the production of aphthæ; and eſpecially a neglect of keeping the tongue and fauces clean; the pernicious and prepoſterous method of curing fevers, and other inflammatory diſeaſes, by hot medicines; and expoſing the bodies of children, when over-heated, to a cold air, which by checking perſpiration, has an almoſt unavoidable tendency to accumulate and hoard up ſaline and ſulphureous fordes in the maſs of humours. For the method of preventing and treating this diſorder in infants, ſee the Syſtem of Midwifery, Part IX. Sect V.

APIS, *muſca*, the bee, or fly, in aſtronomy, a ſouthern conſtellation, ſee the Syſtem, Sect. VIII. and Plate VI. Fig. II.

Apis, or Bee, in entomology, is a genus of inſects belonging to the order of inſecta hymenoptera. The mouth is furniſhed with two jaws, and a proboſcis infolded in a double ſheath; the wings are four, the two foremoſt covering thoſe behind when at reſt: in the anus or tail of the females and working bees there is a hidden ſting. They are diſtinguiſhed into ſeveral ſpecies, each of which has its peculiar genius, talent, manners, and diſpoſition. Variety prevails in the order of their architecture, and nature of their materials. Some live in ſociety, and ſhare the toils; ſuch are the common bee and drone. Others dwell and work in ſolitude, building the cradles of their families; as the leaf-cutter bee does with the roſe-tree leaf; the upholſterer with the gaudy tapeſtry of the corn roſe; the maſon-bee with a plaſter, the wood piercer with ſawduſt. All are employed in their little hermitage, with the care of providing for the wants of their poſterity. The ſpecies enumerated by Linnæus are 55.

In the Philoſophical Tranſactions, No. 172, we have an account of a ſpecies of honey-bee found in ſome parts of America, very different in form and manners from the common bee of Europe. Their combs are compoſed of a ſeries of ſmall bottles or bladders of wax, of a duſky brown or blackiſh colour; and each of theſe is much of the ſize and ſhape of a Spaniſh olive. They hang together in cluſters almoſt like a bunch of grapes, and are ſo contrived, that each of them has its aperture, while the bees are at work upon it; but as ſoon as it is filled with honey, this aperture is cloſed, and the bees leave it, and go to work upon another veſſel. Their lodgings are uſually taken up in the hollow of an old tree, or in ſome cavity of a rock by the ſea-ſide. They are ſagacious in chooſing the moſt ſecure retreats, becauſe their honey is ſo delicious a bait, that they are hunted after by many animals; and they have no power of defending themſelves, having no ſtings as our bees have. The combs are brittle; and the honey is clear and liquid like rock water. It is uſed by the natives rather as a drink with their food than as honey. They uſe it alſo in medicine as a purge, drinking half a pint of it in the morning faſting.

The mellifica, or domeſtic honey-bee, is one of the moſt curious ſpecies. It is furniſhed with downy hairs; has a duſky coloured breaſt, and browniſh belly; the tibiæ of the hind-legs are ciliated, and tranſverſely ſtreaked on the inſide. Each foot terminates in two hooks, with their points oppoſite to each other; in the middle of theſe hooks there is a little thin appendix, which when unfolded, enables the inſects to faſten themſelves to glaſs or the moſt poliſhed bodies. This part they likewiſe employ for tranſmitting the ſmall particles of crude wax which they find upon flowers to the cavity in their thigh, hereafter deſcribed. The queen and drones, who never collect wax in this manner, have no ſuch cavity. This ſpecies is alſo furniſhed with a proboſcis or trunk, which ſerves to extract the honey from flowers; and has, beſides, a real mouth ſituated in the forepart of the head, with which it is able to feed on the farina of flowers, from which afterwards is made wax. The belly is divided into ſix rings or joints; which ſometimes ſhorten the body, by ſlipping the one over the other. In the inſide of the belly there is a ſmall bladder or reſervoir, in which the honey is collected, after having paſſed through the proboſcis and a narrow pipe which runs through the head and breaſt. This bladder, when full of honey, is about the ſize of a ſmall pea.

The ſting, which is ſituated at the extremity of the belly, is a very curious weapon; and, when examined by the microſcope, appears of a ſurpriſing ſtructure. It has a horney ſheath or ſcabbard, which includes two bearded darts. This ſheath ends in a ſharp point, near the extremity of which a ſlit opens, through which, at the time of ſtinging, the two bearded darts are protruded beyond the end of the ſheath: one of theſe is a little longer than the other, and fixes its beard firſt; and the other inſtantly following, they penetrate alternately deeper and deeper taking hold of the fleſh with their beards or hooks, till the whole ſting is buried in the fleſh; and then a venomous juice is injected through the ſame ſheath, from a little bag at the root of the ſting. Hence the wound occaſions an acute pain and ſwelling of the part, which ſometimes continue ſeveral days. Theſe effects are beſt remedied by enlarging the wound directly, to give it ſome diſcharge. This poiſon ſeems to owe its miſchievous efficacy to certain pungent ſalts. Let a bee be provoked to ſtrike its ſting againſt a plate of glaſs, and there will be a drop of the poiſon diſcharged and left upon the glaſs. This being placed under a double microſcope, as the liquor evaporates, the ſalts will be ſeen to concrete, forming oblong, pointed clear cryſtals.—Mr. Derham counted on the ſting of a waſp eight beards on the ſide of each dart, ſomewhat like the beards of fiſh-hooks; and the ſame number is to be counted on the darts of the bee's ſting. When theſe beards are ſtruck deep in the fleſh, if the wounded perſon ſtarts, or diſcompoſes the bee before it can diſengage them, the ſting is left behind ſticking in the wound: but if he have patience to ſtand quiet, the creature brings the hooks down cloſe to the ſides of the darts, and withdraws the weapon; in which caſe, the wound is always much leſs painful. The danger of being ſtung by bees may be in a great meaſure prevented by a quiet compoſed behaviour. A thouſand bees will fly and buzz about a perſon without hurting him, if he ſtand perfectly ſtill, and forbear diſturbing them even when near his face; in which caſe he may obſerve them for hours together without danger: but if he moleſts or beats them away, he uſually ſuffers for it. It has been lately affirmed, that a perſon is in perfect ſafety in the midſt of myriads of bees, if he but carefully keep his mouth ſhut, and breathe gently through the noſtrils only: the human breath, it would ſeem, being peculiarly offenſive to their delicate organs: and merely with this precaution, it is ſaid, the very hives may be turned up, and even part of the comb cut out, while the bees are at work.

Oeconomy, Instincts, &c. *of the* Honey-bee.

We may conſider a hive of bees as a well peopled city, in which are commonly found from 15,000 to 18,000 inhabitants. This city is in itſelf a monarchy;—compoſed of a *queen*; of males, which are the *drones*; and of *working bees*, which have been ſuppoſed and called neuters. The combs, which are of pure wax, ſerve as their magazine of ſtores, and for the nurſing places of their young offspring. There is between the combs a ſpace ſufficient for two bees to march abreaſt, without embarraſſing each other; and in ſome parts it is more ſpacious. There are alſo holes, or narrow paſſes, which croſs the combs tranſverſely, and are intended to ſhorten the way when the bees paſs from one comb to another.

The Queen is eaſily diſtinguiſhed from the other bees by the form of her body: ſhe is longer and larger than they are, and her wings are much ſhorter than theirs in proportion to her body; for the wings of the other bees cover their whole body, whereas thoſe of the queen hardly reach beyond her middle, or end at about the third ring of her belly. Her hinder parts are more taper than thoſe of the other bees, terminating ſharper. Her belly and legs are of a deep yellow, much reſembling the pureſt gold. She is unwieldly in her flight, a reaſon for her ſeldom flying but when ſhe leaves the parent hive to go and ſettle a colony. All the bees form her retinue, and like dutiful ſubjects repair to the place ſhe chooſes. She is armed with a vigorous ſting. Leſs paſſionate however than her ſubjects, ſhe only uſes her ſting when long provoked, or when in conteſt for imperial ſway. Never more than one remains in a hive, and that is the conqueror.

A hive of bees cannot ſubſiſt without a queen, as ſhe alone produces their numerous poſterity; and on this account their fidelity and attachment to their ſovereign is admirable.

Mr. Wildman, by his dexterity in the management of bees, ſome years ago, ſurpriſed the whole kingdom. He can cauſe a ſwarm to light where he pleaſes, almoſt inſtantaneouſly; he can order them to ſettle on his head, then remove them to his hand; command them to depart and ſettle on a window, table, &c. at pleaſure. We ſhall ſubjoin his method of performing theſe feats, in his own words:

"Long experience has taught me, that as ſoon as I turn up a hive, and give it ſome taps on the ſides and bottom, the queen immediately appears, to know the cauſe of this alarm; but ſoon retires again among her people. Being accuſtomed to ſee her ſo often, I readily perceive her at firſt glance; and long practice has enabled me to ſeize her inſtantly, with a tenderneſs that does not in the leaſt endanger her perſon. This is of the utmoſt importance; for the leaſt injury done to her brings immediate deſtruction to the hive, if you have not a ſpare queen to put in her place, as I have too often experienced in my firſt attempts. When poſſeſſed of her, I can without injury to her, or exciting that degree of reſentment that may tempt her to ſting me, ſlip her into my other hand, and, returning the hive to its place, hold her there, till the bees miſſing her, are all on wing, and in the utmoſt confuſion. When the bees are thus diſtreſſed, I place the queen where-ever I would have the bees to ſettle. The moment a few of them diſcover her, they give notice to thoſe near them, and thoſe to the reſt; the knowledge of which ſoon becomes ſo general, that in a few minutes they all collect themſelves round her; and are ſo happy in having recovered this ſole ſupport of their ſtate, that they will long remain quiet in their ſituation. Nay, the ſcent of her body is ſo attractive of them, that the ſlighteſt touch of her, along any place or ſubſtance, will attach the bees to it, and induce them to purſue any path ſhe takes." This was the only witchcraft uſed by Mr. Wildman, and is that alone which is practiſed by others who have ſince made ſimilar exibitions. In ſhort, ſeize on the queen, and you are ſure of leading all the bees of a hive to any place you pleaſe.

The

The bees of her hive immediately ceaſe working, when their queen dies by any accident. They conſume their honey, fly about their own and other hives at unuſual hours when other bees are at reſt, and pine away if not ſoon ſupplied with another ſovereign. Her loſs is proclaimed by a clear and uninterrupted humming. This ſign ſhould be a warning to the owner of the bees, to take what honey remains in the hive, or to procure them another queen. In this laſt caſe, the flock inſtantly revives; pleaſure and activity are apparent through the whole hive; the preſence of the ſovereign reſtores vigour and exertion, and her voice commands univerſal reſpect and obedience: of ſuch importance is the queen to the exiſtence and proſperity of the other members of the community.

The diſſection of the queen-bee ſhows evidently that ſhe lays many thouſand eggs. It is computed that the ovaria of a queen-bee contain more than 5000 eggs at one time; and therefore it is not difficult to conceive that a queen-bee may produce 10,000 or 12,000 bees or even more, in the ſpace of two months.

The angry diſpoſition of bees is eaſily ſoftened by the frequent intercourſe of thoſe who take care of them, for they grow more tame when they are often handled. The experience of ages has now eſtabliſhed the ſort of bees which have been found to anſwer beſt the purpoſes of keeping them. The working bees have the care of the hive, collect the wax and honey, fabricate and work up the wax, build the cells, feed the young, keep the hive clean, drive from thence ſtrangers, and employ themſelves in all other concerns relating to the hive. The working bee has two ſtomachs; one which contains the honey, and a ſecond in which is contained the crude wax. The working bees have no parts analogous to the ovaria of the queen, or that reſemble the male organs of the drones. Hence they have generally been ſuppoſed to be neutral or of neither ſex. But a different doctrine has lately been eſtabliſhed. The ſting is very neceſſary for a working bee, both as an offenſive and as a defenſive weapon: for their honey and wax excite the envy of many greedy and lazy inſects; and they have alſo to defend themſelves againſt enemies, who are fonder of eating them than their honey. There is likewiſe a time when the drones muſt be ſacrificed and exterminated for the good of the ſociety; and as they are larger and ſtronger than the working bees, theſe laſt would have a very unequal match, were it not for this poiſonous ſting.

There happen alſo among bees, either of the ſame or of different hives, moſt deadly feuds, in which their ſtings are their chief weapons. In theſe conteſts, great ſkill may be diſcerned in their manner of pointing the ſting between the ſcaly rings which cover their bodies, or to ſome other eaſily vulnerable part. The bee which firſt gains the advantage remains the conqueror: though the victory coſts the victor his life, if he has left his ſting in the body of the enemy; for, with the ſting, ſo much of his body is torn out, that death inevitably follows. Bees have very ſevere conflicts when whole hives engage in a pitched battle, and many are ſlain on both ſides. Their fighting and plundering one another ought chiefly to be imputed, as Mr. Thorley obſerves, either to their perfect abhorrence of ſloth and idleneſs, or to their inſatiable thirſt for honey; for when, in ſpring or autumn, the weather is fair, but no honey can be collected from plants, and is to be found only in the hives of other bees, they will venture their lives to get it there. Dr. Warder aſſigns another cauſe of their fighting; which is, the neceſſity that the bees are reduced to when their own hive has been plundered, at a ſeaſon when it is too late for them to repair the loſs by any induſtry, in the fields.

Sometimes one of the queens is killed in battle. In this caſe, the bees of both hives unite as ſoon as her death is generally known among them. All then become one people; the vanquiſhed go off with the robbers, richly laden with their own ſpoils, and return every day with their new aſſociates to pillage their old habitation. This cauſes a throng, unuſual for the ſeaſon, at the door of the hive they are plundering: and if the owner liſts it up at night, when all are gone home, he will find it empty of inhabitants; though there perhaps will remain in it ſome honey, which he takes as his property.

When two ſwarms take flight at the ſame time, they ſometimes quarrel, and great numbers are deſtroyed on both ſides, till one of the queens is ſlain. This ends the conteſt, and the bees of both ſides unite under the ſurviving ſovereign.

When the bees begin to work in their hives, they divide themſelves into four companies; one of which roves in the fields in ſearch of materials; another employs itſelf in laying out the bottom and partitions of their cells; a third is employed in making the inſide ſmooth from the corners and angles; and the fourth company brings food for the reſt, or relieves thoſe who return with their reſpective burdens. But they are not kept conſtant to one employment; they often change the taſks aſſigned them: thoſe that have been at work, being permitted to go abroad; and thoſe that have been in the fields already, take their places. They ſeem even to have ſigns, by which they underſtand each other; for when any of them want food, it bends down its trunk to the bee from whom it is expected, which then opens its honey-bag, and lets ſome drops fall into the others mouth, which is at that time opened to receive it. Their diligence and labour is ſo great, that, in a day's time, they are able to make cells which lie upon each other, numerous enough to contain 3000 bees.

APIUM, PARSLEY; A genus of the digynia order, belonging to the pentandria claſs of plants. There are only two ſpecies of apium; the petroſelinum, or common parſley, a native of Sardinia; and the graveolens, or ſmallage, a native of Britain: the culture of both which are well known. Common parſley is reckoned an effectual cure for the rot in ſheep, provided they are fed with it twice a week for two or three hours each time: but hares and rabbits are ſo fond of this herb, that they will come from a great diſtance to feed upon it; and in the countries where theſe animals abound, they will deſtroy it, if not very ſecurely fenced againſt them; ſo that whoever has a mind to have plenty of hares in their fields, may draw them from all parts of the country by cultivating parſley. For the method, ſee TREATISE ON GARDENING, Article Kitchen Garden, month of February.

APOCALYPSE, REVELATION, the name of one of the ſacred books of the New Teſtament, containing revelations concerning ſeveral important doctrines of Chriſtianity. The word is Greek, and derived from ἀποκαλυπτω, to *reveal*, or *diſcover*. This book, according to Irenæus, was written about the year 96 of Chriſt, in the iſland of Patmos, whither St. John had been baniſhed by the emperor Domitian. But Sir Iſaac Newton places the writing of it earlier, viz. in the time of Nero. This of all books of the New Teſtament is that about which the ancient fathers and the practice of the church, were the moſt and the longeſt divided. Some attribute this book to the arch-heretic Cerinthus: but the ancients unanimouſly aſcribed it to John, the ſon of Zebedee, and brother of James; whom the Greek fathers call the *Divine*, by way of eminence, to diſtinguiſh him from the other evangeliſts. This book has not, at all times, been eſteemed canonical. There were many churches in Greece, as St. Jerome informs us, which did not receive it; neither is it in the catalogue of canonical books prepared by the council of Laodicea, nor in that of St. Cyril of Jeruſalem: but Juſtin, Irenæus, Origen, Cyprian, Clemens of Alexandria, Tertullian, and all the fathers of the fourth, fifth, and the following centuries, quote the Revelations as a book then acknowledged to be canonical. The Alogians, Marcionites, Cerdonians, and Luther himſelf, rejected this book: but the Proteſtants have forſaken Luther in this particular; and Beza has ſtrongly maintained againſt his objections, that the Apocalypſe is authentic and canonical. Of all their objections againſt the authority of this book, that ſeems the beſt grounded which is drawn from thoſe words in chap. ii. ver. 13. *Write to the angel of the church of Thyatira*: there was not, ſay they, any Chriſtian church at Thyatira at that time. St. Epiphanius, who grants them this point, is forced to have recourſe to the prophetic ſpirit; as if St. John had foreſeen there would be a church there in courſe of time. The Apocalypſe conſiſts of twenty-two chapters. The three firſt are an inſtruction to the biſhops of the ſeven churches of Aſia Minor. The fifteen following chapters contain the perſecutions which the church was to ſuffer from the Jews, heretics, and Roman emperors. Next, St. John propheſies of the vengeance of God, which he will exerciſe againſt thoſe perſecutors, againſt the Roman empire, and the city of Rome: which, as the Proteſtants ſuppoſe, he deſcribes under the name of Babylon, the great whore, ſeated upon ſeven hills. In the laſt place, the 19th, 20th, 21ſt, and 22d chapters, deſcribe the triumph of the church over its enemies, the marriage of the Lamb, and the happineſs of the church triumphant.

"It is a part of this prophecy (ſays Sir Iſaac Newton,) that it ſhould not be underſtood before the laſt age of the world; and therefore it makes for the credit of the prophecy, that it is not yet underſtood. The folly of interpreters has been to foretel times and things by this prophecy, as if God deſigned to make them prophets. By this raſhneſs they have not only expoſed themſelves, but brought the prophecy alſo into contempt. The deſign of God was much otherwiſe: he gave this and the prophecies of the Old Teſtament, not to gratify mens curioſities, by enabling them to foreknow things: but that, after they were fulfilled, they might be interpreted by the events; and his own providence, not the interpreters, be then manifeſted thereby to the world. And there is already ſo much of the prophecy fulfilled, that as many as will take pains in this ſtudy, may ſee ſufficient inſtances of God's providence."

APOCRYPHA, or APOCRYPHAL BOOKS, ſuch books as are not admitted into the canon of ſcripture, being either not acknowledged as divine, or conſidered as ſpurious. The word is Greek; and derived from απο, and κρυπτω to *hide* or *conceal*; becauſe the origin of ſuch books was unknown, or becauſe they contain ſome myſteries not fit to be known. When the Jews publiſhed their ſacred books, they gave the appellations of *canonical* and *divine* only to ſuch as they then made public; ſuch as were ſtill retained in their archives they called *apochryphal*, for no other reaſon but becauſe they were not public; ſo that they might be really ſacred and divine, though not promulged as ſuch. Thus, in reſpect of the Bible, all books were called *apochryphal* which were not inſerted in the

Jewiſh canon of ſcripture. Voſſius obſerves, that, with regard to the ſacred books, none are to be accounted apocryphal, except ſuch as had neither been admitted into the ſynagogue nor the church, ſo as to be added to the canon, and read in public. The proteſtants do not only reckon thoſe books to be apocryphal which are eſteemed ſuch in the church of Rome, as the prayer of Manaſſeh king of Judah, the third and fourth books of Eſdras, St. Barnabas's epiſtle, the book of Hermas, the addition at the end of Job, and 151ſt pſalm; but alſo Tobit, Judith, Eſther, the book of Wiſdom, by Jeſus the ſon of Sirach, Baruch the prophet, the Song of the Three Children, the hiſtory of Suſannah, the hiſtory of Bell and the Dragon, and the firſt and ſecond books of Maccabees. It is now pretended that theſe books are not received by the Jews, or ſo much as known to them. None of the writers of the New Teſtament cite or mention them: neither Philo or Joſephus ſpeak of them. The Chriſtian church was for ſome ages an utter ſtranger to theſe books. Origen, Athanaſius, Hilary, Cyril of Jeruſalem, and all the orthodox writers, who have given catalogues of the canonical books of ſcripture, unanimouſly concur in rejecting theſe out of the canon. And as to the New Teſtament, they are divided in their opinions, whether the epiſtle to the Hebrews, the epiſtle of St. James, and the ſecond epiſtle of St. Peter, the ſecond and third epiſtles of St. John, the epiſtle of St. Jude, and the Revelations, are to be acknowledged as canonical or not. The Proteſtants acknowledge ſuch books of ſcripture only to be canonical as were ſo eſteemed to be in the firſt ages of the church; ſuch as are cited by the earlieſt writers among the Chriſtians as of divine authority, and after the moſt diligent enquiry were received and ſo judged by the council of Laodicea. The ſeveral epiſtles abovementioned, and the book of Revelations, whatever the ſentiments of ſome particular perſons are or may have been of them, are allowed by all the reformed churches to be parts of the canon of the New Teſtament. The apocryphal books, however, according to the ſixth article of the church of England, are to be read for example of life and inſtruction of manners: but it doth not apply them to eſtabliſh any doctrine.

We meet with numerous apocryphal, or ſuppoſititious books, publiſhed under the names of patriarchs, prophets, evangeliſts, apoſtles, primitive fathers, ſaints, martyrs, &c. Apocryphal propheſies, apocryphal goſpels, apocryphal epiſtles, apocryphal acts, apocryphal apocalypſes, &c. The writing of books under ſpurious names, and obtruding them for the works of inſpired authors, though once reputed laudable, and conſecrated under the name of pious fraud, was condemned very early by an apoſtolical canon, in the inſtance of a prieſt, who was depoſed for forging the acts of Paul and Thecla. Bing. Orig. Eccleſ. lib. xvii. cap. 5.

APODES, in ichthyology, the name of an order of fiſhes. For the characters and claſs of this Order, and alſo of the ſeveral genera which is compriſes, ſee the SYSTEM, Sect. V.

APOGEE, in aſtronomy, that point in the orbit of the ſun, or a planet, which is fartheſt diſtant from the earth. The apogee is a point in the heavens at the extreme of the line of the apſides; in which the ſun, or a planet, is at the greateſt diſtance than it can be at, from the earth, in its whole revolution. The oppoſite point to this is called the perigee; ſee the SYSTEM, Sect. VII.

APOLLO, in mythology, a pagan deity worſhipped by the Greeks and Romans. He was the God of light and poetry; and was regarded as the inventor and patron of the fine arts. He had a famous temple at Delphos, where his oracles were in great eſtimation. Apollo is principally diſtinguiſhed in ancient ſtatues by the beauty of his face, and the gracefulneſs of his figure. Accordingly Virgil calls him, the beautiful; and Tibullus, the well-ſhaped God. Apollo had a variety of names, either derived from his principal attributes, or the chief places where he was worſhipped. He was called the Healer from his enlivening warmth and cheering influence; Pæan, from the peſtilential heats: to ſignify the former, the ancients placed the graces in his right-hand; and for the latter, a bow and arrows in his left: Nomius, or the ſhepherd, from his fertilizing the earth, and thence ſuſtaining the animal creation: Delius, from his rendering all things manifeſt: Pythius, from his victory over Python: Lycias, Phœbus, and Phuneta, from his purity and ſplendor. As Apollo is almoſt always confounded by the Greeks with the ſun, it is no wonder that he ſhould be dignified with ſo many attributes. It was natural for the moſt glorious object in nature, whoſe influence is felt by all creation, and ſeen by every animated part of it, to be adored as the fountain of light, heat, and life. The power of healing diſeaſes being chiefly given by the ancients to medicinal plants and vegetable productions, it was natural to exalt into a divinity the viſible cauſe of their growth. Hence he was alſo ſtyled the God of Phyſic; and that external heat which cheers and invigorates all nature, being transferred from the human body to the mind, gave riſe to the idea of all mental effervescence coming from this god; hence, likewiſe, poets, prophets, and muſicians, are ſaid to be *Numine afflati*, inſpired by Apollo. To the other perfections of this divinity the poets have added beauty, grace, and the art of captivating the ear and the heart, no leſs by the ſweetneſs of his eloquence, than by the melodious ſounds of his lyre. However, with all theſe accompliſhments, he had not the talent of captivating the fair, with whoſe charms he was enamoured. But the amours and other adventures related of this god during his reſidence on earth, are too numerous, and too well known, to be inſerted here.

There can be do doubt but that Apollo was more generally revered in the Pagan world than any other deity; having, in almoſt every region of it, temples, oracles, and feſtivals, as innumerable as his attributes: the wolf and hawk were conſecrated to him, as ſymbols of his piercing eyes; the crow and the raven, becauſe theſe birds were ſuppoſed to have by inſtinct the faculty of prediction; the laurel, from a perſuaſion that thoſe who ſlept with ſome branches of that tree under their heads received certain vapours, which enabled them to prophecy. The cock was conſecrated to him, becauſe by his crowing he anounces the riſing of the ſun; and the graſshopper on account of his ſinging faculty, which was ſuppoſed to do honour to the God of muſic. Moſt of the ancient poets have celebrated this tuneful inſect, but none better than Anacreon, Ode 43.

Plutarch, who was himſelf a prieſt of Apollo, impreſſed with the higheſt reſpect and veneration for him and for muſic, in his dialogue upon that art, makes one of his interlocutors ſay, that an invention ſo uſeful and charming could never have been the work of man, but muſt have originated from ſome god, ſuch as Apollo, the inventor of the flute and lyre, improperly attributed to Hyagnis, Marſyas, Olympus, and others; and the proofs he urges in ſupport of this aſſertion, ſhow, if not its truth, at leaſt that it was the common and received opinion.

It ſeems as if the account of Apollo could not be concluded by any thing that is left to offer on the ſubject, ſo properly, as by part of the celebrated hymn of Callimachus, which during many ages was performed and heard by the moſt poliſhed people on the globe, with the utmoſt religious zeal, at the feſtivals inſtituted to this god.

Ha! how the laurel, great APOLLO's tree,
And all the cavern, ſhakes! Far off, far off,
The man that is unhallow'd: for the god
Approaches. Hark! he knocks: the gates
Feel the glad impulſe; and the ſever'd bars
Submiſſive clink againſt their brazen portals.
Why do the Delian palms incline their boughs,
Self-mov'd; and hov'ring ſwans, their throats releas'd
From native ſilence, carol ſounds harmonious?
Begin, young men, the hymn: let all your harps
Break their inglorious ſilence; and the dance,
In myſtic numbers trod, explain the muſic.
But firſt by ardent pray'r, and clear luſtration,
Purge the contagious ſpots of human weakneſs:
Impure no mortal can behold Apollo.
So may you flouriſh, favour'd by the god,
In youth with happy nuptials, and in age
With ſilver hairs, and fair deſcent of children;
So lay foundations for aſpiring cities,
And bleſs your ſpreading colonies' increaſe.
Pay ſacred rev'rence to Apollo's ſong;
Leſt watchful the far-ſhooting god emit
His fatal arrows. Silent, Nature ſtands;
And ſeas ſubſide, obedient to the ſound,
Of Io! Io Pæan! nor dares Thetis
Longer bewail her lov'd Achilles' death;
For Phœbus was his foe. Nor muſt ſad Niobe
In fruitleſs ſorrow perſevere, or weep
Even thro' the Phrygian marble. Hapleſs mother!
Whoſe fondneſs could compare her mortal offspring
To thoſe which fair Latona bare to Jove.
Io! again repeat ye, Io Pean!

Recite Apollo's praiſe till night draws on,
The ditty ſtill unfiniſh'd; and the day
Unequal to the godhead's attributes
Various, and matter copious of your ſongs.
Sublime at Jove's right-hand Apollo ſits,
And thence diſtributes honour, gracious king,
And theme of verſe perpetual. From his robe
Flows light ineffable! his harp, his quiver,
And Lactian bow, are gold; with golden ſandals
His feet are ſhod. How rich! how beautiful!
Beneath his ſteps the yellow min'ral riſes;
And earth reveals her treaſures. Youth and beauty
Eternal deck his cheek; from his fair head,
Perfumes diſtil their ſweets; and cheerful Health,
His duteous hand-maid, through the air improv'd
With laviſh hand diffuſes ſcents ambroſial.
The ſpearman's arm by thee, great god, directed,
Sends forth a certain wound. The laurel'd bard,
Inſpir'd by thee, compoſes verſe immortal.
Taught by thy art divine, the ſage phyſician
Eludes the urn, and chains or exiles death.

Perpetual fires ſhine hallow'd on thy altars,
When annual the Carnean feaſt is held;

The

The warlike Libyans, clad in armour, lead
The dance; with clanging ſwords and ſhields they beat
The dreadful meaſure; in the chorus join
Their women; brown, but beautiful: ſuch rites
To thee well pleaſing———
———The monſtrous Python
Durſt tempt thy wrath in vain; for dead he fell,
To thy great ſtrength and golden arms unequal.
Io! while thy unerring hand elanc'd
Another and another and another dart, the people
Joyfully repeated *Io! Io Pæan!*
Elance the dart, Apollo; for the ſafety
And health of man, gracious thy mother bore thee!

PRIOR.

APOLLO BELVIDERE, one in the firſt claſs of the ancient ſtatues. The excellence of this ſtatue conſiſts in the expreſſion of ſomething divine, whereas the reſt excel only in things that are common to men. This ſtatue may, perhaps juſtly enough, claim the preference, even in this ſuperior and diſtinguiſhed claſs of the beſt remains of all antiquity. There are about twenty ancient ſtatues, which the moderns have diſcovered that are referred to the firſt claſs: and conſidered each as the chief beauty in its kind.

APOLOGUE, a moral fable; or a feigned relation intended to inform and amend the manners. Jul. Scaliger derives the name from απολογου, inaſmuch as the apologue means ſomething more than what at firſt ſight it expreſſes. Such are the fables of Æſop: whence, moral fables are uſually denominated, Æſopic fables. F. De Colonia makes it eſſential to the apologue, that it contain what paſſes among brutes; and diſtinguiſhes it from the parable by this, that the latter, though feigned, conſiſts of poſſible circumſtances, which the former does not, ſince beaſts cannot ſpeak. There is this farther difference between them, that the latter is a ſimilitude drawn from natural, moral, or any other branches of knowledge; the former only from moral topics. Apologue, according to ſome, differs from fable, as the former is uſed in ſpeeches and harangues, to perſuade; the latter in tragedies, comedies, and other pieces of poetry, to inſtruct and correct the manners. Apologue alſo differs from fable, as the latter is only calculated for the uſe of men, and carries a graver and weightier admonition; whereas apologues are propoſed to children. We find many things in authors concerning the origin of apologue, the diſtinguiſhing characters of apologues, the uſe and advantage of the way of teaching by apologues. See BAYLE, Dict. Crit. in voc, & Shafteſb. Charact. tom. iii.

APOPHYSIS, in anatomy, a protuberance of a bone; or a part eminent, and jutting out beyond the reſt. It is the ſame with what we otherwiſe call proceſs, eminence, probole, projecture, protuberance, ecphyſis, head, and the like. Apophyſis differ from epiphyſes, as theſe latter are only appendages adhering or contiguous to a bone; whereas the former are productions or continuations of the bone itſelf, ſhooting out from it like branches from the trunk of a tree. See the SYSTEM. Part I. Sect. I.

APOPLEXY, in medicine, a ſudden privation of all the ſenſes, and all the ſenſible motions of the body, excepting thoſe of the heart and lungs; attended with a great depravation or ſuſpenſion of the principal faculties of the ſoul. The word comes from αποπλασσειν, to ſtrike, or aſtoniſh; this diſtemper ſtriking ſuddenly; and, as it were, like a thunder-bolt. For deſcription, cauſes, prognoſis, and cure of this diſeaſe, ſee the SYSTEM, Genus 35.

APOSTACY, the abandoning the true religion. The primitive Chriſtian church diſtinguiſhed ſeveral kinds of apoſtacy. The firſt, of thoſe who went over entirely from Chriſtianity to Judaiſm; the ſecond, of thoſe who mingled Judaiſm and Chriſtianity together: and the third, of thoſe who complied ſo far with the Jews as to communicate with them in many of their unlawful practices, without making a formal profeſſion of their religion. But the fourth ſort was of thoſe who, after having been ſome time Chriſtians, voluntarily relapſed into Paganiſm:

The perverſion of a Chriſtian to Judaiſm, Paganiſm, or other falſe religion, was puniſhed by the emperors Conſtantius and Julian with confiſcation of goods; to which the emperors Theodoſius and Valentinian added capital puniſhment, in caſe the apoſtate endeavoured to pervert others to the ſame iniquity. A puniſhment too ſevere for any temporal laws to inflict; and yet the zeal of our anceſtors imported it into this country; for we find by Bracton, that in his time apoſtates were to be burnt to death. Doubtleſs the preſervation of Chriſtianity, as a national religion, is, abſtracted from its own intrinſic truth, of the utmoſt conſequence to the civil ſtate: which a ſingle inſtance will ſufficiently demonſtrate. The belief of a future ſtate of rewards and puniſhments, the entertaining juſt ideas of the moral attributes of the ſupreme Being, and a firm perſuaſion that he ſuperintends and will finally compenſate every action in human life (all which are clearly revealed in the doctrines, and forcibly inculcated by the precepts of our ſaviour Chriſt), theſe are the grand foundation of all judicial oaths, which call God to witneſs the truth of thoſe facts, which perhaps may be only known to him and the party atteſting: all moral evidence therefore, all confidence in human veracity, muſt be weakened by apoſtacy, and overthrown by total infidelity. Wherefore all affronts to Chriſtianity, or endeavours to depreciate its efficacy, in thoſe who have once poſſeſſed it, are highly deſerving of cenſure. But yet the loſs of life is a heavier penalty than the offence, taken in a civil light, deſerves; and taken in a ſpiritual light, our laws have no juriſdiction over it. The puniſhment, therefore, has long ago become obſolete; and the offence of apoſtacy was for a long time the object only of the eccleſiaſtical courts, which corrected the offender *pro ſalute animæ*. But about the cloſe of the laſt century, the civil liberties to which we were then reſtored being uſed as a cloke of maliciouſneſs, and the moſt horrid doctrine ſubverſive of all religion being publickly avowed both in diſcourſe and writings, it was thought neceſſary again for the civil power to interpoſe, by not admitting thoſe miſcreants to the privileges of ſociety, who manifeſted ſuch principles as deſtroyed all moral obligation. To this end it was enacted by ſtatute 9 and 10 W. III. c. 32. That if any perſon educated in, or having made profeſſion of, the Chriſtian religion, ſhall by writing, printing, teaching, or adviſed ſpeaking, deny the Chriſtian religion to be true, or the holy ſcriptures to be of divine authority; he ſhall upon the firſt offence be rendered incapable to hold any office or place of truſt; and, for the ſecond, be rendered incapable of bringing any action, or of being guardian, executor, legatee, or purchaſer of lands, and ſhall ſuffer three years impriſonment without bail. To give room however for repentance, if, within four months after the firſt conviction, the delinquent will in open court publickly renounce his error, he is diſcharged for that once from all diſabilities.

APOSTLE properly ſignifies a meſſenger or perſon ſent by another upon ſome buſineſs; and hence, by way of eminence, denotes one of the diſciples commiſſioned by Jeſus Chriſt to preach the goſpel. Our bleſſed Lord ſelected twelve out of the number of his diſciples to be inveſted with the apoſtleſhip. Their names were Simon Peter, Andrew, James the greater, John, Philip, Bartholomew, Thomas, Matthew, James the leſs, Jude ſirnamed Lebbeus or Thaddeus, Simon the Canaanite, and Judas Iſcariot. Of theſe Simon, Andrew, James the greater, and John, were fiſhermen; and Matthew a publican, or receiver of the public revenues: of what profeſſion the reſt were, we are not told in Scripture; though it is probable they were fiſhermen. There are various conjectures as to the reaſon of our Saviour's making choice of *twelve* apoſtles. The moſt probable is, that it might be in alluſion to the twelve patriarchs, as the founders of their ſeveral tribes; or to the twelve chief heads or rulers of thoſe tribes, of which the body of the Jewiſh nation conſiſted. This opinion ſeems to be countenanced by what our Saviour tells his apoſtles, that, "when the Son of man ſhall ſit in the throne of his glory, *they* alſo ſhall ſit upon twelve thrones judging the twelve tribes of Iſrael."

Our Lord's firſt commiſſion to his apoſtles was in the third year of his public miniſtry, about eight months after their ſolemn election; at which time he ſent them out by two and two. They were to make no proviſion of money for their ſubſiſtence in their journey, but to expect it from thoſe to whom they preached. They were to declare, that the kingdom of heaven, or the Meſſiah, was at hand; and to confirm their doctrine by miracles. They were to avoid going either to the Gentiles or to the Samaritans, and to confine their preaching to the people of Iſrael. In obedience to their Maſter, the apoſtles went into all the parts of Paleſtine inhabited by the Jews, preaching the goſpel, and working miracles. The evangelical hiſtory is ſilent as to the particular circumſtances attending this firſt preaching of the apoſtles; and only informs us, that they returned, and told their maſter of all that they had done.

Their ſecond commiſſion, juſt before our Lord's aſcenſion into heaven, was of a more extenſive and particular nature. They were now not to confine their preaching to the Jews, but to "go and teach ALL nations, baptizing them in the name of the Father, and of the Son, and of the Holy Ghoſt." Accordingly they began publicly, after our Lord's aſcenſion, to exerciſe the office of their miniſtry, working miracles daily in proof of their miſſion, and making great numbers of converts to the Chriſtian faith. This alarmed the Jewiſh Sanhedrim; whereupon the apoſtles were apprehended, and, being examined before the high-prieſt and elders, were commanded not to preach any more in the name of Chriſt. But this injunction did not terrify them from perſiſting in the duty of their calling; for they continued daily, in the temple, and in private houſes, teaching and preaching the goſpel. After the apoſtles had exerciſed their miniſtry for twelve years in Paleſtine, they reſolved to diſperſe themſelves in different parts of the world, and agreed to determine by lot what part each ſhould take. According to this diviſion, St. Peter went into Pontus, Galatia, and thoſe other provinces of the Leſſer Aſia. St. Andrew had the vaſt northern countries of Scythia and Sogdiana allotted to his portion. St. John's was partly the ſame with Peter's, namely, the Leſſer Aſia. St. Philip had the Upper Aſia aſſigned to him, with ſome parts of Scythia and Colchis. Arabia

bia Felix fell to St. Bartholomew's ſhare. St. Matthew preached in Chaldæa, Perſia, and Parthia. St. Thomas preached likewiſe in Parthia; as alſo to the Hyrcanians, Bactrians, and Indians. St. James the leſs continued in Jeruſalem, of which church he was biſhop. St. Simon had for his portion Egypt, Cyrene, Libya, and Mauritania; St. Jude, Syria and Meſopotamia; and St. Matthias, who was choſen in the room of the traitor Judas, Cappadocia and Colchis. Thus, by the diſperſion of the apoſtles, Chriſtianity was very early planted in a great many parts of the world. We have but very ſhort and imperfect accounts of their travels and actions.

In order to qualify the apoſtles for the arduous taſk of converting the world to the Chriſtian religion, they were, in the firſt place, miraculouſly enabled to ſpeak the languages of the ſeveral nations to whom they were to preach; and, in the ſecond place, were endowed with the power of working miracles, in confirmation of the doctrines they taught; gifts which were unneceſſary, and therefore ceaſed, in the after ages of the church, when Chriſtianity came to be eſtabliſhed by the civil power. St. Paul is frequently called the *apoſtle*, by way of eminence; and the *apoſtle of the Gentiles*, becauſe his miniſtry was chiefly made uſe of for the converſion of the Gentile world, as that of St. Peter was for the Jews, who is therefore ſtyled the *apoſtle of the circumciſion*. The ſeveral apoſtles are uſually repreſented with their reſpective badges or attributes: St. Peter with the keys; St. Paul with a ſword; St. Andrew with a croſs or ſaltier; St. James minor with a fuller's pole; St. John with a cup, and winged ſerpent flying from it; St. Bartholomew with a knife; St. Philip with a long ſtaff, whoſe upper end is formed into a croſs; St. Thomas with a lance; St. Matthew with a hatchet; St. Matthias with a battle-ax; St. James major with a pilgrim's ſtaff and a gourd-bottle; St. Simon with a ſaw; and St. Jude with a club. This appellation was alſo given to the ordinary travelling miniſters of the church.—Thus St. Paul, in the epiſtle to the Romans, xvii. 7. ſays, "Salute Andronicus and Jenia, my kinſmen and fellow-priſoners, who are of note among the apoſtles." It was likewiſe a title given to thoſe ſent by the churches to carry their alms to the poor of other churches. This uſage they borrowed from the ſynagogues, who called thoſe whom they ſent on this meſſage by the ſame name; and the function or office itſelf ἀποστολη, *apoſtole*, q. d. *miſſion*. Thus St. Paul, writing to the Philippians, tells them, that Epaphroditus their apoſtle had miniſtered to his wants, ch. ii. 25. The appellation is given in like manner to thoſe perſons who firſt planted the Chriſtian faith in any place. Thus Dionyſius of Corinth is called the *apoſtle of France*; Xavier the *apoſtle of the Indies*, &c. In the Eaſt Indies the Jeſuit miſſionaries were alſo called *apoſtles*.

APOSTLES *creed*: a *formula*, or ſummary, of the Chriſtian faith, drawn up, according to Ruffinus, by the apoſtles themſelves; who, during their ſtay at Jeruſalem, ſoon after our Lord's aſcenſion, agreed upon this *creed*, as a rule of faith, and as a *word of diſtinction* by which they were to know friends from foes. Baronius, and ſome other authors, conjecture, that they did not compoſe it till the ſecond year of the reign of Claudius, a little before their diſperſion. As to their manner of compoſing it, ſome fancy, that each apoſtle pronounced his article, which is the reaſon of its being called *ſymbolum apoſtolicum*, it being made up of ſentences jointly contributed. But there are reaſons which may induce us to queſtion whether the apoſtles compoſed any ſuch creed as this. For, firſt, neither St. Luke in the Acts, nor any other eccleſiaſtical writer before the fifth century, make any mention of an aſſembly of the apoſtles in order to the compoſing of a creed. Secondly, the fathers of the three firſt centuries, in diſputing againſt the heretics, endeavour to prove that the doctrine contained in this creed was the ſame which the apoſtles taught; but they never pretend that the apoſtles compoſed it. Thirdly, if the apoſtles had made this creed, it would have been the ſame in all churches, and in all ages; and all authors would have cited it after the ſame manner. But the caſe is quite otherwiſe. In the ſecond and third ages of the church there were as many creeds as authors, and one and the ſame author ſets down the creed after a different manner in ſeveral places of his works; which is an evidence that there was not at that time any creed which was reputed to be the apoſtles. In the fourth century, Ruffinus compares together the three ancient creeds of the churches of Aquileia, Rome, and the Eaſt, which differ very conſiderably in the terms. Beſides, theſe creeds differed not only in the terms and expreſſions, but even in the articles, ſome of which were omitted in one or other of them; ſuch as thoſe of the *deſcent into hell*, the *communion of the ſaints*, and the *life everlaſting*. From theſe reaſons it may be gathered, that though this creed may be ſaid to be that of the apoſtles in regard to the doctrines contained therein, yet it is not to be referred to them as the authors and firſt compoſers of it. Who was the true author of it, is not ſo eaſy to determine; though its great antiquity may be inferred from hence, that the whole form, as it now ſtands in the Engliſh liturgy, is to be found in the works of St. Ambroſe and Ruffinus, the former of whom flouriſhed in the third century, and the latter in the fourth century. The primitive Chriſtians, in regard they always concealed this and their other myſteries, did not publicly recite the creed, except at the times of baptiſm; which, unleſs in caſes of neceſſity, were only at Eaſter and Whitſuntide. The conſtant repeating it was not introduced into the church till the end of the fifth century; about which time Petrus Gnapheus, biſhop of Antioch, preſcribed the recital of it every time divine ſervice was performed.

APOSTOLIC, APOSTOLICAL, ſomething that relates to the apoſtles or deſcends from them. Thus we ſay, the apoſtolical age, apoſtolic doctrine, apoſtolical character, conſtitutions, traditions, &c. Apoſtolic, in the primitive church, was an appellation given to all ſuch churches as were founded by the apoſtles; and even to the biſhops of thoſe churches, as being the reputed ſucceſſors of the apoſtles.—Theſe were confined to four, viz. Rome, Alexandria, Antioch, and Jeruſalem. In after-times, other churches aſſumed the ſame quality, on account, principally, of the conformity of their doctrine with that of the churches which were apoſtolical by foundation, and becauſe all biſhops held themſelves ſucceſſors of the apoſtles, or acted in their dioceſes with the authority of apoſtles. In progreſs of time, the biſhop of Rome growing in power above the reſt; and the three patriarchates of Alexandria, Antioch, and Jeruſalem, falling into the hands of the Saracens, the title apoſtolical was reſtrained to the pope, and his church alone. Though ſome of the popes, and St. Gregory the Great, not contented to hold the title by this tenure, began, at length, to inſiſt, that it belonged to them by another and peculiar right, as being the ſucceſſors of St. Peter. The council of Rheims in 1049 declared that the pope was the ſole apoſtolical primate of the univerſal church. And hence a great number of *apoſtolicals*: *apoſtolical* ſee, *apoſtolical* nuncio, *apoſtolical* notary, *apoſtolical* brief, *apoſtolical* chamber, *apoſtolical* vicar, &c.

APOSTOLICAL *fathers* is an appellation uſually given to the writers of the firſt century who employed their pens in the cauſe of Chriſtianity. Of theſe writers, Cotelerius, and after him Le Clerc, have publiſhed a collection in two volumes, accompanied with both their own annotations, and the remarks of other learned men.

APOSTROPHE, in rhetoric, a figure by which a perſon who is either abſent or dead is addreſſed as if he were preſent, and attentive to us. This figure is, in boldneſs, a degree lower than the addreſs to perſonified objects; ſince it requires a leſs effort of imagination to ſuppoſe perſons preſent who are dead or abſent, than to animate inſenſible beings and direct our diſcourſe to them. The poems of Oſſian abound with the moſt beautiful inſtances of this figure. "Weep on the rocks of roaring winds, O Maid of Iniſtore! bend thy fair head over the waves, thou fairer than the ghoſt of the hills when it moves in a ſun-beam at noon over the ſilence of Morven! He is fallen! Thy youth is low; pale beneath the ſword of Cuchullin!"

Cicero's apoſtrophe to Tubero, in his oration for Ligarius, is judged one of the fineſt paſſages in his works. That apoſtrophe of Demoſthenes, wherein he addreſſes himſelf to the Greeks ſlain at the battle of Marathon, is alſo famous; Cardinal Perron ſays, it has procured the orator as much glory as if he had raiſed them from the dead.

APOSTROPHE, or APOSTROPHUS, in grammar, alſo denotes a note or character placed over a letter, in lieu of a vowel, to denote that the vowel is cut off, and not to be pronounced. As *ev'n* for *even*; *th' angelic hoſt*, for *the angelic*, &c. The affectation of frequent apoſtrophes, ſo uſual among ſome late Engliſh writers, is a great abuſe. In proſe, apoſtrophes are indefenſible, and tend to vitiate the language; their uſe in poetry is to reduce a line to the proper meaſure.

APOTHECARY, one who practiſes the art of pharmacy. In London, the apothecaries are one of the city-companies. They were incorporated by a charter from king James I. procured at the ſolicitation of Dr. Mayerne and Dr. Aitkins: till that time they only made a part of the grocer's company; plums, ſugar, ſpice, Venice treacle, Mithridate, &c. were ſold in the ſame ſhop and by the ſame perſon. The reaſon of ſeparating them was, that medicines might be better prepared, and in oppoſition to divers perſons who impoſed unwholeſome remedies on the people. By an act which was made perpetual in the ninth year of George I. they are exempted from ſerving upon juries, or in ward and pariſh offices. They are obliged to make up their medicines according to the formulas preſcribed in the college diſpenſatory; and are liable to have their ſhops viſited by the cenſors of the college, who are empowered to deſtroy ſuch medicines as they think not good. They have a hall in Black Friars, where there are two fine laboratories, out of which all the ſurgeons cheſts are ſupplied with medicines for the royal Britiſh navy.

To his majeſty belong two apothecaries: the ſalary to the firſt, 320l. to the ſecond, 273l.—To the houſehold belong alſo two.

The charitable diſpenſation of medicines by the Chineſe is well deſerving notice. They have a ſtone, which is ten cubits high, erected in the public ſquares of their cities: on this ſtone are engraved the names of all ſorts of medicines with the price of each; and when the poor ſtand in need of any relief from

from phyſic, they go to the treaſury, where they receive the price each medicine is rated at.

APOTHEOSIS, in antiquity, an heathen ceremony, whereby their emperors and great men were placed among the gods. The word is derived from ἀπο, and Θεος, *God*. After the apotheoſis, which they alſo called deification and conſecration, temples, altars, and images, were erected to the new deity; ſacrifices, &c. were offered, and colleges of prieſts inſtituted. It was one of the doctrines of Pythagoras which he had borrowed from the Chaldees, that virtuous perſons after their death were raiſed into the order of the gods. And hence the ancients deified all the inventors of things uſeful to mankind; and thoſe who had done any important ſervice to the commonwealth.—Tiberius propoſed to the Roman ſenate the apotheoſis of Jeſus Chriſt, as is related by Euſebius, Tertullian, and Chryſoſtom. Juvenal rallying the frequent apotheoſes, introduces poor Atlas, complaining that he was ready to ſink under the burden of ſo many new gods as were every day added to the heavens. Seneca ridicules the apotheoſis of Claudius with admirable humour. We often meet with the conſecration or apotheſis of emperors repreſented on medals; where we ſee the pyramids of ſeveral ſtories, each growing leſs and leſs; we ſee alſo the eagles flying away with the ſouls of the deceaſed emperors. A gem in the muſæum of Brandenburg repreſents the apotheoſis of Julius Cæſar, mounted upon the celeſtial globe, and holding an helm in his hand, as if he were now the governor of Heaven, as before of the earth.

APOZEM in medicine, a form of remedy, otherwiſe called a *decoction*. The word is derived from αποζεω, *ferveſacio, I make hot*. Apozems are a claſs of liquid medicines, compoſed of the juices of divers plants, roots, woods, flowers, leaves, fruits, and ſeeds, drawn out by boiling in water and ſweetened and clarified. An apozem differs from a ſyrup, in thickneſs and conſiſtence; the ſyrup being more denſe and viſcous than the apozem, from the quantity of ſugar. It differs from a julap, in that it is thicker, and more viſcous: and is not made with diſtilled water, as julaps are, but only with common water. There are purging apozems, cephalic apozems, hepatic apozems, antarthritic, diuretic, ſtyptic, &c. apozems. Apozem differs from infuſion, on account of the greater degree of heat made uſe of in preparing the former, whereby the apozem becomes more fully impregnated with thoſe parts of the ſubject which are readily ſoluble in boiling water. Apozems are medicines of the extemporaneous kind, and therefore the leſs uſed, becauſe that which is once made up will not keep. What is directed in this form, is generallly ſent to the patient in the quantity of a quart at a time, to be drank off plentifully as common drink.

APPARENT, in a general ſenſe, that which is viſible, or evident to the eye, or the underſtanding. Among mathematicians and aſtronomers, it denotes things as they appear to us, in contradiſtinction from real or true; thus we ſay, *apparent* diameter, diſtance, magnitude, place, figure, &c. of bodies.

APPARENT *conjunction* of the planets is, when a right line ſuppoſed to be drawn through the centre of two planets, does not paſs through the centre of the earth, but through the eye of the ſpectator.

APPARENT *heir*, in law. No inheritance can veſt, nor can any perſon be the actual complete heir of another, till the anceſtor is previouſly dead. *Nemo eſt hæres viventis*. Before that time the perſon who is next in the line of ſucceſſion is called an *heir apparent*, or *heir preſumptive*. Heirs *apparent* are ſuch, whoſe right of inheritance is indefeaſible, provided they outlive the anceſtor: as the eldeſt ſon or his iſſue, who muſt by the courſe of the common law be heirs to the father whenever he happens to die. Heirs *preſumptive* are ſuch, who, if the anceſtor ſhould die immediately, would in the preſent circumſtances of things be his heirs: but whoſe right of inheritance may be defeated by the contingency of ſome nearer heir being born; as a brother or nephew, whoſe preſumptive ſucceſſion may be deſtroyed by the birth of a child: or a daughter, whoſe preſent hopes may be hereafter cut off by the birth of a ſon. Nay, even if the eſtate hath deſcended, by the death of the owner, to ſuch brother, or nephew, or a daughter; in the former caſes, the eſtate ſhall be diveſted and taken away by the birth of a poſthumous child; and in the latter, it ſhall alſo be totally diveſted by the birth of a poſthumous ſon.

APPARITION, in a general ſenſe, denotes ſimply the appearance of a thing. In a more limited ſenſe, it is uſed for a ſpectre or ghoſt.—Several inſtances of apparitions occur in the Bible; that of Samuel, raiſed by the witch of Endor, has occaſioned great diſputes. We find great controverſies among authors, in relation to the reality, the exiſtence or non-exiſtence, the poſſibility or impoſſibility, of apparitions. The Chaldeans, the Jews, and other nations, have been the ſteady aſſertors of the belief of apparitions. The denial of ſpirits and apparitions is by ſome made one of the marks of infidelity, if not of atheiſm. Many of the apparitions we are told of in writers, are doubtleſs mere deluſions of the ſenſe; many others are fictitious, contrived merely to amuſe, or anſwer ſome purpoſe. Apparitions, it is certain, are machines that on occaſion have been of good ſervice both to generals, to miniſters of ſtate, to prieſts, and others.

Partial darkneſs, or obſcurity, are the moſt powerful means by which the ſight is deceived: night is therefore the proper ſeaſon for apparitions. Indeed the ſtate of the mind, at that time, prepares it for the admiſſion of theſe deluſions of the imagination. The fear and caution which muſt be obſerved in the night; the opportunity it affords for ambuſcades and aſſaſſinations; depriving us of ſociety, and cutting off many pleaſing trains of ideas, which objects in the light never fail to introduce, are all circumſtances of terror: and perhaps, on the whole, ſo much of our happineſs depends upon our ſenſes, that the deprivation of any one may be attended with proportionable horror and uneaſineſs. The notions entertained by the ancients reſpecting the ſoul, may receive ſome illuſtration from theſe principles. In dark or twilight the imagination frequently tranſforms an inanimate body into a human figure; on approaching, the ſame appearance is not to be found: hence they ſometimes fancied they ſaw their anceſtors; but not finding the reality, diſtinguiſhed theſe illuſions by the name of *ſhades*.

Many of theſe fabulous narrations might originate from dreams. There are times of ſlumber when we are not ſenſible of being aſleep. On this principle, Hobbes has ingeniouſly accounted for the ſpectre which is ſaid to have appeared to Brutus. "We read," ſays he, "of M. Brutus, that at Philippi, the night before he gave battle to Auguſtus Cæſar, he ſaw a fearful apparition, which is commonly related by hiſtorians as a viſion; but, conſidering the circumſtances, one may eaſily judge it to have been but a ſhort dream. For ſitting in his tent, penſive and troubled with the horror of his raſh act, it was not extraordinary for him, ſlumbering in the cold, to dream of that which moſt affrighted him; which fear, as by degrees it made him wake, ſo it muſt needs make the apparition by degrees to vaniſh: and having no aſſurance that he ſlept, he could have no cauſe to think it a dream, or any thing but a viſion."—The well-known ſtory told by Clarendon, of the apparition of the Duke of Buckingham's father, will admit of a ſimilar ſolution. There was no man in the kingdom ſo much the ſubject of converſation as the Duke, and from the corruptneſs of his character, he was very likely to fall a ſacrifice to the enthuſiaſm of the times. Sir George Villiers is ſaid to have appeared to the man at midnight: therefore there is the greateſt probability that the man was aſleep; and the dream affrighting him, made a ſtrong impreſſion, and was likely to be repeated.

APPEAL, in law, the removal of a cauſe from an inferior to a ſuperior court or judge, when a perſon thinks himſelf aggrieved by the ſentence of the inferior judge. Appeals lie from all the ordinary courts of juſtice to the Houſe of Lords. In eccleſiaſtical caſes, if an appeal is brought before a biſhop, it may be removed to the archbiſhop; if before an archdeacon, to the court of arches, and thence to the archbiſhop; and from the archbiſhop's court to the king in chancery. Appeal, in common law, denotes an accuſation by a private ſubject againſt another for ſome heinous crime; demanding puniſhment on account of the particular injury ſuffered, rather than for the offence againſt the public.

APPEARANCE, in law, is the defendant's engaging to anſwer a cauſe or action entered againſt him in ſome court of judicature. *Appearance*, in the King's Bench, is the defendant's filing either of common or ſpecial bail, if the action be by bill. If it be original, by the *appearance* muſt be with the philazer of the county where the arreſt was. *Appearance*, in the Common Pleas, muſt be entered with the philazer there, but if it be by bill, with the prothonotary.

APPEARANCE, in perſpective, is the repreſentation or projection of a figure, body, or like object, upon the perſpective plane. The appearance of an objective right line is always a right line. See the SYSTEM, Sect. II. The appearance of an opake body and a luminary being given, to find the appearance or the ſhadow, ſee Sect. VII.

APPEARANCES, in aſtronomy, &c. are more uſually called phenomena and phaſes. In optics, we uſe the term direct appearance for the view or ſight of any object by direct rays; without either refraction or reflection.

APPELLATION, the name by which any thing is known or diſtinguiſhed when ſpoken of. Nothing can be more foreign to the original meaning of many words and proper names than their preſent appellations, frequently owing to the hiſtory of thoſe things being forgotten, or an ignorance of the language in which they were expreſſed. Who, for example, when the crier of a court bawls out, "O yes, O yes," would dream that it was a proclamation commanding the talkers to become hearers, being the French word *Oyez*, "liſten," retained in our courts ever ſince the pleadings were held in law French? Or would any perſon ſuppoſe that the head-land on the French coaſt, near Calais, called by our ſeamen Blackneſs, could be ſo titled from its French name of *Blanc Nez*, or, the *White Head-land*.

King Henry the Eighth having taken the town of Bullogne in France, the gates of which he brought to Hardes in Kent,

where they are ſtill remaining, the flatterers of that reign highly magnified this action, which, Porto Bello like, became a popular ſubject for ſigns; and the port or harbour of Bullogne, called *Bullogne mouth*, was accordingly ſet up at a noted inn in Holborn; the name of the inn long out-living the ſign and fame of the conqueſt, an ignorant painter employed by a no leſs ignorant landlord, to paint a new one, repreſented it by a bull and a large gaping human mouth (anſwering to the vulgar pronunciation of *Bull and Mouth*). The ſame piece of hiſtory gave being to the *bull and gate*, originally meant for Bullogne gate, and repreſented by an embattled gate or entrance into a fortified town.

The *barber's pole* has been the ſubject of many conjectures: ſome conceiving it to have originated from the word *poll* or head, with ſeveral other conceits, as far-fetched and as unmeaning: but the true intention of that party coloured ſtaff was to ſhew that the maſter of the ſhop practiſed ſurgery, and could breathe a vein as well as mow a beard; ſuch a ſtaff being to this day, by every village-practitioner, put into the hand of a patient undergoing the operation of phlebotomy. The white band which encompaſſes the ſtaff, was meant to repreſent the fillet, thus elegantly twined about it.

Nor were the *chequers* (at this time a common ſign of a public-houſe) leſs expreſſive, being the repreſentation of a kind of draught-board called *tables*, and ſhowed that there that game might be played. From their colour, which was red, and the ſimilarity to a lattice, it was corruptly called the *red lettuce*, which word is frequently uſed by ancient writers to ſignify an alehouſe. The Spectator has explained the ſign of the *bell ſavage inn* plauſibly enough, in ſuppoſing it to have been originally the figure of a beautiful female found in the woods, called in French *la belle ſauvage*. But another reaſon has ſince been aſſigned for that appellation, namely, that the inn was once the property of Lady Arabella Savage, and familiarly called Bell Savage's inn, probably repreſented, as at preſent, by a bell and a ſavage or wild man, which was a rebus for her name; rebuſſes being much in faſhion in the 16th century, of which the bolt and tun is an inſtance.

The *three blue balls* prefixed to the doors and windows of pawn-brokers ſhops, by the vulgar humorouſly enough ſaid to indicate that it is two to one that the things pledged are ever redeemed, was in reality the arms of a ſet of merchants from Lombardy, who were the firſt that publickly lent money on pledges. They dwelt together in a ſtreet, from them named Lombard-ſtreet, in London, and alſo gave their name to another at Paris. The appellation of Lombard was, formerly, all over Europe, conſidered as ſynonimous to that of uſurer.

At the inſtitution of yeomen of the guards, they uſed to wait at table on all great ſolemnities, and were ranged near the buffets; this procured them the name of *buffetiers*, not very unlike in ſound to the jocular appellation of *beef-eaters*, now given them; though probably it was rather the voluntary miſnomer of ſome wicked wit, than an accidental corruption ariſing from ignorance of the French language. The opprobrious title of *bum-bayliffe*, ſo conſtantly beſtowed on the ſheriff's officers, is, according to Judge Blackſtone, only the corruption of *bound-bayliffe*, every ſheriff's officer being obliged to enter into bonds and to give ſecurity for his good behaviour, previous to his appointment. A *cordwainer* ſeems to have no relation to the occupation it is meant to expreſs, which is that of a ſhoemaker. But *cordonier*, originally ſpelt *cordaunier*, is the French word for that trade; the beſt leather uſed for ſhoes coming originally from Cordua in Spain. Spaniſh-leather ſhoes were once famous in England.

APPELLATIVE, or noun APPELLATIVE, in grammar, a common name; or a name which belongs or is applicable to things of a certain kind. Such are the names, man, angel, horſe, plant, tree, &c. Appellatives ſtand oppoſed to *proper* names, which belong only to individuals; as Peter, Gabriel, Bucephalus, &c. See the SYSTEM, Part II. Chap. III. Art. 2.

APPETITE, in medicine, is more particularly uſed to denote a natural periodical call or deſire to eat and drink, in order to repair what had been waſted by the ſeveral excretions of the body. A loſs or proſtration of appetite is called *anorexia*. The Gentian root is good in this caſe. See GENTIANA. A prepoſterous appetency of things not proper for food is called *pica*. An immoderate appetite is called *bulimia*, or *fames canina*. Some, however, diſtinguiſh between the βουλιμια and canine appetite, as the latter is attended with a lientery, or other cœliacal flux. See the Article ANOREXIA.

APPLE-*tree*, a ſpecies of the genus pyrus. For deſcription of the genus, and the ſpecies which appertain to it, ſee the article PYRUS. For the culture of apple-trees, ſee the Treatiſe on GARDENING, article Fruit-garden, months Jan. and Feb.

APPLICATION, in a general ſenſe, the act of applying one thing to another by approaching or bringing them nearer together. Motion is defined by a ſucceſſive application of any thing to different parts of ſpace. The application of a veſicatory to the neck, or other part, produces an irritation of the bladder. The true and great ſecret in phyſic, is how to apply a medicine, not how to make it.

APPLICATION, in theology, is particularly uſed, by ſome divines, for the act whereby our Saviour tranſfers, or makes over to us, what he had earned or purchaſed by his holy life and death. Accordingly it is by this application of the merits of Chriſt, that we are to be juſtified, and entitled to grace and glory. The ſacraments are the ordinary means, or inſtruments whereby this application is effected.

APPLICATION is ſometimes uſed in geometry for what, in arithmetic, we call diviſion. Application alſo ſignifies the fitting or applying one quantity to another, whoſe areas, but not figures, are the ſame. Thus Euclid ſhews how, on a right line given, to apply a parallelogram that ſhall be equal to a right-lined figure given.

APPLY, among mathematicians, ſometimes ſignifies to tranſfer a line given, into a circle, moſt commonly, or into any other figure; ſo that its ends may be in the perimeter of the figure.

APPLY denotes alſo as much as divide, eſpecially among Latin writers: who, as they ſay, *duc.* AB *in* CB, draw AB into CB, when they would have AB multiplied by CB; or rather when they would have a right-angled parallelogram made of thoſe lines; ſo they ſay, *applica* AB *ad* CB, apply AB to CB, when they would have CB divided by AB;

$$\text{which is thus expreſſed, } \frac{CB}{AB}.$$

APPREHENSION, denotes the ſimple attention of the mind to an object preſented either to our ſenſe, or our imagination, without paſſing a judgment, or making any inference. The word literally denotes the action of the hand, whereby it takes hold of, and graſps any thing; being formed of *ad*, and *prehendo*, I catch. In this ſenſe, apprehenſion differs from notion, as the act of the mind, whereby a notion is formed, differs from an act of the mind, whereby we attend to a notion already formed. Apprehenſion is likewiſe uſed to expreſs an inadequate and imperfect idea: and thus it is applied to our knowledge of God, in contradiſtinction to comprehenſion.

APPREHENSION, in law, ſignifies the ſeizing a criminal, in order to bring him to juſtice. See ARREST.

APPRENTICE, from *apprendre*, to learn, one who is bound by covenant to ſerve a tradeſman or artificer a certain time, uſually ſeven years, upon condition of the maſter's inſtructing him in his art or myſtery. Apprentices may be diſcharged on reaſonable cauſe; but if any, whoſe premium has been leſs than ten pounds, run away from their maſters, they are compellable to ſerve out the time of abſence, or give ſatisfaction for it, at any period within ſeven years after expiration of the original contract. Apprentices gain a ſettlement in that pariſh where they laſt ſerved forty days; and by the 5th of Elizabeth, c. 4. they have an excluſive right to exerciſe the trade in which they have been inſtructed, in any part of England. However, the reſolutions of the courts have in general rather confined than extended the reſtriction of this ſtatute. See Blackſtone's Com. vol. i. p. 426, &c. Anciently, benchers in the inns of court were called apprentices of the law, in Latin *apprenticii juris nobiliores*; as appears by Mr. Selden's note on Forteſcue; and ſo the learned Plowden ſtiles himſelf. Sir Henry Finch, in his *Nomotechnia*, writes himſelf, *apprentice de ley*: Sir Edward Coke, in his Inſt. ſays, *apprentici legis*, in pleading, are called, *homines conſiliarii, & in lege periti*; and in another place, apprentices and other counſellors of law.

APPRENTICESHIP, the ſervitude of an apprentice, or the duration of his indenture. Seven years ſeem anciently to have been, all over Europe, the uſual term eſtabliſhed for the duration of apprenticeſhips in the greater part of incorporated trades. All ſuch incorporations were anciently called *univerſities*; which, indeed, is the proper Latin name for any incorporation whatever. The univerſity of ſmiths, the univerſity of taylors, &c. are expreſſions which we commonly meet with in the old charters of ancient towns. When thoſe particular incorporations which are now peculiarly called *univerſities* were firſt eſtabliſhed, the term of years which it was neceſſary to ſtudy, in order to obtain the degree of maſter of arts, appear evidently to have been copied from the term of apprenticeſhip in common trades, of which the incorporations were much more ancient. As to have wrought ſeven years under a maſter properly qualified was neceſſary in order to intitle any perſon to become a maſter, and to have himſelf apprentices in a common trade; ſo to have ſtudied under a maſter properly qualified, was neceſſary to entitle him to become a maſter, teacher, or doctor, (words anciently ſynonimous), in the liberal arts, and to have ſcholars or apprentices (words likewiſe originally ſynonimous) to ſtudy under him.

In Scotland there is no general law which regulates univerſally the duration of apprenticeſhips. The term is different in different corporations. Where it is long, a part of it may generally be redeemed by paying a ſmall fine. In moſt towns too, a very ſmall fine is ſufficient to purchaſe the freedom of any corporation. The weavers of linen and hempen cloth, the principal manufactures of the country, as well as all other artificers ſubſervient to them, wheelmakers, reelmakers, &c. may exerciſe their trades in any town corporate without paying any

any fine. In all towns corporate, all perſons are free to ſell butcher's meat upon any lawful day of the week. Three years is in Scotland a common term of apprenticeſhip, even in ſome very nice trades; and in general there is no country in Europe in which corporation laws are ſo little oppreſſive.

APPROACH, in gardening, is uſed in ſpeaking of the method of inarching or innoculating, which is called grafting by approach. For the ſeveral methods of grafting, ſee the TREATISE, month of February.

APPROACHES, in fortification, the ſeveral works made by the beſiegers for advancing or getting nearer to a fortreſs, or place beſieged. Such are trenches, mines, ſaps, lodgments, batteries, galleries, epaulments, &c. See the Article WAR.

APPROACHING, in fowling, a term uſed to expreſs ſuch devices as are contrived for the getting within ſhot of ſhy birds. It is principally uſed in marſhy low places. The beſt method of approaching is by means of three hoops, tied together at proper diſtances, according to the height of the man that is to uſe it, and having boughs of trees tied all round it, with cords to hang it over his ſhoulders; a man getting into this, conceals himſelf, and approaches by degrees towards his game in the form of a moving buſh. Geeſe, ducks, and teal, quit the waters in the evening, and paſs the night in the fields, but at the approach of morning they return to the water again, and even when on the water they will retire to great diſtances, on the approach even of a horſe or cow, ſo that the buſineſs of the ſtalking horſe is of little uſe; but this device of approaching by the moving buſh, ſucceeds tolerably well with them.

APPROPRIATE, in law, is underſtood of a church or benefice, the patronage whereof is annexed to ſome church-dignitary, who appoints a vicar to ſerve the cure; the patron receiving the chief produce of it. There are computed to be in England 3845 churches appropriate and impropriate.

APPROPRIATION, in the canon law, a ſevering of a benefice eccleſiaſtical to the proper and perpetual uſe of ſome religious houſe. The contrivance of appropriations ſeems to have ſprung from the policy of the monaſtic orders, who have never been deficient in ſubtile inventions for the increaſe of their own power and emoluments. At the firſt eſtabliſhment of parochial clergy, the tithes of the pariſh were diſtributed in a fourfold diviſion; one for the uſe of the biſhop, another for maintaining the fabric of the church, a third for the poor, and the fourth to provide for the incumbent. When the fees of the biſhops became otherwiſe amply endowed, they were prohibited from demanding their uſual ſhare of theſe tithes, and the diviſion was into three parts only. And hence it was inferred by the monaſteries, that a ſmall part was ſufficient for the officiating prieſt; and that the remainder might well be applied to the uſe of their own fraternities (the endowment of which was conſtrued to be a work of the moſt exalted piety), ſubject to the burden of repairing the church and providing for its conſtant ſupply. And therefore they begged and bought, for maſſes and obits, and ſometimes even for money, all the advowſons within their reach, and then appropriated the benefices to the uſe of their own corporation. But, in order to complete ſuch appropriation effectually, the king's licence, and conſent of the biſhop, muſt be firſt obtained; becauſe both the king and the biſhop may ſome time or other have an intereſt, by lapſe, in the preſentation to the benefice; which can never happen if it be appropriated to the uſe of a corporation, which never dies: and alſo becauſe the law repoſes a confidence in them, that they will not conſent to any thing that ſhall be to the prejudice of the church. The conſent of the patron alſo is neceſſarily implied, becauſe the appropriation can be originally made to none but to ſuch ſpiritual corporation as is alſo the patron of the church; the whole being indeed nothing elſe but an allowance for the patrons to retain the tithes and glebe in their own hands, without preſenting any clerk, they themſelves undertaking to provide for the ſervice of the church. When the appropriation is thus made, the appropriators and their ſucceſſors are perpetual parſons of the church; and muſt ſue and be ſued, in all matters concerning the rights of the church, by the name of *parſons*.

This appropriation may be ſevered, and the church become diſappropriate, two ways; as, firſt, if the patron or appropriator preſents a clerk, who is inſtituted and inducted to the parſonage: for the incumbent ſo inſtituted and inducted is to all intents and purpoſes complete parſon; and the appropriation being once ſevered, can never be re-united again, unleſs by a repetition of the ſame ſolemnities. And, when the clerk ſo preſented is diſtinct from the vicar, the rectory thus veſted in him becomes what is called a *fine-cure*; becauſe he hath no care of ſouls, having a vicar under him to whom that cure is committed. Alſo, if the corporation which has the appropriation is diſſolved, the parſonage becomes diſappropriate at common law: becauſe the perpetuity of perſon is gone, which is neceſſary to ſupport the appropriation. In this manner, and ſubject to theſe conditions, may appropriations be made at this day: and thus were moſt if not all of the appropriations at preſent exiſting originally made; being annexed to biſhoprics, prebends, religious houſes, nay, even to nunneries, and certain military orders, all of which were ſpiritual corporations. At the diſſolution of monaſteries, by ſtatutes 27 Hen. VIII. c. 28. and 31 Hen. VIII. c. 13. the appropriations of ſeveral parſonages which belonged to thoſe reſpective religious houſes, amounting to more than one third of all the pariſhes in England, would have been by the rules of the common law diſappropriated; had not a clauſe in thoſe ſtatutes intervened, to give them to the king in as ample a manner as the abbots, &c. formerly held the ſame at the time of their diſſolution. This though perhaps ſcarcely defenſible, was not without example: for the ſame was done in former reigns, when the alien priores (that is, ſuch as were filled by foreigners only) were diſſolved and given to the crown. And from theſe two roots have ſprung all the lay-appropriations or ſecular parſonages which we now ſee in the kingdom; they having been afterwards granted out from time to time by the crown.

Appropriation is where the advowſon of a parſonage is given or belongs to any biſhopric, religious houſe, college, &c. and to their ſucceſſors; ſo that the houſe or body is both patron and parſon, and ſome one of the members officiates as vicar.

It is called appropriation, becauſe the profits of the living are appropriated to the uſe of the patrons; ſo that parſons, though they are not ordinarily accounted *domini uſufructuarii*, having no right of fee-ſimple; yet, by reaſon of the perpetuity of their ſucceſſion, are here reputed owners of the fee-ſimple, and are therefore called *proprietarii*. See the Article PARSON. To make an appropriation after licenſe obtained of the king in chancery, the conſent of the diocеſan, patron, and incumbent, is neceſſary, if the church be full; if it be void, the diocеſan and the patron, upon the king's licenſe, may conclude it. To diſſolve an appropriation, it is enough to preſent a clerk to the biſhop, and for him to inſtitute and induct him: for, that once done, the benefice returns to its former nature. This is called diſappropriation.

APPROXIMATION, in arithmetic and algebra, a continual approach ſtill nearer and nearer to a root or quantity ſought, without a poſſibility of ever arriving at it exactly. It is evident, that if a number propoſed be not a true ſquare, it is in vain to hope for a juſt quadratic root thereof, expliceable by rational numbers, integers, or fractions; whence in ſuch caſes, we muſt content ourſelves with approximations, ſomewhat near the truth, without pretending to accuracy: and ſo for the cubic root, of what is not a perfect cube; and the like for ſuperior powers. For the method of extracting the root of an Equation by approximation, ſee the Syſtem of ALGEBRA. Sect. V. Art. 16.

APPULSE, from *ad*, and *pulſo*, *I act on*, in a general ſenſe, a thing's being brought to, or in contact with another. Articulation is either by appulſe, i. e. when one of the moveable organs touches and reſts on ſome of thoſe which are immoveable; or without appulſe, only by inclination of the moveable organ to the immoveable.

APPULSE, in aſtronomy, the approach of any planet to a conjunction with the ſun, or a ſtar. It is a ſtep toward a tranſit, occultation, conjunction, eclipſe, &c. Mr. Flamſtead, M. de la Hire, and others, have given obſervations of the moon's appulſes to the Pleiades. Phil. Tranſ. No. 76. p. 361. M. Acad. Scienc. an. 1708.

APRICOT, a ſpecies of the genus prunus. For deſcription of the genus, and the ſpecies which appertain to it, ſee the Article PRUNUS. For the culture of apricots, ſee the Treatiſe on GARDENING, Months January, March, May, and July. For the method of making Apricot water, ſee the Article WATER.

APRIL, the fourth month of the year, according to the common computation; but the ſecond, according to that of the aſtronomers. The word is derived from *Aprilis*, of *aperio*, *I open*; becauſe the earth, in this month, begins to open her boſom for the production of vegetables. In this month the ſun travels through the ſign Taurus.

APSIS, in aſtronomy, is applied to two points in the orbits of planets, wherein they are at the greateſt, and the leaſt, diſtance from the ſun, or earth. The higher apſis is more particularly denominated the aphelion, or apogee; the lower, the perihelion, or perigee. See the SYSTEM, Sect. VII.

APTERA, from *a* and πτερον, wing, in the ſyſtem of Entomology, an order comprehending all thoſe inſects which have no wings. For the characters and claſſification, ſee the SYSTEM, Order 7.

APUS, AVIS INDICUS, in aſtronomy, a conſtellation of the ſouthern hemiſphere placed near the pole, between the triangulum auſtrale and the chameleon, ſuppoſed to repreſent the bird of paradiſe. The apus, is ſuppoſed one of thoſe birds called apodes, as having no feet. See the SYSTEM, Sect. VIII. Plate 6. Fig. 2.

APYROUS, a word applied to denote that property of ſome bodies, by which they reſiſt the moſt violent fire without any ſenſible alteration. Apyrous bodies ought to be diſtinguiſhed from thoſe which are refractory. Refractory ſubſtances are thoſe which cannot by violent heat be fuſed, whatever other alteration they may ſuſtain. But a body, properly ſpeaking, apyrous, can neither be fuſed by heat, nor can undergo any

any other change. Diamonds were long thought to be poſſeſſed of this property. But ſome late experiments have ſhown, that diamonds may be intirely diſſipated or evaporated by heat, and are therefore not intitled to be ranked among apyrous ſubſtances. Perhaps there is no body in nature eſſentially and rigorouſly apyrous. But it is ſufficient that there be bodies apyrous relatively to the degree of fire which art can produce, to intitle them to that name.

AQUA, a term frequently met with in the writings of phyſicians, chymiſts, &c. for certain medicines, or menſtruums, in a liquid form, diſtinguiſhed from each other by peculiar epithets, as *aqua alexiteria*, *aqua aluminoſa*, *aqua mirabilis*, &c.

AQUA *fortis*, a name given by artiſts to nitrous acid of a certain ſtrength, from its diſſolving power: that which is concentrated and ſmoking, is called *ſpirits of nitre*. The aqua-fortis uſed by dyers, braſs-founders, &c. is not only weaker than ſpirit of nitre, but contains a portion of vitriolic acid. It may be made by diſtilling crude nitre with calcined vitriol, equal parts. The nitrous acid, expelled by the vitriolic, will riſe in red fumes, and paſs into the receiver. The vitriolic acid, uniting with the alkaline baſis of the nitre, forms vitriolated tartar; but, there being more vitriolic acid than is requiſite to ſaturate the alkali, the ſurplus riſes with the nitrous acid; aqua-fortis, therefore, is a mixture of theſe two acids. It may alſo be made by diſtilling crude nitre with ſomewhat more than half its weight of oil of vitriol; or by mixing one part of oil of vitriol with nine parts pure ſpirits of nitre. For a further account, ſee the Syſtem of CHYMISTRY, Part I. Chap. V. Sect. III.

AQUA *mercurialis*, a preparation of aqua regia, and ſublimate of mercury, with a little mercury, placed in a ſand-heat, till the ſolution of the mercury be made. It is a mark of perfection of the aqua mercurialis, if it turn a piece of copper caſt into it, of a ſilver colour. It is by this water that the alchemiſts pretend all metalline bodies may be reduced to their firſt matter, or mercury.

AQUA *regia*, a compound of nitrous and marine acid, in different proportions according to the purpoſe for which it is intended. It is uſually made by diſſolving, in nitrous acid, ſal ammoniac, or common *ſalt*, both which are combinations of marine acid with alkali. When made with ſal ammoniac, the common proportion is one part of this ſalt to four parts of nitrous acid; but to diſſolve platina, equal parts are requiſite. A purer aqua regia may be made by ſimply mixing the two acids.

Aqua regia is particularly uſed as a menſtruum for gold: it likewiſe diſſolves all other metals, except ſilver. The gold diſſolved in aqua regia is, in fact, diſſolved in the dephlogiſticated marine acid only, which, being deprived of its phlogiſton by the nitrous acid, recovers it from the gold, and thus renders gold ſoluble; for metals are not ſoluble in acids until they loſe a part of their phlogiſton. For a further account, ſee the Syſtem of CHYMISTRY, Part I. Chap. V. Sect. V.

AQUA *Vitæ*, is commonly underſtood of what is otherwiſe called *brandy* or ſpirit of wine, either ſimple or prepared with aromatics. Some, however, diſtinguiſh between them; appropriating the term *brandy*, to what is drawn from wine, or the grape; and *aqua vitæ* to that drawn after the ſame manner, from malt, &c. See the Article BRANDY, and Treatiſe on DISTILLATION.

AQUÆDUCT, in hydraulics and architecture, a ſtructure formed for conveying water from one place to another, over grounds that are unequal. The word is compounded of the Latin ſubſtantive *aqua* water, and *ductus* a channel by which that water may be conducted. Aquæducts of every kind were long ago the wonders of Rome; the vaſt quantity of them which they had; the prodigious expence employed in conducting waters over arcades from one place to another, at the diſtance of 30, 40, 60, and even 100 miles, which were either continued or ſupplied by other labours, as by cutting mountains and piercing rocks; all this ought to ſurpriſe us: nothing like this is undertaken in our times; we dare not even think of purchaſing public conveniency at ſo dear a rate. Appias the cenſor adviſed and conſtructed the firſt aquæduct. His example gave the public luxury a hint to cultivate theſe objects; and the force of prodigious and indefatigable labour diverted the courſe of rivers and floods to Rome. Agrippa, in that year when he was ædile, put the laſt hand to the magnificence of theſe works. It is chiefly in this reſpect that the modern ſo much reſembles the ancient city of Rome. For this advantage, ſhe is peculiarly indebted to Sextus V. and to Paul V. who for grandeur and magnificence emulated the maſters of the univerſe. There are ſtill to be ſeen, in different places contiguous to Rome, ſtriking remains of theſe aquæducts; arches continued through a long ſpace, over which were extended the canals which carried the water to the city. The *aquæduct* which Lewis XIV. cauſed to be built near Maintenon, for carrying water from the river Bieque to Verſailles, is the greateſt aquæduct which now ſubſiſts in the world; it is 7666 fathoms in length, above 2586 in height, and contains 242 arcades.

The neceſſity of making aquæducts at an enormous expence of money, time and labour, is now totally precluded by the great improvements made in hydroſtatics and hydraulics; a method having been diſcovered of conveying fluids, by their preſſure, over hills and vallies, in bended pipes to any height not greater than the level of the ſprings whence they flow. See the SYSTEM of Hydroſtatics and Hydraulics, Part II. Art. 1. and Plate I. Fig. 11.

AQUARIUS, in aſtronomy, the eleventh ſign in the zodiac, reckoning from Aries; from which alſo the eleventh part of the ecliptic takes its name. The ſun moves through aquarius in the month of January; it is marked thus, ♒. See the SYSTEM, Sect. IX. and the Plate annexed to the Treatiſe on the Globes, Fig. 3 and 4.

AQUATINTA, a method of etching on copper, lately invented, by which a ſoft and beautiful effect is produced, reſembling a fine drawing in water-colours or Indian ink.

Previous to the operation upon the plate, the following powder muſt be prepared.—Take of alphaltum and fine tranſparent roſin, equal parts, ſuppoſe two ounces of each, and pound them ſeparately. Through a muſlin ſieve (which may be formed with part of a chip-box of three or four inches diameter) ſift upon a ſheet of paper a thin ſtratum of the alphaltum, above which ſift a ſimilar layer of the roſin, and upon this another layer of alphaltum, continuing theſe alternate layers till both of the powders are exhauſted: then paſs the mixture through the ſame ſieve upon the paper once or twice, or till both appear to be ſufficiently incorporated, when the powder is ready for uſe. Some, inſtead of the above mixture, uſe gum ſandarach pounded. The main proceſs is as follows.—A copper plate being poliſhed in the uſual way, lay the etching ground upon it, and etch the outlines of your deſign in the manner directed under the article ETCHING: The ground is then to be ſoftened with a little greaſe, and wiped off with a rag; leaving, however, as much greaſe upon the plate as juſt to dim the copper. You now ſift your powder upon the ſurface of the plate; after which, ſtrike the other ſide of it pretty ſmartly againſt the edge of the table, in order to diſcharge it of the looſe powder: This done, with a hand-vice hold the back of the plate over a chaffing-diſh of charcoal fire, till it becomes ſo hot as to give pain upon being touched with the back of the hand; and the powder which adhered to the greaſe will now be fixed to the plate. The plate being then ſuffered to cool, take turpentine varniſh mixed with ivory black, and with a hair pencil dipt into it, cover all the lights or places where there is no work or ſhades. A rim or border of bees-wax is now to be raiſed round the plate: Then having reduced the aquafortis to a proper ſtrength by vinegar or water, you pour it on, and let it ſtand five minutes for the firſt or lighteſt ſhade: after which, pour it off; and having waſhed the plate with water, ſet it on edge to dry; then with the varniſh ſtop up your light ſhades, pour on the aquafortis for the ſecond tint, and let it ſtand five minutes more; proceeding in the ſame manner for every tint till you produce the darkeſt ſhades. If a bold open ground is wanted in any part, this requires an after-operation: The ground muſt be laid as the other, by ſifting on the powder; only this powder is much coarſer, and the plate muſt be much more heated in order that the particles of the powder may ſpread, and form ſmall circles: even good clean roſin will do by itſelf.

In etching landſkips, the ſky and diſtant objects are alſo performed by a ſecond operation, and the powder is ſifted upon the plate with a finer ſieve. If the trees or any part of the fore-ground require to be higher finiſhed, the plate muſt be entirely cleanſed from greaſe with bread, and a ground laid in the common way of etching; when you may finiſh as highly and as neatly as you pleaſe with the needle or point, by ſtippling with dots, and biting up thoſe parts, or by a rolling-wheel.

The preceding is the method for prints of one ſingle tint. But if different colours are to be expreſſed, there will be required as many different plates, each plate having only the part etched upon it which is deſigned to be charged with its proper colour: unleſs (as may happen in particular ſubjects) ſome of the colours are ſo diſtant from each other as to allow the printer room to fill them in with his rubber without blending them; in which caſe, two or more different colours may be printed from the ſame plate at once.—Where different plates are neceſſary, a ſeparate one, having a pin in each corner, muſt be provided as a ſole or bottom to the aquatinta plates; and theſe again muſt be exactly fitted, having each a ſmall hole in their corners for paſſing over the pins of the ſole: the ſaid pins ſerving the double purpoſe of retaining the plates ſucceſſively in their due poſition, and of directing the printer in placing the paper exactly on each plate ſo as not to ſhift; by which means each tint or colour will be received on its proper place.—This is the method practiſed at Paris. A landſcape or ſimilar ſubject, however, may be printed off at once in the different proper colours, by painting theſe upon the plate. In this caſe, the colours muſt be pretty thick in their conſiſtence; and the plate muſt be carefully wiped in the uſual way after the laying on of each tint, as well as receive a general wipe upon its being charged with all the tints.

This art is kept as ſecret as poſſible by thoſe who practiſe it; and

and it is believed that no particular explanation or directions, before the present, have been communicated to the public. In order to ſucceed, however, great care and judgement are requiſite; and much depends upon a certain nicety of management, which is only attainable by practice.

AQUEOUS, Aqueous, ſomething that partakes of the nature of water, or abounds therewith; thus milk is ſaid to conſiſt of an aqueous or ſerous, and a butyrous part. The chemiſts ſeparate the aqueous part or phlegm from all bodies by diſtillation.

Aqueous *humour*, is the firſt or outermoſt, and the rareſt of the three humours of the eye. It lies immediately above the tunica aranea and ciliary ligament, and under the cornea, which it cauſes to protuberate a little; and is ſuppoſed to be furniſhed by certain ducts provided for the purpoſe. See the ſyſtem of Anatomy, Part VII. Sect. 5. It is found ſo ſpirituous, that it will not freeze in the ſevereſt froſt.

Anatomiſts are divided about the origin and conveyance of this humour.—It is certain the ſource muſt be pretty plentiful, inaſmuch as, if by any accident the coats it is contained in be wounded, ſo that the humour runs out, and the cornea collapſes, the wound readily heals, by only cloſing the eye, and the humour recruits; of which we have numerous inſtances among phyſicians. Dr. Nuck thinks he has diſcovered the ducts in the ſclerotica, whereby this humour is furniſhed. Others, denying the reality of thoſe ducts, ſuppoſe it immediately derived from the arteries. Dr. Drake admits the ducts, and takes them to be only branches of the excretory ducts of the glandula innominata, and lachrymalis; which piercing the tunics of the eye, deliver their liquor by ways hitherto unknown. Mr. Warner obſerves that this humour is ſecreted by the extremities of the moſt minute lymphatic arteries of the iris; and that a proper quantity of it is received, and occaſionally returned again, into the larger veins, and courſe of general circulation, by means of minute lymphatic, or abſorbent veins, correſponding to thoſe arteries.

AQUILA, in aſtronomy, a conſtellation of the northern hemiſphere; uſually joined with Antinous. The ſtars in the conſtellation Aquila and Antinous, in Ptolemy's catalogue, are 15; in Tycho's, 19; in Hevelius's, 42; in the Britannic catalogue, 71. See the System, Sect. VIII. and Plate VI.

ARA *thuribuli*, the *altar of incenſe*, in aſtronomy, a ſouthern conſtellation, not viſible in our hemiſphere, conſiſting, according to Ptolemy, of ſeven ſtars, and according to Sharp's catalogue annexed to that of Mr. Flamſtead, of nine ſtars. See the System, Sect. VIII. and Plate VI.

ARABIC, or Arabian, ſomething that relates to Arabia, or the Arabs.

Arabic figures or characters, are the numeral characters commonly made uſe of in arithmetical computations. The arabic characters ſtand contradiſtinguiſhed to the Roman. The learned are generally of opinion, that the arabic figures were firſt taught us by the Saracens, who borrowed them from the Indians.—Scaliger was ſo ſatisfied of their novelty, that he immediately pronounced a ſilver medallion, he was conſulted about, to be modern, upon his being told that the numeral figures 234, 235, were upon it. The common opinion is, that Planudes, who lived towards the cloſe of the 13th century, was the firſt Chriſtian who made uſe of them. Father Mabillon even aſſures us, in his work *de Re Diplomatica*, that he has not found them any where earlier than the fourteenth century. Yet Dr. Wallis inſiſts on their being of a much older ſtanding; and concludes they muſt have been uſed in England, at leaſt as long ago as the time of Hermannus Contractus, who lived about the year 1050, if not in ordinary affairs, yet at leaſt in mathematical ones, and particularly in the aſtronomical tables. Vide Wall. Algebr. c. 4. The ſame author gives us an inſtance of their antiquity in England, from a mantle-tree of a chimney, in the parſonage-houſe of Helmdon in Northamptonſhire, wherein is the following inſcription in *baſſo relievo*, No. 1133, being the date of the year 1133. Philoſ. Tranſact. No. 154. Mr. Luffkin furniſhes a yet earlier inſtance of their uſe in the window of a houſe, part of which is a Roman wall, near the market place in Colcheſter; where, between two carved lions, ſtands an eſcutcheon, containing the figures 1090. Philoſ. Tranſact. No. 255. Mr. Huet is even of opinion, that theſe characters were not borrowed from the Arabs, but from the Greeks; and that they were originally no other than the Greek letters which we all know that people made uſe of to expreſs their numbers by.

Arabic, or Arabian learning, is divided into two ſtates, or periods, viz. Ante-Mahometan, and Mahometan. The Arab learning in this firſt period, conſiſted, according to Abulpharagius, in the knowledge of their language, the propriety of diſcourſe, the compoſition of verſe, and the ſcience of the ſtars: but their chief attention ſeems to have been directed to oratory and poetry. Hiſt. Dynaſt. Renaudot de Barbar. Ariſt. verſ. Fabricii Bibl. Græca, lib. vi. cap. 5. § 6. The ſecond period is more diſtinguiſhed, at leaſt from the time of Al Mamon, the ſeventh caliph of the family of the Abaſſides, who flouriſhed about the year 820, and has the honour of being the founder of the modern Arabian learning. He ſent for all the beſt books out of Chaldea, Greece, Egypt, and Perſia, relating to phyſic, aſtronomy, coſmography, muſic, chronology, &c. and penſioned a number of learned men, ſkilled in the ſeveral languages and ſciences, to tranſlate them into arabic. By this means, divers of the Greek authors, loſt in their own country and language, have been preſerved in arabic. Elmac. Hiſt. Sar. lib. ii. cap. 8. Leo Africanus de Viris illuſt. ap. Arabes, cap. 1. Fabricii Bib. Græc. lib. vi. cap 9. Gravii in Præf. ad Tab. Geog. Voſſ. de Sect. Phil. cap. 3. § 17. From that time Arabia became the chief ſeat of learning; and we find mention by Abulpharagius, Pococke, D'Herbelot, and Hottinger, of learned men, and books without number. The revival of learning in the tenth century, by Gerbert, known after his elevation to the pontificate by the title of Silveſter II. and afterwards among the Europeans in general, may be aſcribed to the inſtructions and writings of the Arabian doctors and philoſophers, and to the ſchools which they founded in ſeveral parts of Spain and Italy. And in the twelfth century, the inquiſitive of different countries frequented the ſchools of the Saracens in Spain, and diſſeminated the knowledge which they obtained there after their return. At this time, many of the learned productions of the Arabians were tranſlated into Latin, which facilitated the general progreſs of ſcience.

Arabic, or Arabian *philoſophy*, before Mahomet was Sabian, and included the ſyſtem and ceremonies of that ſect of idolaters. This it was that Mahomet ſet himſelf to decry; and he is even ſaid by ſome, to have carried his oppoſition ſo far as prohibit, if not puniſh, all ſtudy of philoſophy. But his followers, by degrees got over this reſtraint; the love of learning increaſed; till, under the memorable caliphate of Al Mamon, Ariſtotle's philoſophy was introduced and eſtabliſhed among them; and from them propagated, with their conqueſts, through Egypt, Africa, Spain, and other parts. As they choſe Ariſtotle for their maſter, they chiefly applied themſelves to that part of philoſophy called logic, and thus became proficients in the knowledge of words, rather than things. Whence they have been ſometimes denominated, *Maſters of the wiſdom of words*; ſometimes the *Talking Sect*. Their philoſophy was involved in quaint arbitrary terms and notions, and their demonſtrations drawn from thence, as from certain principles, &c. Walch Hiſt. Logic. lib. ii. ſec. 2. § 1.

ARAC, or Arrac, a ſpirituous liquor, imported from the Eaſt-Indies; chiefly uſed by way of a dram, and in punch. Arac or arrac, is a vinous ſpirit obtained by diſtillation, in the Eaſt-Indies, from rice or ſugar, fermented with the juice of cocoa nuts. The Goa arac is made from the toddy, the Batavia arac from rice and ſugar. There is likewiſe a kind of ſhrub from which arac is made. Goa and Batavia are the chief places for arac.—At Goa, there are divers kinds: ſingle, double, and treble diſtilled. The double diſtilled, which is that commonly ſent abroad, is but a weak ſpirit in compariſon with Batavia arac; yet on account of its peculiar and agreeable flavour, is preferred to all the other aracs of India. This is attributed to the earthen veſſels which they uſe at Goa to draw the ſpirit; whereas at Batavia they uſe copper ſtills.

ARACHNOIDES, in anatomy, a fine, thin, tranſparent membrane, which lying between the dura and pia mater, is ſuppoſed to inveſt the whole ſubſtance of the brain, medulla oblongata, and the ſpinal marrow. The word is borrowed from ἀραχνη, *a ſpider*, or *ſpider's web*, and εἰδος, form; in regard to the fineneſs of the part, which is ſuppoſed to reſemble that of a ſpider's web. See the System, Part VI. Sect. 1.

Arachnoides, or Aranea *tunica*, is likewiſe uſed for a fine ſlender tunic, wherewith the chryſtalline humour is encompaſſed. This is called by others cryſtalloides, and tunica cryſtallina, or capſula cryſtallina. See the System, Part VII. Sect. 5.

ARÆOMETER, Aræometrum, an inſtrument wherewith to meaſure the denſity or gravity of fluids. The word is formed of ἀραιος, *thin*, and μετρον, *meaſure*. The aræometer, or water-poiſe, is uſually made of glaſs; conſiſting of a round hollow ball, which terminates in a long ſlender neck, hermetically ſealed at top; there being firſt as much running mercury put into it, as will ſerve to balance or keep it ſwimming in an erect poſition.

ARANEA, the Spider. A genus of inſects belonging to the order of Aptera, or inſects without wings. See the Syſtem of Entomology, Sect. IV. Order 7. All the ſpecies of ſpiders have eight legs, with three joints in each, and terminating in three crooked claws; eight eyes, two before, two behind, and the reſt on the ſides of the head. In the fore-part of the head, at the mouth, there is a pair of ſharp crooked claws or forceps: theſe ſtand horizontally; and, when not exerted for uſe, are concealed in two caſes contrived for their reception, in which they fold like a claſp-knife, and there lie between two rows of teeth. Theſe claws are the weapons with which they kill flies, &c. for their food. The belly or hinder part is ſeparated from the head and breaſt by a ſmall thread-like tube. The ſkin or outer ſurface is a hard poliſhed cruſt. Spiders have five tubercles or nipples at the extremity of the belly, whoſe apertures they can enlarge or contract at pleaſure. It is through theſe apertures that they ſpin a gluey ſubſtance with which their bellies are full. They fix the end of their threads by applying theſe nipples to any ſubſtance, and the

thread lengthens in proportion as the animal recedes from it. They can ſtop the iſſuing of the threads by contracting the nipples, and re-aſcend by means of the claws on their feet, much in the ſame manner as ſome men warp up a rope. When the common houſe-ſpider begins her web, ſhe generally chooſes a place where there is a cavity, ſuch as the corner of a room, that ſhe may have a free paſſage on each ſide, to make her eſcape in caſe of danger. Then ſhe fixes one end of her thread to the wall, and paſſes on to the other ſide, ſpinning the thread out of theſe nipples as ſhe proceeds, till ſhe arrives at the other ſide, and there fixes the other end of it. Thus ſhe paſſes and repaſſes, till ſhe has made as many parallel threads as ſhe thinks neceſſary for her purpoſe. After this, ſhe begins again and croſſes theſe by other parallel threads, which may be named the *woof*. Theſe are the toils or ſnares which ſhe prepares for entangling flies, and other ſmall inſects, which happen to light upon it. But, beſides this large web, ſhe generally weaves a ſmall cell for herſelf, where ſhe lies concealed watching for her prey. Betwixt this cell and the large web, ſhe has a bridge of threads, which, by communicating with the threads of the large one, both give her early intelligence when any thing touches the web, and enable her to paſs quickly in order to lay hold of it. There are many other methods of weaving peculiar to different ſpecies of ſpiders; but as they are all intended for the ſame purpoſe, it is needleſs to give particular deſcriptions of them.

That darting-out of long threads, however, which has been obſerved by naturaliſts, and by means of which ſome ſpecies can convey themſelves to great diſtances, deſerves particular notice. Dr. Liſter tells us, that attending cloſely to a ſpider weaving a net, he obſerved it ſuddenly to deſiſt in the midwork; and turning its tail to the wind, it darted out a thread with the violence and ſtream we ſee water ſpout out of a jet: this thread, taken up by the wind, was immediately carried to ſome fathoms long, ſtill iſſuing out of the belly of the animal. By-and-by the ſpider leaped into the air, and the thread mounted her up ſwiftly. After this diſcovery, he made the like obſervation in near thirty different ſorts of ſpiders; and found the air filled with young and old, ſailing on their threads, and doubtleſs ſeizing gnats and other inſects in their paſſage, there being often manifeſt ſigns of ſlaughter, legs and wings of flies, &c. on theſe threads, as well as in their webs below. Dr. Huſſe diſcovered the ſame thing about the ſame time.

To fly they cannot ſtrictly be ſaid, as they are carried into the air by external force: but they can, in caſe the wind ſuffer them, ſteer their courſe, and perhaps mount and deſcend at pleaſure: and to the purpoſe of rowing themſelves along the air, it is obſervable that they ever take their flight backwards; that is, their head looking a contrary way, like a ſculler upon the Thames. It is ſcarce credible to what height they will mount; which yet is preciſely true, and a thing eaſily to be obſerved by one that ſhall fix his eye ſome time on any part of the heavens, the white webs, at a vaſt diſtance, very diſtinctly appearing from the azure ſky: but this is in autumn only, and that in very fair and calm weather. In a letter to Mr. Ray, dated January 1670, ſpeaking of the height ſpiders are able to fly to, Dr. Liſter ſays, "Laſt October, &c. I took notice that the air was very full of webs: I forthwith mounted to the top of the higheſt ſteeple on the Miniſter (in York), and could there diſcern them yet exceeding high above me." He further obſerves, that they not only thus ſhoot their threads upward, and mount with it in a line almoſt perpendicular; they alſo project them in a line parallel to the horizon, as may be ſeen by their threads running from one wall to another in a houſe, or from one tree to another in a field, and even from wall to wall acroſs gardens of conſiderable extent.

The matter of which the ſpider's threads are formed, we have obſerved, is a viſcid juice, elaborated in the body of the animal, and emitted from papillæ ſituated at the extremity of the belly; which papillæ are furniſhed with numerous apertures that do the buſineſs of wire-drawers, as it were, in forming the threads. Of theſe apertures Mr. Reaumur obſerves, there are enough in the compaſs of the ſmalleſt pin's head to yield a prodigious number of diſtinct threads. The holes are perceived by their effects: take a large garden-ſpider ready to lay its eggs, and apply the finger on a part of its papillæ; as you withdraw that finger it will take with it an amazing number of different threads. Mr. Reaumur has often counted 70 or 80 with a microſcope, but has perceived that there were infinitely more than he could tell. In effect, if he ſhould ſay that each tip of a papilla furniſhed a thouſand, he is perſuaded he would ſay much too little. The part is divided into an infinity of little prominences, like the eyes of a butterfly, &c. Each prominence no doubt makes its ſeveral threads; or rather between the ſeveral protuberances there are holes that give vent to threads; the uſe of the protuberances, in all probability, being to keep the threads at their firſt exit, before they are yet hardened by the air, aſunder. In ſome ſpiders thoſe protuberances are not ſo ſenſible; but in lieu thereof there are tufts of hair which may ſerve the ſame office, viz. to keep the threads a-part. Be this as it will, there may threads come out at above a thouſand different places in every papilla; conſequently the ſpider having five papillæ, has holes for above five thouſand threads.

Such is the tenuity of the threads in the larger ſort of ſpiders. But if we examine the young produced by thoſe, we ſhall find that they no ſooner quit their egg than they begin to ſpin. Indeed their threads can ſcarce be perceived, but the webs may: they are frequently as thick and cloſe as thoſe of houſe-ſpiders; and no wonder, there being often four or five hundred little ſpiders concurring to the ſame work. How minute muſt their holes be? the imagination can ſcarce conceive that of their papillæ! The whole ſpider is perhaps leſs than a papilla of the parent which produced it. But there are even ſome kinds of ſpiders ſo ſmall at their birth, that they are not viſible without a microſcope. There are uſually found an infinity of theſe in a cluſter, and they only appear like a number of red points: And yet there are webs found under them, though well nigh imperceptible. What muſt be the tenuity of one of theſe threads? Mr. Leewenhoek has computed that 100 of the ſingle threads of a full grown ſpider are not equal to the diameter of the hair of his beard; and conſequently, if the threads and hair be both round, ten thouſand ſuch threads are not bigger than ſuch a hair. He calculates further, that when young ſpiders firſt begin to ſpin, four hundred of them are not larger than one which is of a full growth; allowing which, four millions of a young ſpider's threads are not ſo big as the ſingle hair of a man's beard.

The act of generation among ſpiders varies in different ſpecies. As theſe inſects prey upon each other, except during the time of their amours, they dare not come within reach of one another but with the utmoſt caution. They may ſometimes be ſeen ſtretching out their legs, ſhaking the web, and tampering with each other by a ſlight touch with the extremity of their feet; then, as in a fright, dropping haſtily down their thread, and returning in a few moments to make freſh trial by feeling. When once both parties are well aſſured of the ſex they have to deal with, the approaches of their feet, in order to feel, become more frequent, confidence takes place, and the inſtant of amorous dalliance enſues. "We cannot," ſays, Lyonnet, "but admire how careful they are not to give themſelves up blindly to a paſſion, or venture on an imprudent ſtep which might become fatal to them." A caveat this to the human kind. Liſter and Lyonnet, two accurate obſervers, ſay, that the extremity of thoſe arms, or claws, which the ſpider uſes to graſp his prey with, ſuddenly opens, as it were by a ſpring, and lets out a white body, which the male applies beneath the abdomen of the female to fulfil the wiſh of nature. In the water-ſpider, the ſexual organs are ſituated at the hinder parts of the male, are curve, and act as it were by a ſpring; thoſe of the females are diſtinct. Nature by a thouſand varied methods accompliſhes her purpoſe.

Spiders frequently change their colour, which varies much, in reſpect to ſeaſon, ſex, age, &c. but they are in general more beautifully variegated in autumn; a ſeaſon not only the moſt opportune and plentiful reſpecting their prey, but the time when they arrive at their greateſt magnitude, and are in their height of vigour. The ſpecies of aranea enumerated by naturaliſts amount to upwards of 50; of which it may here ſuffice to mention a few of the moſt remarkable.

The Diadema is the largeſt ſpider which this country produces. The abdomen is of an oval form, downy, and of a ruddy yellow colour, which is very variable in different ſeaſons; being ſometimes paler, at others very dark coloured. The upper part is beautifully adorned with black and white circles and dots, having a longitudinal band in the middle, compoſed of oblong and oval-ſhaped pearl-coloured ſpots, ſo arranged as to reſemble a fillet, ſimilar to thoſe worn by the eaſtern kings. The ground upon which this fillet and the white dots are laid, when viewed with a glaſs, and the ſun ſhining thereon, is beautiful and rich beyond all deſcription. There are varieties in colour of this ſpider when young: ſome have their abdomen purple, ornamented with white dots, the legs yellow and annulated with a deeper colour: others have their abdomen of a fine red likewiſe ornamented with white, but the legs of a fine pale green colour, annulated with dark purple or black. It inhabits the birch tree.

The Aquatica, is of a livid colour, with an oval belly, and a tranſverſe line, and two hollowed points. It frequents the freſh waters of Europe. But it is in ſome ſort amphibious: for it can live on land as well as in the water, and comes often on ſhore for its food; yet it ſwims well in water, both on its belly and back: it is diſtinguiſhable by its brightneſs. In the water its belly appears covered with a ſilver varniſh, which is only a bubble of air attached to the abdomen by means of the oily humours which tranſpire from its body, and prevent the immediate contact of the water. This bubble of air is made the ſubſtance of its dwelling, which it conſtructs under water: for it fixes ſeveral threads of ſilk, or ſuch fine matter, to the ſtalks of plants in the water, and then aſcending to the ſurface, thruſts the hinder part of its body above water, drawing it back again with ſuch rapidity, that it attaches underneath a bubble of air, which it has the art of detaining under water, by placing it underneath the threads above mentioned, and which it binds like a covering almoſt all around the air-bubble. Then it aſcends again for another air-bubble; and thus proceeds until

til it has conſtructed a large aerial apartment under water, which it enters into or quits at pleaſure. The male conſtructs for himſelf one near to the female: and when love invites, he breaks through the thread walls of the female's dwelling, and the two bubbles attached to the bellies of both unite into one, forming one large nuptial chamber. The female is ſometimes laid for a whole day together ſtretched on her back, waiting for the arrival of the male, without motion, and ſeemingly as if dead. As ſoon as he enters and glides over her, ſhe ſeems to be brought to life again, gets on her legs and runs after the male, who makes his eſcape with all poſſible ſpeed. The female takes care of the young, and conſtructs ſimilar apartments on purpoſe for them. The figure of this ſpider has nothing remarkable; and would be overlooked among a crowd of curioſities, if the ſpectator be unacquainted with its ſingular art of conſtructing an aerial habitation under water, and thus uniting together the properties of both elements. It lodges during the winter in empty ſhells, which it dexterouſly ſhuts up with a web.

The Faſciata, with yellow bands round the belly, and duſky rings on the legs, is a native of Barbary, and is as large as the thumb. It inhabits hedges and thickets: its webs have large meſhes, and it reſides in the center. The ſnares are ſpread for large flies, waſps, drones, and even locuſts: the leſſer inſects can eſcape through the meſhes. The animal which it entangles is ſoon bound with ſtrong threads; killed by the ſpider's jaws; and partly eat, if the ſpider is hungry: the reſt is concealed under ſome neighbouring dry leaves, covered with a kind of web and a blackiſh glue in great abundance. Its larder is ſaid to be often plentifully ſtored:—Its neſt is of the ſize of a pigeon's egg, divided horizontally, and ſuſpended by the threads of the inſect, which are of a ſilvery white, and ſtronger than ſilk. The young ones live in amity; but when grown up, are mortal enemies. They never meet but they fight with violence, and their battle only ends with the death of the weakeſt. The dead body is carefully ſtored in the larder. Twelve of theſe ſpiders, by way of experiment, were ſhut up together; and, after a battle of eight days, the ſtrongeſt only remained alive.

The Tarantula has the breaſt and belly of an aſh colour; the legs are likewiſe aſh-coloured, with blackiſh rings on the under part; the fangs or nippers are red on the inner ſide, the reſt being blackiſh: two of its eyes are larger than the other, red, and placed in the front; four other eyes are placed in a tranſverſe direction towards the mouth; the other two are nearer the back: it has two antennæ or feelers. It is a native of Italy, Cyprus, Barbary, and the Eaſt Indies. It lives in bare fields, where the lands are fallow, but not very hard; and from its antipathy to damp and ſhade, chooſes for its reſidence the riſing part of the ground facing the eaſt. Its dwelling is about four inches deep, and half an inch wide; at the bottom it is curved, and there the inſect ſits in wet weather, and cuts its way out if water gains upon it. It weaves a net at the mouth of the hole. Theſe ſpiders do not live quite a year. In July they ſhed their ſkin, and proceed to propagation; which, from a mutual diſtruſt, as they frequently devour one another, is a work undertaken with great circumſpection. They lay about ſeven hundred and thirty eggs, which are hatched in the ſpring; but the parent does not live to ſee her progeny, having expired early in the winter. The Ichneumon fly is their moſt formidable enemy. The bite of the tarantula is ſaid to occaſion an inflammation in the part, which in a few hours brings on ſickneſs, difficulty of breathing, and univerſal faintneſs. The perſon afterwards is affected with a delirium, and ſometimes is ſeized wih a deep melancholy. The ſame ſymptoms return annually, in ſome caſes, for ſeveral years; and at laſt terminate in death. Muſic, it has been pretended, is the only cure. A muſician is brought, who tries a variety of airs, till at laſt he hits upon one that urges the patient to dance; the violence of which exerciſe produces a proportionable agitation of the vital ſpirits, attended with a conſequent degree of perſpiration, the certain conſequence of which is a cure. Such are the circumſtances that have been generally related, and long credited, concerning the bite of this animal.

In the Philoſophical Tranſactions for the year 1672, p. 406, is an extract of a letter from Dr. Thomas Cornelio, a Neapolitan phyſician, to John Doddington, Eſq. his majeſty's reſident at Venice, communicated by the latter, in which, ſpeaking of his intention to ſend to Mr. Doddington ſome tarantulas, he ſays, "Mean while I ſhall not omit to impart to you what was related to me a few days ſince by a judicious and unprejudiced perſon; which is, that being in the country of Otranto, where thoſe inſects are in great numbers, there was a man who, thinking himſelf ſtung by a tarantula, ſhowed in his neck a ſmall ſpeck, about which in a very ſhort time there aroſe ſome pimples full of a ſerous humour; and that, in a few hours after, the poor man was ſorely afflicted with very violent ſymptoms, as ſyncopes, very great agitations, giddineſs of the head, and vomiting; but that without any inclination at all to dance, and without a deſire of having any muſical inſtruments, he miſerably died within two days. The ſame perſon affirmed to me, that thoſe that think themſelves bitten by tarantulas, except ſuch as for evil ends feign themſelves to be ſo, are ſo the moſt part young wanton girls, whom the Italian writers call *Dolce di Sale*; who, by ſome particular indiſpoſition falling into this melancholy madneſs, perſuade themſelves, according to the vulgar prejudice, to have been ſtung by a tarantula.

Dr. Serao, an Italian phyſician, has written an ingenious book, in which he has effectually exploded this opinion as a popular error; and in the Philoſophical Tranſactions, No. 60, for the year 1770, p. 236. is a letter from Dominico Cirillo, M. D. profeſſor of natural hiſtory in the univerſity of Naples; wherein, taking notice of Serao's book, he ſays, That having had an opportunity of examining the effects of this animal in the province of Taranto, where it is found in great abundance, he finds that the ſurpriſing cure of the bite of the tarantula by muſic has not the leaſt truth in it; and that it is only an invention of the people, who want to get a little money by dancing when they ſay the tarantiſm begins. He adds, "I make no doubt but ſometimes the heat of the climate contributes very much to warm their imaginations, and throw them into a delirium, which may in ſome meaſure be cured by muſic; but ſeveral experiments have been tried with the tarantula, and neither men nor animals after the bite have had any other complaint than a very trifling inflammation upon the part, like that produced by the bite of a ſcorpion, which goes off by itſelf without any danger at all. In Sicily, where the ſummer is ſtill warmer than in any part of the kingdom of Naples, the tarantula is never dangerous; and muſic is never employed for the cure of the pretended tarantiſm."

Mr. Swinburn, when in the country of the tarantula, was deſirous of inveſtigating minutely every particular relative to that inſect; but the ſeaſon was not far enough advanced, and no *tarantati* (perſons bitten, or pretending to be bitten, by the tarantula) had begun to ſtir. He prevailed, however, upon a woman who had formerly been bitten, to act the part, and dance the tarantata before him. A great many muſicians were ſummoned, and ſhe performed the dance, as all preſent aſſured him, to perfection. At firſt ſhe lolled ſtupidly on a chair, while the inſtruments were playing ſome dull muſic. They touched, at length, the chord ſuppoſed to vibrate to her heart; and up ſhe ſprang with a moſt hideous yell, ſtaggered about the room like a drunken perſon, holding a handkerchief in both hands, raiſing them alternately, and moving in very true time. As the muſic grew briſker, her motions quickened, and ſhe ſkipped about with great vigour and variety of ſteps, every now and then ſhrieking very loud. The ſcene was far from pleaſant; and, at his deſire, an end was put to it before the woman was tired. Wherever the tarantati are to dance, he informs us, a place is prepared for them, hung round with bunches of grapes and ribbons. The patients are dreſſed in white, with red, green, or yellow ribbons, for thoſe are their favorite colours; on their ſhoulders they caſt a white ſcarf, let their hair fall looſe about their ears, and throw their heads as far back as they can bear it. They are exact copies of the ancient prieſteſſes of Bacchus. The orgies of that god, whoſe worſhip, under various ſymbols, was more widely ſpread over the globe than that of any other divinity, were no doubt performed with energy and enthuſiaſm by the lively inhabitants of this warm climate. The introduction of Chriſtianity aboliſhed all public exhibitions of theſe heatheniſh rites, and the women durſt no longer act a frantic part in the character of Bacchantes. Unwilling to give up ſo darling an amuſement, they deviſed other pretences; and poſſeſſion by evil ſpirits may have furniſhed them with one. Accident may alſo have led them to a diſcovery of the tarantula; and, upon the ſtrength of its poiſon, the Puglian dames ſtill enjoy their old dance, though time has effaced the memory of its ancient name and inſtitution: and this Mr. Swinburn takes to be the origin of ſo ſtrange a practice. If at any time theſe dancers are really and involuntarily affected, he ſuppoſes it can be nothing more than an attack upon their nerves, a ſpecies of St. Vitus's dance; and he inclines the more to the idea, as there are numberleſs churches and places throughout theſe provinces dedicated to that ſaint.

Many ſenſible people of the country, however, differ in opinion from Dr. Serao and other authors, who have ridiculed the pretended diſorder, and affirmed that the venom of this ſpecies of ſpider can produce no effects but ſuch as are common to all others. The Brindiſians ſay, that the tarantulas ſent to Naples for the experiment were not of the true ſort, but a much larger and more innocent one; and that the length of the journey, and want of food, had weakened their power ſo much, as to ſuffer the Doctor or others to put their arm into the bag where they were kept with impunity. They quote many examples of perſons bitten as they ſlept out in the fields during the hot months, who grew languid, ſtupid, deprived of all courage and elaſticity, till the ſound of ſome favourite tune rouſed them to dance, and throw off the poiſon. Theſe arguments of their's, however, Mr. Swinburn thinks of little weight: for they acknowledged that elderly perſons were more frequently infected than young ones; and that moſt of them were women, and thoſe unmarried. No perſon above the loweſt rank in life was ever ſeized with this malady, nor is there an inſtance

inſtance of its cauſing death. The length of the dance, and the patient's powers of bearing ſuch exceſſive fatigue in the canicular ſeaſon, prove nothing; becauſe every day, at that time of the year, peaſants may be ſeen dancing with equal ſpirit and perſeverance, though they do not pretend to be ſeized with the tarantiſm. The illneſs may therefore be attributed to hyſterics, exceſſive heat, ſtoppage of perſpiration, and other effects of ſleeping out of doors in a hot ſummer air, which is always extremely dangerous, if not mortal, in moſt parts of Italy. Violent exerciſe may have been found to be a certain cure for this diſorder, and continued by tradition, though the date and circumſtances of this diſcovery have been long buried in oblivion; a natural paſſion for dancing, imitation, cuſtom of the country, and a deſire of raiſing contributions upon the ſpectators, are probably the real motives that inſpire the tarantati. Before Serao's experiments, the tarantula had been proved to be harmleſs, from trials made in 1693 by Clarizio, and in 1740 at Lucera by other naturaliſts.

ARBITRATION is where the parties injuring and injured, ſubmit all matters in diſpute, concerning any perſonal chattels or perſonal wrong, to the judgment of two or more arbiters or arbitrators; who are to decide the controverſy: and if they do not agree, it is uſual to add, that another perſon be called in as umpire, *(imperator* or *impar)* to whoſe ſole judgment it is then referred; or frequently there is only one arbitrator originally appointed. This deciſion, in any of theſe caſes, is called an *award*. And thereby the queſtion is as fully determined, and the right transferred or ſettled, as it could have been by the agreement of the parties or the judgment of a court of juſtice. An arbitration is either general, that is, including all actions, quarrels, and demands; or ſpecial, which includes one or more matters or facts ſpecified. By ſtatute 9 and 10 W. III. cap. 15. ſect. 1. after May 11th, 1698, all merchants and others deſiring to end any controverſy, for which there is no remedy but by perſonal action, or ſuit in equity, by arbitration, may agree that their ſubmiſſion of the ſuit to the award or umpirage of any perſons, ſhall be made a rule of any of his majeſty's courts of record, which the parties ſhall chuſe; and may inſert ſuch their agreement in their ſubmiſſion, or in the condition of the bond or promiſe: and upon producing an affidavit of ſuch agreement, and upon reading and filing ſuch affidavit in the court ſo choſen, the ſame may be entered on record in ſuch court, and a rule of court ſhall be thereupon made, that the parties ſhall ſubmit to, and finally be concluded by, ſuch arbitration or umpirage; and in caſe of diſobedience thereto, the party neglecting or refuſing, ſhall be ſubject to all the penalties of contemning a rule of court, and proceſs ſhall be iſſued accordingly; which ſhall not be ſtopped or delayed by any order, &c. of any other court, either of law or equity, unleſs it appear on oath, that the arbitrators or umpire miſbehaved themſelves, and that ſuch award was corruptly or unduly procured. Sec. 2. Any arbitration or umpirage procured by corruption or undue means ſhall be void, and ſet aſide by any court of law or equity, ſo as ſuch corruption or undue practice be complained of in the court where the rule is made for ſuch arbitration, before the laſt day of the next term after ſuch arbitration made and publiſhed to the parties. The power of arbitrators is to be regulated by the compromiſe between the parties, as to what concerns the differences they are to determine; and whatever they decree beyond that is of no effect.

ARBORESCENT, a term uſed to denote any thing that ſhoots or grows up in form of a tree. Botaniſts ſpeak of arboreſcent ſhrubs and plants; the ſedum arboreſcens, &c. Mineraliſts treat of arboreſcent metals, arboreſcent ſilver, arboreſcent iron, arboreſcent ſtones, &c. The fungus marinus is ranked by ſome in the claſs of arboreſcens fluors; the chemiſts produce arboreſcent cryſtallizations, which they call philoſophical trees. Phil. Tranſ. No. 198. No. 111. and No. 129. Zoologiſts give inſtances of arboreſcent animals, particularly fiſhes. The arboreſcent ſtar-fiſh, *ſtella arboreſcens*, is one of the curioſities of nature found in ſeveral cabinets of natural rarities.

ARBUTUS, the ſtrawberry-tree; a genus of the monogynia order, belonging to the decandria claſs of plants. The calyx is divided into five parts; the corolla is ovated; and the fruit is a berry with five cells. The unedo, or common ſtrawberry-tree, is a native of Italy, Spain, and alſo of Ireland; and is now very common in the Britiſh gardens. Of this ſpecies there are four varieties, viz. the oblong-fruited, the round-fruited, the red-flowered, and the double-bloſſomed. One deſcription is nearly common to them all; and their inconſiderable variation is almoſt ſufficiently ſhown in their reſpective appellations. The andrachne will grow to a larger ſize than the arbutus. The leaves are ſmooth, and nearly of the ſame figure as the preceding ſort; though they are larger, and have their edges undivided. The flowers grow like the other ſorts; are of the ſame colour; and they are ſucceeded by large oval, ſcarlet fruit. It is called the *Oriental Strawberry-tree*, becauſe this ſort grows plentifully in many parts of the Eaſt, and is uſeful to the inhabitants for many purpoſes in life. Beſides the above, there are three other ſpecies of arbutus, viz. the acadienſis, a native of Acadia; the alpina, or mountain ſtrawberry-tree, a native of Britain; and the uvaurſi, a plant lately diſcovered in the highlands of Scotland, and which formerly was thought not to be a native of Britain. For the culture of ſtrawberries, ſee the Treatiſe on GARDENING, article FRUIT GARDEN, months February, April, May, June, and July.

ARCA, in conchology, a genus of ſhells, belonging to the order Bivalves. For the generic and ſpecific characters, ſee the Syſtem, Order II. Genus 13. For the claſſification, ſee the Synoptical Table.

ARCH, a part of any curve line; e. gr. of a circle, an ellipſis, or the like. Arch of a circle, is a part of the circumference thereof, leſs than a half, or ſemicircle. See the Syſtem of GEOMETRY, Sect. III.

ARCH, in architecture, a concave or hollowed piece of building, conſtructed in ſuch a manner that the ſeveral ſtones of which it is compoſed keep one another in their places. The terms *arch* and *vault* properly differ only in this, that the arch expreſſes a narrower, and the vault a broader, piece of the ſame kind. The principal difference in the form of arches is, that ſome are circular, and others elliptical; the former having a larger or ſmaller part of a circle, the other of an ellipſis. What are called *ſtrait arches*, are thoſe frequently uſed over doors and windows, the upper and under edges of which are ſtrait and parallel, and the ends and joints all pointing towards a centre. For a more copious account of this branch of architecture, ſee the SYSTEM.

Triumphal arch is a gate or paſſage into a city, built of ſtone or marble, and magnificently adorned with architecture, ſculpture, inſcriptions, &c. ſerving not only to adorn a triumph, at the return from a victorious expedition, but alſo to preſerve the memory of the conqueror to poſterity. The moſt celebrated triumphal arches, now remaining of antiquity, are that of Titus, of Septimius Severus, and of Conſtantine, at Rome, of which we have figures given us by Des Godetz.—One of the gates of Orange is a triumphal arch of C. Marius.—The gates, Peyro at Montpelier, and of St. Denis, St. Martin, and St. Antoine, at Paris, may alſo be reckoned triumphal arches of the moderns.

ARCH, in aſtronomy.—Diurnal arch of the ſun is part of a circle parallel to the equator, deſcribed by the ſun in his courſe betwixt riſing and ſetting. His nocturnal arch is of the ſame kind; excepting that it is deſcribed between his ſetting and riſing. See the SYSTEM, Sect. IX. The latitude and elevation of the pole are meaſured by an arch of the meridian; and the longitude, by an arch of a parallel circle.

ARCHANGEL, an intellectual ſubſtance or angel, placed in the ſecond order among the bleſſed ſpirits which compoſe the celeſtial hierarchy. The word is compounded of the Greek ἀρχος, *prince*, and ἀγγελος, *angel*.

ARCHBISHOP, the name of a church dignitary of the firſt claſs. Archbiſhops were not known in the eaſt till about the year 320; and though there were ſome ſoon after this who had the title, yet that was only a perſonal honour, by which the biſhops of conſiderable cities were diſtinguiſhed. It was not till of late that archbiſhops became metropolitans, and had ſuffragans under them. Athanaſius appears to be the firſt who uſed the title *archbiſhop*, which he gave occaſionally to his predeceſſor; Gregory Nazianzen, in like manner, gave it to Athanaſius; not that either of them were entitled to any juriſdiction, or even any precedence in virtue of it. Among the Latins, Iſidore Hiſpalenſis is the firſt that ſpeaks of archbiſhops. He diſtinguiſhes four orders or degrees in the eccleſiaſtical hierarchy, viz. patriarchs, archbiſhops, metropolitans, and biſhops. There are now two archbiſhoprics in England; viz. of Canterbury and York; the prelates whereof are called primates, and metropolitans; with this only difference, that the former is called primate of *all* England, and the latter ſimply, primate of England. The archbiſhop, beſide the inſpection of the biſhops and inferior clergy in the province over which he preſides, exerciſes epiſcopal juriſdiction in his own dioceſe. He is guardian of the ſpiritualities of any vacant ſee in his province, as the king is of the temporalities; and exerciſes eccleſiaſtical juriſdiction in it. He is entitled to preſent by lapſe to all the eccleſiaſtical livings in the diſpoſal of his dioceſan biſhop, if not filled within ſix months. He has likewiſe a cuſtomary prerogative, upon conſecrating a biſhop, to name a clerk or chaplain to be provided for by ſuch biſhop; in lieu of which it is now uſual to accept an option. He is ſaid to be enthroned when veſted in the archbiſhopric; whereas biſhops are ſaid to be inſtalled. The eccleſiaſtical government of England is divided into two provinces, viz. Canterbury and York. Canterbury hath the following ſuffragan biſhoprics appertaining to it, St. Aſaph, Bangor, Bath and Wells, Briſtol, Chicheſter, Litchfield and Coventry, St. David's, Ely, Exeter, Gloucester, Hereford, Landaff, Lincoln, London, Norwich, Oxford, Peterborough, Rocheſter, Saliſbury, Wincheſter, and Worceſter. To York appertain the biſhoprics of Carliſle, Cheſter, and Durham; to which may be added the biſhopric of Sodor and Man, whoſe biſhop is not a Lord of Parliament.

The archbiſhop of Canterbury had anciently, viz. till the

year

year 1152 jurisdiction over Ireland as well as England, and was styled a *patriarch*, and sometimes *alterius orbis papa*, and *orbis Britannici pontifex*. Matters were done and recorded in his name thus, *Anno pontificatus nostri primo*, &c. The first archbishop of Canterbury was Austin, appointed by king Ethelbert, on his conversion to Christianity, about the year 598. He was also *legatus natus*. He even enjoyed some special marks of royalty; as to be patron of a bishopric, which he was of Rochester; and to make knights, coin monies, &c. He is still the first peer of England, and the next to the royal family; having precedence of all dukes, and all great officers of the crown. It is his privilege, by custom, to crown the kings and queens of this kingdom. He may retain and qualify eight chaplains; whereas a duke is, by statute, allowed only six. He has, by common law, the power of probates of wills and testaments, and granting letters of administration. He has also a power to grant licences and dispensations in all cases formerly sued for in the court of Rome, and not repugnant to the law of God. He accordingly issues special licences to marry, to hold two livings, &c. and he exercises the right of conferring degrees. He also holds several courts of judicature; as, the Court of Arches, Court of Audience, Prerogative Court, and Court of Peculiars.

The archbishop of York has the like rights in his province as the archbishop of Canterbury. He has precedence of all dukes not of the royal blood; and of all officers of state, except the lord high chancellor. He has also the rights of a count palatine over Hexhamshire. The first archbishop of York was Paulinus, appointed by Pope Gregory, about the year 622. He had formerly jurisdiction over all the bishops of Scotland; but, in the year 1470, pope Sextus IV. created the bishop of St. Andrew's archbishop and metropolitan of all Scotland.

Scotland, whilst episcopacy prevailed in that country, had two Archbishops, of St. Andrew's and Glasgow; of which the former was accounted the metropolitan; and, even before it arrived at the dignity of an archbishopric, resisted, with great spirit, all the attempts of the archbishops of York in England to become the metropolitans of Scotland. The sees of Argyle, Galloway, and the Isles, were suffragans to Glasgow; all the others in the kingdom to St. Andrew's. Ireland has four archbishops; of Armagh, Dublin, Cashel, and Tuam; the former of whom is primate of all Ireland.

ARCHDEACON, a church-officer vested with the jurisdiction over the laity and clergy, next after the bishop, either through the whole diocese, or only a part of it. But as the archdeacons, in their original institution, had no relation to the diocese, but only to the episcopal see, so it was by several steps and degrees that they attained to the power they now enjoyed. At their first institution, their proper business was, to attend the bishop at the altar, to direct the deacons and other inferior officers in their several duties, for the orderly performance of divine service, to attend the bishop at ordinations, and to assist him in the management of the revenues of the church; but without any thing that could be called jurisdiction in the present sense of the word, either in the cathedral or out of it.

We have sixty archdeacons in England: their office is to visit every two years in three, to inquire into the reparations and moveables belonging to the church, reform abuses in ecclesiastical matters, and bring the more weighty affairs before the bishop; besides which they have also a power to suspend, excommunicate, and in many places to prove wills, and in some to institute to benefices. It is one of the archdeacon's offices to induct all clerks into their benefices within his jurisdiction; and by the act of uniformity, he is now obliged to be in priests orders. Many archdeacons, in old foundations, have, by prescription, their courts and officials, as bishops have. Archdeaconries are commonly given by bishops, who do therefore prefer to the same by collation: but if an archdeaconry be in the gift of a layman, the patron doth present to the bishop, who institutes in like manner as to another benefice; and then the dean and chapter do induct him, that is, after some ceremonies, place him in a stall in the cathedral church to which he belongeth, whereby he is said to have a place in the choir.

ARCHDUKE, a duke vested with some quality, pre-eminence, and authority, above other dukes. The archduke of Austria is a very ancient title. There have also formerly been archdukes of Lorrain and Brabant. Austria was erected into a marquisate by Otho, or Henry I. and into a duchy by Frederic I. in 1156; but we do not well know when, or why, the title archduchy was given it.

ARCHERS, a kind of militia or soldiery armed with bows and arrows. The word is formed of *arcus*, "a bow," whence *arcuarius*, and even *arquis*, and *arquites*, as they are also denominated in the corrupt state of the Latin tongue. Archers were much employed in former times: but they are now laid aside, excepting in Turkey and some of the eastern countries; where there are companies of archers still subsisting in their armies, and with which they did terrible execution at the battle of Lepanto. As an exercise, the practice of archery is still kept up in many places. See the article ARCHERY.

ARCHERY, the art or exercise of shooting with a bow and arrow. In most nations the bow was anciently the principal implement of war, and by the expertness of the archers alone was often decided the fate of battles and of empires. In this island archery was greatly encouraged in former times, and many statutes were made for the regulation thereof; whence it was that the English archers in particular became the best in Europe, and procured them many signal victories.

The *Artillery Company* of London, though they have long disused the weapon, are the remains of the ancient fraternity of bowmen or archers. Artillery (*artillerie*) is a French term signifying *archery*; as the *king's bowyer* was in that language styled *artillier du roy*: And from that nation the English seem to have learnt at least the cross-bow archery. We therefore find that William the Conqueror had a considerable number of bowmen in his army at the battle of Hastings, when no mention is made of such troops on the side of Harold: And it is supposed that these Norman archers shot with the arbalest (or cross-bow), in which formerly the arrow was placed in a groove, being termed in French a *quadrel*, and in English a *bolt*.

Of the time when shooting with the long bow first began among the English, at which exercise they afterwards became so expert, there appear no certain accounts. Their chroniclers do not mention the use of archery as expressly applied to the cross-bow, or the long-bow, till the death of Richard I. who was killed by an arrow at the siege of Limoges in Guienne, which Hemmingford mentions to have issued from a cross-bow. After this, which happened in 1199, there appear not upon record any notices of archery for nearly 150 years, when an order was issued by Edward III. in the 15th year of his reign, to the sherives of most of the English countries for providing 500 white bows and 500 bundles of arrows, for the then intended war against France. Similar orders are repeated in the following years; with this difference only, that the Sheriff of Gloucestershire is directed to furnish 500 painted bows as well as the same number of white. The famous battle of Cressy was fought four years afterwards, in which our chroniclers state that we had 2000 archers, who were opposed to about the same number of the French, together with a circumstance which seems to prove, that by this time we used the long-bow, whilst the French archers shot with the arbalest. The circumstance alluded to is as follows: Previously to the engagement there fell a very heavy rain, which is said to have much damaged the bows of the French, or perhaps rather the strings of them. Now the long-bow (when unstrung) may be most conveniently covered so as to prevent the rain's injuring it; nor is there scarcely any addition to the weight from such a case; whereas the arbalest is of a most inconvenient form to be sheltered from the weather. As therefore, in the year 1342, orders were issued to the sherives of each county to provide 500 bows, with a proper proportion of arrows, it seems probable that these were long bows, and not the arbalest. At the above-mentioned battle, the English ascribed their victory chiefly to the archers. The battle of Poictiers was fought A. D. 1356, and gained by the same means.

Sometimes the archers gained great victories without even the least assistance from the men-at-arms; as, particularly, the decisive victory over the Scots at Homildon, A. D. 1402. In that bloody battle, the men-at-arms did not strike a stroke, but were mere spectators of the valour and victory of the archers. The Earl of Douglas, who commanded the Scotch army in that action, enraged to see his men falling thick around him by showers of arrows, and trusting to the goodness of his armour (which had been three years in making), accompanied by about eighty lords, knights, and gentlemen in complete armour, rushed forward, and attacked the English archers sword in hand. But he soon had reason to repent his rashness. The English arrows were so sharp and strong, and discharged with so much force, that no armour could repell them. The Earl of Douglas, after receiving five wounds, was made prisoner; and all his brave companions were either killed or taken. Philip de Comines acknowledges, what our own writers assert, that the English archers excelled those of every other nation; and Sir John Fortescue says again and again, "that the might of the realme of England standyth upon archers." The superior dexterity of their archers gave the English a great advantage over their capital enemies the French and Scots. The French depended chiefly on their men at arms, and the Scots on their pikemen; but the ranks of both were often thinned and thrown into disorder by flights of arrows before they could reach their enemies.

James I. of Scotland, who had seen and admired the dexterity of the English archers, and who was himself an excellent archer, endeavoured to revive the exercise of archery among his own subjects, by whom it had been too much neglected. With this view, he ridiculed their awkward manner of handling their bows, in his humorous poem of Christ's Kirk on the Green; and procured the following law to be made in his first parliament, A. D. 1424, immediately after his return to Scotland: "That all men might buse thame to be archares fra the be 12 years of oge; and that at ilk ten punds worth of land thair be made bow markes, and speciallie near paroche kirks, quhairn upon halie dayis men may cum, and at the leist schute thryse about, and have usage of archarie: and whasa usis not archarie, the laird of the land fall rais of him a wedder; and gif the laird raisis not the said pane, the king's shiref or his ministers fall rais it to the king." But the untimely death of that excellent prince prevented the effectual execution of this law.

There is not found any act of Parliament of Henry V. in relation to archery, and all the orders in Rymer till the battle of Agincourt relate to great guns, from which he ſeems at firſt to have expected more conſiderable advantage than from the training of bowmen. It ſhould ſeem, however, that this ſort of artillery, from its unwieldineſs, bad and narrow roads, together with other defects, was as yet but of little uſe in military operations. In the year 1417 this king therefore aſcribes his victory at Agincourt to the archers, and directs the ſherives of many counties to pluck from every gooſe ſix wing-feathers for the purpoſe of improving arrows, which are to be paid for by the king. In 1421, though the French had been defeated both at Creſſy, Poictiers, and Agincourt, by the Engliſh archers, yet they ſtill continued the uſe of the croſs-bow; for which reaſon Henry V. as duke of Normandy, confirms the charters and privileges of the baliſtarii, which had been long eſtabliſhed as a fraternity in his city of Rouen.

In the fifth year of Edward IV. an act paſſed, that every Engliſhman, and Iriſhman dwelling with Engliſhmen, ſhall have an Engliſh bow of his own height which is directed to be made of yew, wych, hazel, aſh, or awburne, or any other reaſonable tree according to their power. The next chapter alſo directs that butts ſhall be made in every townſhip, which the inhabitants are obliged to ſhoot up and down every feaſt-day, under the penalty of a halfpenny when they ſhall omit this exerciſe. In the 14th year however, of this ſame king, it appears by Rymer's Fœdera, that 1000 archers were to be ſent to the duke of Burgundy, whoſe pay is ſettled at ſixpence a-day, which is more than a common ſoldier receives clear in the preſent times, when proviſions are ſo much dearer, and the value of money ſo much decreaſed. This circumſtance ſeems to prove, very ſtrongly, the great eſtimation in which archers were ſtill held. In the ſame year, Edward preparing for a war with France, directs the ſherives to procure bows and arrows, "as moſt ſpecially requiſite and neceſſary."

On the war taking place with Scotland, eight years after this, Edward provides both ordnance and archers; ſo that though the uſe of *artillery* (as we now term it) was then gaining ground, yet that of the bow and arrow was not neglected. Richard III. by his attention to archery, was able to ſend 100 bowmen to the duke of Bretagne, and he availed himſelf of the ſame troops at the battle of Bulworth. During the reign of Henry VII however, there appeared no order relative to gunpowder or artillery; whilſt, on the other hand, in 1488, he directs a large levy of archers to be ſent to Brittanny, and that they ſhall be reviewed before they embark. In the 19th year of his reign, this ſame king forbids the uſe of the croſs-bow, becauſe "the long-bow had been much uſed in this realm, whereby honour and victory had been gotten againſt outward enemies; the realm greatly defended, and much more the dread of all Chriſtian princes by reaſon of the ſame." During the reign of Henry VIII. ſeveral ſtatutes were made for the promotion of archery. The 8th Eliz. c. 10. regulates the price of bows, and the 13th Eliz. c. 14. enacts, that bow-ſtaves ſhall be brought into the realm from the Hanſe Towns and the Eaſtward; ſo that archery ſtill continued to be an object of attention in the legiſlature.

In Rymer's *Fœdera* there is neither ſtatute nor proclamation of James I. on this head; but it appears by Dr. Birch's Life of his ſon, (Prince Henry) that at eight years of age he learned to ſhoot both with the bow and gun, whilſt, at the ſame time, this prince had in his eſtabliſhment an officer, who was ſtyled *bow-bearer*. The king granted a ſecond charter to the artillery company, by which the powers they had received from Henry VIII. were conſiderably extended. Charles I. appears, from the dedication of a treatiſe, intitled *The Bowman's Glory*, to have been himſelf an archer; and in the eighth year of his reign he iſſued a commiſſion to the chancellor, lord-mayor, and ſeveral of the privy-council, to prevent the fields near London being ſo incloſed as "to interrupt the neceſſary and profitable exerciſe of ſhooting," as alſo to lower the mounds where they prevented the view from one mark to another.

Catherine of Portugal, (queen to Charles II.) ſeems to have been much pleaſed with the ſight at leaſt of this exerciſe; for, in 1676, by the contributions of Sir Edward Hungerford and others, a ſilver badge for the marſhal of the fraternity was made, weighing 25 ounces, and repreſenting an archer drawing the long-bow (in the proper manner) to his ear, with the following inſcription: *Reginæ Catherinæ Sagittarii.* The ſupporters are two bowmen, with the arms of England and Portugal. In 1682 there was a moſt magnificent cavalcade and entertainment given by the Finſbury archers, when they beſtowed the titles of "duke of Shoreditch," "marquis of Iſlington," &c. upon the moſt deſerving. Charles II. was preſent upon this occaſion; but the day being rainy, he was obliged ſoon to leave the field.

So lately as the year 1753 targets were erected in the Finſbury fields, during the Eaſter and Whitſun-holidays; when the beſt ſhooter was ſtyled Captain for the enſuing year, and the ſecond Lieutenant. Why this military weapon was ſo deciſive in the battles of former days, the following reaſons may be ſuggeſted. Before the introduction of fire-arms, the enemy could only be ſtruck at a diſtance by ſlings, the bow uſed by the ancients, or the croſs-bow; to all which the Engliſh long-bow was infinitely ſuperior. As for ſlings, they never have been uſed in the more northern parts of Europe by armies in the field; nor does their uſe indeed ſeem to have been at all convenient, or extenſively practicable, for two principal reaſons: in the firſt place, ſlingers cannot advance in a compact body, on account of the ſpace to be occupied by this weapon in its rotatory motion; in the next place, the weight of the ſtones to be carried muſt neceſſarily impede the ſlingers greatly in their movements. The bow of the ancients, again, as repreſented in all their reliefs, was a mere toy, compared with that of our anceſtors; it was therefore chiefly uſed by the Parthians, whoſe attacks (like thoſe of the preſent Arabs) were deſultory. As for the croſs-bow, it is of a moſt inconvenint form for carriage, even with the modern improvements; and in caſe of rain, could not be eaſily ſecured from the weather. After the firſt ſhot, moreover, it could not be recharged under a conſiderable time, whilſt the bolts were alſo heavy and cumberſome. The Engliſh long-bow, on the other hand, together with the quiver of arrows, was eaſily carried by the archer, as eaſily ſecured from rain, and recharged almoſt inſtantaneouſly. It is not therefore extraordinary, that troops, who ſolely uſed this moſt effectual weapon, ſhould generally obtain the victory, even when oppoſed to much more numerous armies.

It may be urged, that theſe loſſes having been experienced by our enemies, muſt have induced them to practice the ſame mode of warfare. But it is thought that the long-bow was not commonly uſed even in England till the time of Edward III. when the victory at Creſſy ſufficiently proclaimed the ſuperiority of that weapon. It required, however, ſo much training before the archer could be expert, that we muſt not be ſurpriſed if ſoon afterwards this military exerciſe was much neglected, as appears by the preambles of ſeveral ancient ſtatutes. Whilſt the military tenures ſubſiſted, the ſovereign could only call upon his tenants during war, who, therefore, attended with the weapons they had been uſed to, and which required no previous practice. On the other hand, the Engliſh archers were obliged, by acts of parliament, even in time of peace, to erect butts in every pariſh, and to ſhoot on every Sunday and holiday, after repairing perhaps to theſe butts from a conſiderable diſtance, whilſt the expence of at leaſt a yew-bow is repreſented as being a charge which they were ſcarcely equal to. The king and parliaments of this country, having thus compelled the inhabitants to ſuch training, the Engliſh armies had (it ſhould ſeem) the ſame advantage over their enemies as the excluſive uſe of fire arms would give us at preſent.

It appears alſo by what hath been already ſtated, that the long-bow continued to be in eſtimation for more than two centuries after gunpowder was introduced, which probably aroſe from muſkets being very cumberſome and unwieldy. The flower of ancient armies likewiſe was the cavalry, againſt which the long-bow never failed to prevail, as man and horſe were too large objects to be miſſed; and hence the great number of French nobility who were priſoners at Creſſy, Poictiers and Agincourt; for being dismounted (if not wounded) whilſt they were alſo clad in heavy armour, they could not make their eſcape. The ſame reaſon accounts for the Engliſh obtaining theſe ſignal victories with ſo inferior numbers; for the nobility and gentry thus becoming priſoners, the other parts of the French army made little or no reſiſtance. No wonder, therefore, that in England the greateſt anxiety was ſhown to promote the exerciſe of this moſt important weapon, and that ſo many ſtatutes were made for that purpoſe.

In Scotland alſo, little leſs attention, though apparently not with equal ſucceſs, was ſhown to the encouragement of the art. In both kingdoms, it was provided, that the importers of merchandiſe ſhould be obliged, along with their articles of commerce, to import a certain proportion of bows, bow-ſtaves, and ſhafts for arrows. In both, every perſon was enjoined to hold himſelf provided in bows and arrows, and was preſcribed the frequent uſe of archery. In both, a reſtraint was impoſed upon the exerciſe of other games and ſports, leſt they ſhould interfere with the uſe of the bow; for it was intended that people ſhould be made expert in the uſe of it as a military weapon, by habituating them to the familiar exerciſe of it as an inſtrument of amuſement. As there was no material difference between the activity and bodily ſtrength of the two people, it might be ſuppoſed that the Engliſh and Scots wielded the bow with no unequal vigour and dexterity: but from undoubted hiſtorical monuments it appears that the former had the ſuperiority; of which one inſtance has been already narrated. By the regulations preſcribed in their ſtatute-book for the practice of archery, we find that the Engliſh ſhot a very long bow, thoſe who were arrived at their full growth and maturity being prohibited from ſhooting at any mark that was not diſtant upwards of 220 yards.

In the uſe of the bow, great dexterity as well as ſtrength ſeems to have been requiſite. Though we hear of arrows at Cheviot Chace, which were a yard long, yet it is by no means to be ſuppoſed that the whole band made uſe of ſuch, or could draw them to the head. The regulation of the Iriſh ſtatute of Edward IV. viz. that the bow ſhall not exceed the height of the man, is allowed by archers to have been well conſidered; and as the arrow ſhould be half the length of the bow, this would give an arrow of a yard in length, to thoſe only who were ſix feet high. A ſtrong man of this ſize in the preſent times cannot eaſily draw above 27 inches, if the bow is of a proper ſtrength to do execution at a con-

conſiderable diſtance. At the ſame time it muſt be admitted, that as our anceſtors were obliged by ſome of the old ſtatutes to begin ſhooting with the long-bow, at the age of ſeven, they might have acquired a greater ſlight in this exercile, than their deſcendants, though the latter ſhould be allowed to be of equal ſtrength. As the ſhooting with the long-bow was firſt introduced in England, and practiſed almoſt excluſively for nearly two centuries, ſo it hath occaſioned a peculiar method of drawing the arrow to the ear, and not to the breaſt. That this is contrary to the uſage of the ancients is very clear from the reliefs, and from the tradition of the Amazons cutting off one of their paps as it occaſioned an impediment to their ſhooting. The Finſbury archer is, therefore, repreſented in this attitude of drawing to the ear, both in the *Bowman's Glory*, and in the ſilver badge given by Catharine to the Artillery Company. Not many years ago there was a man named Topham, who exhibited ſurpriſing feats of ſtrength, and who happened to be at a public houſe, near Iſlington, to which the Finſbury archers reſorted after their exercile. Topham conſidered the long-bow as a play-thing, only fit for a child; upon which one of the archers laid him a bowl of punch, that he could not draw the arrow two thirds of its length. Topham accepted this bet with the greateſt confidence of winning; but bringing the arrow to his breaſt inſtead of his ear, he was greatly mortified by paying the wager, after many fruitleſs efforts.

As to the diſtance to which an arrow can be ſhot from a long bow with the beſt elevation of forty-five degrees, that muſt neceſſarily depend much both upon the ſtrength and ſlight of the archer; but in general the diſtance was reckoned from eleven to twelve ſcore yards. The butts for exercile, as before noticed, were directed to be diſtant upwards of 220 yards. There is indeed a tradition, that an attorney of Wigan, in Lancaſhire (named Leigh) ſhot a mile in three flights; but the ſame tradition ſtates, that he placed himſelf in a very particular attitude, which cannot be uſed commonly in this exercile. According to Nead, an archer might ſhoot ſix arrows in the time of charging and diſcharging one muſket.

The archers conſider an arrow of from 28 to 24 drop weight to be the beſt for flight or hitting a mark at a conſiderable diſtance, and that yew is the beſt material of which they can be made. As to the feathers, that of a gooſe is preferred; it is alſo wiſhed, that the bird ſhould be two or three years old, and that the feather may drop of itſelf. Two out of three feathers in an arrow are commonly white, being plucked from the gander; but the third is generally brown or grey, being taken from the gooſe; and, from this difference in point of colour, informs the archer when the arrow is properly placed. From this moſt diſtinguiſhed part therefore the whole arrow ſometimes receives its name. And this, by the by, affords an explanation of the grey gooſe wing in the ballad of Cheviot Chaſe. Arrows were armed anciently with flint or metal heads, latterly with heads of iron; of theſe there were various forms and denominations. By an act of parliament, made the 7th of Henry IV. it was enacted, that for the future all the heads for arrows and quarrels ſhould be well boiled or braſed, and hardened at the points with ſteel; and that every arrow-head or quarrel ſhould have the mark of the maker: workmen diſobeying this order were to be fined and impriſoned at the king's will, and the arrow-heads or quarrels to be forfeited to the crown. Arrows were reckoned by ſheaves, a ſheaf conſiſting of 25 arrows. They were carried in a quiver, called alſo an *arrow-caſe*, which ſerved for the magazine; arrows for immediate uſe were worn in the girdle. In ancient times phials of quicklime, or other combuſtible matter, for burning houſes or ſhips, was fixed on the heads of arrows, and ſhot from long bows. This has been alſo practiſed ſince the uſe of gun-powder. Nead ſays, he has known by experience, that an archer may ſhoot an ounce of fire-work upon an arrow 12 ſcore yards. Arrows with wild-fire, and arrows for fire-works, are mentioned among the ſtores at Newhaven and Berwick, in the 1ſt of Edward VI.

The force with which an arrow ſtrikes an object at a moderate diſtance may be conceived from the account given by king Edward VI. in his journal; wherein he ſays, that 100 archers of his guard ſhot before him two arrows each, and afterwards all together; and that they ſhot at an inch board, which ſome pierced quite through, and ſtruck into the other board; divers pierced it quite through with the heads of their arrows, the boards being well-ſeaſoned timber: their diſtance from the mark is not mentioned. To protect our archers from the attacks of the enemy's horſe, they carried long ſtakes pointed at both ends: theſe they planted in the earth, ſloping before them. In the 1ſt Edward VI. 350 of theſe were in the ſtores of the town of Berwick, under the article of archer's ſtakes; there were alſo at the ſame time eight bundles of archers ſtakes in Pontefract caſtle. To prevent the bow-ſtring from ſtriking the left arm, the arm was covered with a piece of ſmooth leather, faſtened on the outſide of the arm; this was called a *bracer*; and to guard the fingers from being cut by the bow-ſtring, archers wore ſhooting gloves.

Though archery continued to be encouraged by the king and legiſlature, for more than two centuries after the firſt knowledge of the effects of gun-powder, yet by the latter end of the reign of Henry VIII. it ſeems to have been partly conſidered as a paſtime. Arthur, the elder brother of Henry, is ſaid to have been fond of this exercile, inſomuch, that a good ſhooter was ſtyled Prince Arthur. We are alſo informed, that he pitched his tent at Mile End, in order to be preſent at this recreation, and that Henry his brother alſo attended. When the latter afterwards became king, he gave a prize at Windſor to thoſe who ſhould excel in this exercile; and a capital ſhot having been made, Henry ſaid to Barlow (one of his guards), "If you ſtill win, you ſhall be duke over all archers." Barlow, therefore, having ſucceeded, and living in Shoreditch, was created duke thereof. Upon another occaſion, Henry and the queen were met by 200 archers on Shooter's hill, which probably took its name from their aſſembling near it to ſhoot at marks. This king likewiſe gave the firſt charter to the Artillery Company, in the 29th year of his reign, by which they are permitted to wear dreſſes of any colour except purple and ſcarlet, to ſhoot not only at marks but birds, if not pheaſants or herons, and within two miles of the royal palaces. They are alſo enjoined by the ſame charter not to wear furs of a greater price than thoſe of the martin. The moſt material privilege, however, is, that of indemnification from murder, if any perſon paſſing between the ſhooter and the mark is killed, provided the archers have firſt called out faſt.

The long-bow maintained its place in our armies long after the invention of fire-arms. Nor have there been wanting experienced ſoldiers who were advocates for its continuance, and who in many caſes even preferred it to the harquebuſs or muſket. King Charles I. twice granted ſpecial commiſſions under the great ſeal for enforcing the uſe of the long bow. The firſt was in the 4th year of his reign: but this was revoked by proclamation four years afterwards, on account of divers extortions and abuſes committed under ſanction thereof. The ſecond, anno 1633, in the 9th year of his reign, to William Neade and his ſon, named William, wherein the former is ſtyled an ancient archer, who had preſented to the king a war-like invention, for uniting the uſe of pike and bow, ſeen and approved by him and his council of war: wherefore his Majeſty had granted them a commiſſion to teach and exercile his loving ſubjects in the ſaid invention, which he particularly recommended the chief officers of his trained bands to learn and practiſe; and the juſtices and other chief magiſtrates throughout England, are therein enjoined to uſe every means in their power to aſſiſt Neade, his ſon, and all perſons authoriſed by them in the furtherance, propagation, and practice of this uſeful invention. Both the commiſſions and proclamation are printed at large in Rymer. At the breaking out of the civil war, the Earl of Eſſex iſſued a precept, dated in November 1642, for ſtirring up all well-affected people by benevolence, towards the raiſing a company of archers for the ſervice of the king and parliament. Archery with the long-bow continues to be uſed as a manly exercile by the inhabitants of Geneva, and in many parts of Flanders; nor is it totally neglected in Great Britain. There are ſeveral ſocieties of archers in England; the chief of which are, the *Woodmen of Arden*, and the *Toxophilite*. But the moſt noted ſociety of this kind, now exiſting, is

The *Royal Company of Archers* in Scotland.—The ancient records of this company having been deſtroyed by fire, about the beginning of the preſent century, no authentic traces of their inſtitution now remain. It is ſaid that they owe their origin to the commiſſioners appointed in the reign of James I. of Scotland for enforcing and overſeeing the exercile of archery in different counties. Thoſe commiſſioners, who were in general men of rank and power, picking out amongſt the better ſort of people under their cogniſance the moſt expert archers, formed them into a company, and upon perilous occaſions made a preſent of their ſervices to the king as his chief body-guards; in which ſituation they often diſtinguiſhed themſelves for their loyalty, their courage, and ſkill in archery. This rank of the king's principal body-guards, the Royal Company ſtill claim within ſeven miles of the metropolis of Scotland.

Certain it is, that by an act of the privy-council of Scotland in 1677, this company was recogniſed under the name and title of "His Majeſty's Company of Archers:" And by the ſame act a piece of plate of the value of L. 20 Sterling was ordered to be given to be ſhot for by them at their annual parades, called *Weapon-ſhawings*, and to be called *The King's Prize*. At this period the Royal Company conſiſted, as it does at preſent, of the principal nobility and gentry of Scotland. But their unfortunate attachment to anti-revolution principles, upon that event's taking place, put almoſt a period to their exiſtence: their public parades or marches were diſcontinued, and the royal prize was with-held. Upon the acceſſion of Queen Anne, their former ſplendor was revived; and in the year 1703 they obtained a royal charter, confirming in general terms all their former rights and privileges, and conferring others upon them. But their partiality to the family of Stewart was at various periods after the cauſe of a temporary proſperity and decline.

Theſe unhappy differences of opinion having totally ſubſided, the Royal Company are now more numerous and flouriſhing than ever, and perhaps even more dexterous archers. His preſent Majeſty, as a mark of his royal patronage and approbation, has been pleaſed to revive the royal prize, which for the firſt time was ſhot for upon the 28th of July 1788 by a numerous and reſpectable meeting. The woodmen of Arden and the Toxophilite have

lately

lately been pleaſed to admit the members of the Royal Company to the freedom of their ſocieties: theſe grants have been followed by reciprocal diplomas from the Royal Company; ſo that the three chief ſocieties of archers in Britain may be ſaid to be now incorporated into one. The prizes belonging to this Company, and which are annually ſhot for, are, 1. A ſilver arrow, given by the town of Muſſelburgh, which appears to have been ſhot for, as early as the year 1603. The victor in this, as in the other prizes, except the king's prize, has the cuſtody of it for a year, then returns it with a medal appended, on which are engraved any motto and device, which the gainer's fancy dictates. 2. A ſilver arrow given by the town of Peebles A. D. 1626. 3. A ſilver arrow given by the city of Edinburgh, A. D. 1709. 4. A ſilver punch-bowl of about the value of 50l. made of Scottiſh ſilver at the expence of the Company A. D. 1720. And, 5. The king's prize abovementioned, which becomes the abſolute property of the winner. All theſe prizes are ſhot for at what is termed *rovers*, the marks being placed at the diſtance of 185 yards. Beſides theſe, there is another prize annually contended for at butt, or point blank diſtance, called the *gooſe*. The ancient manner of ſhooting for this prize was, a living gooſe was built in a turf-butt, having the head only expoſed to view; and the archer who firſt hit the gooſe's head was entitled to the gooſe as his reward. But this cuſtom, on account of its barbarity, has been long ago laid aſide; and, in place of the gooſe-head, a mark, of about an inch diameter, is affixed upon each butt, and the archer who firſt hits this mark is captain of the butt-ſhooters for a year.

The affairs of the Company are managed by a preſes and ſix counſellors, who are choſen annually by the whole members. The council are veſted with the power of receiving or rejecting candidates for admiſſion, and of appointing the Company's officers, civil and military. The Royal Company now conſiſts of above 1000 members, among whom are moſt of the Scottiſh nobility of the firſt diſtinction. A number of the Company meet weekly during the ſummer-ſeaſon in Edinburgh, in the meadows, where they exerciſe themſelves in ſhooting at butts, or rovers: And in the adjoining ground they have a handſome building, erected within theſe 12 years, with ſuitable offices, whither they adjourn after their exerciſe, and where they hold their elections and other meetings, relative to the buſineſs of the ſociety. The uniform of the Royal Company of Archers is tartan, lined with white, and trimmed with green and white fringes; a white ſaſh, with green taſſels; and a blue bonnet, with a St. Andrew's croſs and feathers. The Company have two ſtandards. The firſt of theſe bears on one ſide Mars and Cupid, encircled in a wreath of thiſtles; with this motto; "*In peace and war.*" On the other, a yew-tree, with two men dreſſed and equipped as archers, encircled as the former; motto, *Dat gloria vires.* The other ſtandard diſplays, on one ſide, a lion rampant gules, on a field or, encircled with a wreath; on the top, a thiſtle and crown; motto, *Nemo me impune laceſſit.* On the other, St. Andrew on the croſs, on a field argent; at the top, a crown; motto, *Dulce pro patria periculum.*

ARCHES, or *Court of Arches.* See the Article *Court of* ARCHES.

ARCHITECT, a perſon ſkilled in architecture, or the art of building, who forms plans and deſigns for edifices, conducts the work, and directs the ſeveral artificers employed in it. The word is derived from ἀρχὸς, *princeps*, and τέκτων, *fabur workman*; q. d. the principal workman.

The importance of the profeſſion of an architect requires a man to be poſſeſſed of very ſuperior talents; and his practical knowledge, together with his ſtudy, very much matured: a very ingenious man of the profeſſion has frequently declared it neceſſary a perſon ſhould live three common ordinary lives to be in full poſſeſſion of all that is requiſite to make a complete architect; yet many bold adventurers from the dogmatic practice of meaſuring artificers works; from the bench; cabinet work and upholſtery; gardening; or a trip to Italy; that do not heſitate to aſſume that character, and to practiſe as a profeſſor; although not really poſſeſſed of either one of the numerous qualifications neceſſary to be underſtood to entitle him to the leaſt claim. It is a ſcience of ſo extenſive a nature, that, to attain a full knowledge of it, requires the ſkill of an uncommon genius, together with much ſcientific experience, like its rival arts, Painting and Sculpture, (only with much greater variety) and not to be eaſily attained, unleſs nature is uncommonly bountiful in her aid. Mechanical arts may be learned; and, in one branch only, it requires the ſtudy and practice of many years to become maſter of it. There are various branches in building, and each (though not equally difficult to comprehend) has its different profeſſors; but the Architect muſt take the whole in view, and have a good general knowledge of them all. Virtruvius, in his firſt book of Architecture, calls it a ſcience, attended with a great diverſity of ſtudy, and requires a peculiar knowledge to judge of all the branches belonging to it; that it is partly founded on Theory, and partly on Practice. That the Theory explains and demonſtrates the convenience and proportions requiſite to form the fabric; and the practical conſiſts in the actual and continual Execution of deſigns; and that, when united in an Architect, makes his abilities the moſt accompliſhed.

Deſigning and drawing are next eſſential to deſcribe the artiſt's ideas on paper, to his employer, and the workmen: Geometry, to conſtruct the works on true principles; Optics, to judge of effects, and the perſpective in all points of view; Arithmetic, to form calculations of the value of works, and the admeaſurement and proportions thereof; Hiſtory, to judge of the claſſical ſtyle and manner of the ancients, according to the various periods of the fluctuation of the arts; Judgment, to form proper ideas of ſituations beſt to build upon, quality of materials, &c. Muſic, to judge of ſounds, and their operations in different conſtructed rooms, and of harmoniac proportions, ſo very applicable to architectural forms; Hydraulics, to manage the neceſſary operations of water.

Beſides theſe, already mentioned by Vitruvius, much more practical knowledge is very eſſential, to judge well of natural and artificial foundations proper to build upon; and of the quality, quantity, and value of all materials, neceſſary and proper to build with; viz. the chalk, lime, ſand, earth, brick, ſtone, timber, tile, ſlate, metals, &c. To be a good mechanic is a very great and eſſential thing; but it ſhould be blended with ſuperior taſte, to enable the deſigner to judge of effects; for, as Wotton ſays, "The architect's glory conſiſts in the deſignment and idea of the work." His ambition ſhould be to make the form triumph over the matter. A man may be a very ingenious and good mechanic, and fall ſhort of that judgment; he may alſo be in poſſeſſion of a refined taſte, and very ready at deſign, without the other requiſites; they muſt be united to make an architect capital. In a word, cloſe application to the ſtudy of ancient maſters, and the remaining works of the ancients, together with judgment and taſte to ſelect, and properly to apply the hints which ſuch examples afford, joined to a peculiar genius for the ſtudy of this art, are abſolutely neceſſary to render an architect eminent in his profeſſion.

Among the architects of Greece, Rome, France, &c. we have the following names handed down to us, as men of great ſkill and eminence in the profeſſion, to many of whoſe works the preſent age is much indebted for their beautiful ideas, judgment of proportion, elegance of ſtyle, and correctneſs of compoſition; viz. Hermogenes, Apollodorus, Tarcheſius, Pytheus, Vitruvius, Scamozzi, Serlio, Palladio, Vignola, Barbaro, Viola, Barozzio, Julius Romanus, Cataneo, Alberti, Perrault, De L'Orme, Le Clerc, Sangello, Bramant, Mich. Angelo, Mau-Clerk, Perault, Blondel, Bernini, Bullant, Cigoli, Berani, Oſio, &c.

We ſhall not, as in the former Edition, enumerate the Engliſh Artiſts from the 12th century to the preſent date, as it would treſpaſs on the limits of our work, and prove unintereſting to the readers.

Mr. Walpole obſerves, that names of artiſts, in the reigns of Edward III. and Henry VI. of which even ſo few records exiſt, are not to be expected; but one, he has found, the particulars of whoſe work are expreſſed with ſuch rude ſimplicity, that it may not be unentertaining to the reader to peruſe them: they are extracted from a book belonging to the Church of St. Mary Ratcliffe, at Briſtol.

Memorandom:

That Maſter Cummings hath delivered the 4th day of July, in the year of our Lord, 1470, to Mr. Nicholas Bettes, vicar of Ratcliffe beforeſaid, a new Sepulchre well gilt, and cover thereto, an image of the Creator, ryſing out of the ſame Sepulchre, with all the ordinance that longeth thereto: that is to ſay,

A lath made of timber and iron-work thereto.

Item, Thereto longeth Heven, made of timber, and ſtained cloth.

Item, Hell, made of timber and iron-work, with devils, the number thirteen;

Item, Four knights armed, keeping the Sepulchre, with their weapons in their hands; that is to ſay, two ſpeares, two axes, two paves*.

Item, Four pair of angels wings, for four angels, made of timber, and well painted;

Item, The Fadre, the crown and viſage, the bell with a croſs† upon it well-gilt with fine gold;

Item, The Holy Ghoſt, coming out of Heven in the Sepulchre;

Item, Longeth to the angels four chevelers‡.

This Memorandum is copied from the Minutes of the Antiquarian Society, under the year 1736.

**Paves*: A pave (in French *pavois* or *talevas*) is a large buckler, forming an angle in front, like the ridge of the houſe, and big enough to cover the talleſt man from head to foot.

† *The bell with the croſs*: Probably the ball or mound.

‡ *Four chevelers*: Chevelures or perukes.

ARCHITECTURE is of three different claſſes; viz. CIVIL, MILITARY, and NAVAL.

CIVIL ARCHITECTURE is the art of contriving, or deſigning and executing, commodious buildings for the uſes of civil life; as Houſes, Churches, Halls, Bridges, Palaces, Colleges, Temples, Porticos, &c. See the following Syſtem.

MILITARY ARCHITECTURE, to deſign and erect Fortifications, Ramparts, &c. for places of defence, as offence againſt an enemy; the Military Architect is called an Engineer. See FORTIFICATION.

NAVAL ARCHITECTURE is the art of laying down, and building all kinds of veſſels to float on the water, and docks for the purpoſes thereof, and other aquatic works belonging thereto; and is called a Ship Builder. See NAVAL AFFAIRS.

Therefore Civil Architecture, by way of pre-eminence, is called ARCHITECTURE.

SYSTEM OF ARCHITECTURE.

PART I.

ORIGIN AND PROGRESS OF ARCHITECTURE.

WE are not to look for the origin of architecture in any ſingle nation; but in every nation, when the inhabitants began to leave off their ſavage way of life, and to become civilized; and if there is any nation to be found which hath been always in a civilized ſtate, we may be aſſured that architecture hath always had an exiſtence there. But whatever may be in this, the origin of regular buildings hath been deduced from the conſtruction of the meaneſt huts in a very natural and plauſible manner by ſeveral authors.

SECT. I. Primitive Huts.

Neceſſity is certainly the parent of moſt of the uſeful arts; therefore, upon that common ground, Sir William Chambers in his excellent Treatiſe on Civil Architecture, takes up the idea of primitive huts; we may therefore venture to proceed on the ſame ground, as the maxim is corroborated by various diſcoveries made by our modern voyagers to the South Seas, and countries in their original ſtate of barbariſm.

The Huts of Terra del Fuego, Oonalaſhka, Kamſchatka, Atooi, the Pelew Iſlands, &c. are evident proofs of the conjecture; with this difference, that they ſeem not yet to have arrived at Sir William's refinement of the ſecond and third claſſes, from which, it is ſuppoſed the orders originated; though, indeed, the inſide of the Kamſchatka habitations and the places of public diverſion of Ulietea, Otaheite, and Poulaho, ſeem to indicate columns. It is hardly to be doubted, but ſome degree of regularity, convenience, and even proportion, in the diſpoſition of the ſeveral parts of original building, were known, and practiſed before the orders were inſtituted; and it is to be lamented, that either through ignorance or obſtinacy, the inhabitants of the northern parts of this enlightened iſland are yet ſtrangers even to that comfort; and, as a proof we truſt that the following detail will not be deemed a digreſſion.

The Bothag or Botheys, ſo called, being the habitations of the farmers in the highlands of Scotland, are in the form of a parallelogram, and built with turf; poſts are worked therein, in a very rough manner, inclining to a point, to form a roof; boughs are laid then, and covered with turf lapping over each other, ſomething in the manner of tiles or ſlates; the turf vegetates in wet weather, and the whole building looks like a green hill; the fireplace is ſurrounded with ſtones of a ſufficient height to ſecure the fire from doing damage, and the ſmoak circulates about the room till it eſcapes out at the door, through the roof, or out of a very ſmall hole cut through the turf for a window (which is without glaſs); the floor is of earth, or clay well trod; and the partitions which divide the bed places, are made of rough ſlabs, nailed up with their uneven edges, without regard to privacy, or common decency; a boarded platform is raiſed above the ground for a bedplace; on which is ſome ſtraw, in a kind of ſack; there they repoſe, with very little covering but their plaid; the gentleman by whom we were favoured with this account, was under the neceſſity of reſiding in this Bothag about five months laſt ſummer. He further obſerved, their principal food was potatoes and oat cake, and that they never had meat, unleſs ſome accident happened to their caſtle; and declared, no part of the family ever waſhed or cleaned themſelves while he had his reſidence with them; the inſide of the building, and every thing therein, appeared of a black bronze colour; in theſe Bothags the Highland farmers ſeem to live happy enough among themſelves; but are not at all fond of, or accommodating to ſtrangers. This family was of ſome repute and property in that part of the country. Its remoteneſs muſt ſurely have never allowed its inhabitants the taſte of the common comforts of life; for it is evident no city in Europe is ſuperior, for taſte and elegance, to its capital, allowing for the magnitude.

SECT. II. Religious Edifices.

Having conſidered the firſt, or primitive idea of dwellings, we now proceed to thoſe of Divine worſhip. The ſuperſtition of conſecrating groves and woods to particular deities, was a practice very uſual with the ancients. Pliny tells us, that trees, in old time, ſerved for the Temples of Gods; Tacitus reports this cuſtom of the old Germans; Q. Curtius of the Indians; and almoſt all writers, of the Druids. The Romans, too, were great admirers of this worſhip, and therefore had their Luci, or conſecrated groves, in moſt parts of the city. The moſt probable reaſon given for this practice is, that thoſe dark and lonely ſituations created that fear and awe which ſtruck them with a more proper degree of divine reverence; therefore, thoſe places, being appointed for their worſhip, gives us the preſumption of Primitive Churches; from which idea, no doubt, the Gothic Architecture ſprung.

The bodies of trees in rows, forming an avenue, reſemble the pillars; the ſhoots and ſuckers adhering thereto the ſmaller pillars; the joints, from whence the buds ſhoot, the aſtragals or mouldings; the boughs and ramifications, the groins and vaulted arches; and their interſecting at the top, and ſome returning downward, the apex, and the pendant ornaments, as in the Chapel of Henry the Seventh, at Weſtminſter Abbey; ſo far we may venture on ideal reaſoning on the conſtruction of Gothic Architecture. Its firſt practice is not eaſy to be traced; indeed we read of its being introduced in Rome when that empire was over-run by the Goths, after the reign of Alexander Severus, but know not from whence to date its origin.

Building, in its primitive ſtate, was undoubtedly not only plain, but irregular; and nothing more conſidered than bare neceſſity urged; when, by degrees, mankind inſenſibly improved in the art, and invented methods to render their habitations comfortable and laſting; and therefore, when ſociety began to encreaſe in numbers and wealth, by traffic and commerce, their ideas made gradual advances toward rule, order, and elegance; and at length diſcovered a ſtyle of building which ſucceeding ages have greatly admired and venerated.

SECT. III. Early State of Architecture Amongst the Egyptians, Persians, Assyrians, &c.

When arts and learning became famous in Egypt, Perſia, Aſſyria, &c. Architecture flouriſhed; for we find works amazingly elaborate, mentioned among the great deſigners cotemporary with Noah; in the year of the world 2038, the walls of Babylon are reported to have been built by Semiramis, they were very magnificent, and eſteemed one of the Seven Wonders of the World; they regarded the greatneſs rather than the elegance or uſefulneſs of their buildings, as appears from the immenſe magnitude of their pyramids and obeliſks.

There are not wanting, however, ſome modern authors, who endeavour to deprive the ancients of what is juſtly their due, and will have every thing to be exaggerated which ſeems beyond the power of modern princes to accompliſh. In this way Mr. Goguet, remarkably diſtinguiſhes himſelf; and that without giving any reaſon at all, but merely that he takes it into his head. Speaking of the wonders of ancient Babylon, "All theſe works (ſays he), ſo marvellous in the judgment of antiquity, appear to me to have been extremely exaggerated by the authors who have ſpoken of them. How can we conceive, in effect, that the walls of Babylon could have been 318 feet high, and 81 in thickneſs, in a compaſs of near ten leagues?" To this we may eaſily reply, that the pyramids of Egypt, and the immenſe wall which divides China from Tartary, ſhew us, that even ſuch a work as the wall of ancient Babylon is ſaid to have been, is not altogether incredible. The loweſt computation of the dimenſion of the Chineſe wall is, that it extends in length 1200 miles, is 18 feet high at a medium and as many thick; according to which computation, it muſt contain 9,504,000 ſolid fathoms; and yet, if we may credit the Chineſe hiſtorians, this immenſe maſs of building was finiſhed in five years. If therefore we can ſuppoſe Nebuchadnezzar, or whoever fortified the city of Babylon, to have been capable of employing as many men for 10 years, as were employed in raiſing the Chineſe wall; we may ſuppoſe him able to have fortified the city of Babylon as ſtrongly as it is ſaid to have been; for the maſs of building is not quite double that of the Chineſe wall, though nearly ſo, amounting to 18,189,000 ſolid fathoms.

The Pyramids or Sepulchres of Egypt, in the deſart of Libya, were wonderful ſtructures; the ground on which the largeſt ſtands containing eleven acres and a quarter, and near five hundred feet high; the baſe of which may be readily compared by the incloſure of Lincoln's-Inn-Fields, which Inigo Jones ſet out, with the reported dimenſions of the largeſt of the Egyptian Pyramids.

The Tower of Babel is another remarkable inſtance of the early knowledge of building. The two famous pillars, one of brick, the other of ſtone, erected ſoon after the flood by the ſons of Noah, on which were recorded the remarkable paſſages, from the creation down to the flood; the palace near Andera in Upper Egypt; the ruins of Perſepolis; the amazing Labyrinths; extenſive lakes; gigantic obeliſks; and wonderful ſtaircaſes, &c. are evident teſtimonies of their ſkill, perſeverance, and progreſs in Mathematical and Architectural arts. Among the ancient Egyptians, Perſians, and Babylonians, the vaſt ſtrength and extent of their buildings ſeem to have been what they chiefly valued; and in this they certainly as much excelled the Greeks and modern nations, as the latter excel them in the beautiful proportion and elegance of their ſtructures.

SECT. IV. Rise and Progress of Architecture among the Greeks.

The arts were firſt conveyed into Greece by Cadmus (Grandſon to Agenor, king of Tyre, 562 years after the walls of Babylon were built) from the Phœnicians, who built Thebes, ſo called from the famous Thebes in Egypt; and we find, that about 300 years after the foundation of Rome was laid, that Phidias, an Athenian, built a Temple of the Doric order, whoſe height was ſixty-eight feet to the roof; and, it is ſaid, the Grecians never made uſe of but one order in the height of their buildings.

Greece was furniſhed with many noble monuments of building, which were brought to Rome by Marcellus; viz. The Temple of Jupiter Olympus, the Temple of Cizenis, which Pliny reports was ſo rich and curiouſly wrought, that in all the joints of the ſtone, threads of gold were inlaid to ſeparate them: the Temple of Trallius; of Diana; of Pallas; of Minerva at Athens; of Apollo, &c. all of which teſtify the nobleneſs, uſe, and beauty of architecture, before it was brought to Rome. The forementioned author relates, that Cecrops, the firſt king of Athens, 200 years before the deſtruction of Troy, founded a ſchool for the inſtruction and encouragement of Architects; and to them the invention of three of the regular orders of Architecture are attributed; viz. The Doric, Ionic, and Corinthian; if they collected any ideas of beauty or proportion from the Egyptians, they cultivated, improved, and brought them to perfection; as the orders alluded to, are yet unexampled

exampled ſtandards of taſte and beautiful proportion, as appears by the remaining antiquities of that country in various publications. Greece happily perfected the art; but ambitious Rome ſtole Architecture from her, and laid deſolate its glory; the Emperors pulled down her ſtately edifices and temples, and tranſported them to Rome; there they confined the art and materials to raiſe and immortalize themſelves and poſterity.

SECT. V. Rise and Progress of Architecture among the Romans.

Rome, poſſeſſed of the ineſtimable prize, and at the ſame time ſo extenſive and opulent, ſelected together the greateſt artiſts of thoſe times; who, by their aſſiduity and unwearied purſuits, traced the paths and footſteps of the Grecians, both in learning, arts, and government. Athens furniſhed them with exemplary rules: and, being naturally aſpiring, they ſhone forth in the luſtre and perfection of Architecture, in the various noble ſtructures and temples which they erected to the honour of their emperors, and the victorious conqueſts they made; particularly in their triumphal arches, aqueducts, and baths, which were amazingly rich and elegant; Circi or Circuſes; that of Maximus is ſaid to have been large enough to contain two hundred and ſixty thouſand ſpectators in their proper places. Caracalla cauſed divers parts of it to be ornamented with paint and gilding; and Heliogabalus ordered its floor, on ſome occaſions, to be ſtrewed with gold and ſilver duſt. Columns and obeliſks; their domi or capital houſes; forums; gates; palaces; porticos; temples in great numbers; theatres and amphitheatres; of which the Coliſeum and theatre of Marcellus, built by Auguſtus, are beautiful remains of Roman antiquity; alſo Mauſoleums, tombs and ſepulchres; luci or groves, &c. &c. Rome, in its flouriſhing ſtate, under the Conſuls and Emperors, who were ſo much diſpoſed to building, at one time is ſaid to have in employ upwards of four hundred architects.

Pompey the Great is reported by Tacitus to have built the firſt amphitheatre at Rome; and Marcellus, happy in victory, together with a fine genius, brought from Greece that moſt beautiful and regular piece of Architecture, called after his name. The magnificence of the Romans in their public buildings, many of which are yet to be ſeen, and others traced by their veſtiges, and which are frequently viſited by admirers of the art, and our modern Architects, who are purſuing the ſtudy; are evident proofs, that the art of Architecture was in their full poſſeſſion for about two centuries, when it declined rapidly as the empire was overturned, after the battle of Actium, when the Goths prevailed, who naturally introduced their own ſtyle of building, which, being grafted to the Roman, produce a miſerable effect. We ſee many inſtances of that clumſy barbarity in various publications, particularly in the views of Venice.

SECT. VI. Origin of the Orders.

The Greeks were the inventors of three of the five orders of Architecture. Anciently (ſays Vitruvius) they were more ignorant of the art of proportioning the various parts of a building; they uſed columns; but they cut them at hazard, without rules, without principles, and without having any attention to the proportions which they ought to give them: they placed them likewiſe without any regard to the other parts of the edifice.

Art. I. *Origin of the Doric Order.*

Dorus, ſon of Helen and grandſon of Deucalion, having cauſed a temple to be built at Argos in honour of Juno, that edifice was found by chance to be conſtructed according to the taſte and proportions of the order which afterwards they called Doric. The form of this building having appeared agreeable, they conformed to it for the conſtruction of edifices which they afterwards had to build.

"About the ſame time, the Athenians ſent into Aſia a colony under the conduct of Ion, nephew of Dorus: this undertaking had very good ſucceſs. Ion ſeized on Caria, and there founded many cities: theſe new inhabitants thought to build temples. They propoſed for a model that of Juno at Argos; but, ignorant of the proportion which they ought to give to the columns, and in general to the whole edifice, they ſought for rules capable of regulating their operation. Theſe people wanted, in making their columns ſufficiently ſtrong to ſupport the whole edifice, to render them at the ſame time agreeable to the ſight. For this purpoſe, they thought to have given it the ſame proportion that they found between the foot of a man and the reſt of his body. According to their ideas, the foot made a ſixth part of the human height; in conſequence, they gave at firſt to a Doric column, taking in its chapiter, ſix of its diameters; that is to ſay, they made it ſix times as high as it was thick: afterwards they added to it a ſeventh diameter.

Art. II. *Origin of the Ionic Order.*

This new order of Architecture was not long in giving birth to a ſecond, that would immediately go beyond their firſt invention. The Ionians tried to throw ſtill more delicacy and elegance into their edifices. They employed the ſame method which they had before put in practice for the compoſition of the Doric order: but inſtead of taking for a model the body of a man, the Ionians were regulated by that of a woman. With a view to make the columns of this new order more agreeable and more pleaſing, they gave them eight times as much height as they had diameter. They alſo made channelings all along the trunk to imitate the folds of the robes of women; the volutes of the chapiter repreſented that part of the hair which hung in curls on each ſide of the face. The Ionians added, laſtly, to theſe columns a baſe, which was not in uſe in the Doric order." According to Vitruvius, theſe baſes were made in the manner of twiſted cords, as a kind of caſe for columns. This order of Architecture was called Ionic, from the name of the people who had invented it. Such is the account given by Vitruvius of the origin of improvements in the proportion of columns.

Art. III. *Origin of the Corinthian Order.*

The Corinthian order was not invented till long after the others, and is ſaid to have taken its riſe from the following accident: A baſket had been ſet upon the ground, and covered with a ſquare tile: there grew near it a plant of acanthus or bears-breech; the leaves ſhot up and covered the outer ſurface of the baſket; and as the ſtalks roſe up among them, they ſoon reached the tile which over-hung the edges of the baſket at the top; this ſtopping their courſe upwards, they curled and twiſted themſelves into a kind of volutes. In this ſituation a ſculptor, (Callimachus), ſaw it; the twiſted part of the ſtalk repreſented to him the volutes of the Ionic capital, which, as they were here ſmaller, and more numerous, appeared in a new form; he ſaw the beauty of raiſing them among leaves, and was ſtruck with the repreſentation of a noble and lofty capital; which being afterwards put into execution, has been univerſally admired.

SECT. VII. Decline of the Arts among the Romans.

How magnificent the Romans were in their temples and public buildings, is yet to be ſeen in what remains of them, and which are not only models for all modern Architects, but have never been ſurpaſſed or even equalled to this day. But though the art of Architecture continued almoſt at its higheſt pitch among the Romans for two centuries, it declined exceedingly as the empire began to fail. Tacitus relates, that after the battle of Actium, no men of genius appeared; and after the reign of Alexander Severus, a manner of building altogether confuſed and irregular was introduced, wherein nothing of the true graces and majeſty of the former was preſerved. When the empire was entirely over-run by the Goths, the conquerors naturally introduced their own method of building. Like the ancient Egyptians, the Goths ſeem to have been more ſtudious to amaze people with the greatneſs of their buildings than to pleaſe the eye with the regularity of their ſtructure, or the propriety of their ornaments. They corrected themſelves, however, a little by the models of the Roman edifices which they ſaw before them; but theſe models themſelves were faulty; and the Goths being totally deſtitute of genius, neither architecture nor any other art could be improved by them. Moſt writers who mention the ancient buildings in this iſland, particularly the religious ones, notwithſtanding the ſtriking difference in the ſtyles of their conſtruction, claſs them all under the common denomination of Gothic; a general appellation by them applied to buildings not exactly conformable to ſome one of the five orders of Architecture. Our modern antiquaries, more accurately, divide them into Saxon,—Norman,—and Saracenic, or that ſpecies vulgarly though improperly called modern Gothic.

SECT. VIII. Of the Saxon and Norman Styles.

It has been maintained by ſome, that the Saxon churches, after they began to be built with ſtone, conſiſted only of upright walls, without pillars or arches, the conſtruction of which it is alledged they were entirely ignorant of. But this opinion is not only contradicted by the teſtimony of ſeveral cotemporary or very ancient writers, who expreſsly mention them both, but alſo by the remains of ſome edifices univerſally allowed to be of Saxon workmanſhip, one of them the ancient conventual church at Ely. Indeed, it is highly improbable that the Saxons could be ignorant of ſo uſeful a contrivance as the arch. Many of them, built by the Romans, they muſt have had before their eyes: ſome of which have reached our days; two particularly are now remaining in Canterbury only; one in the caſtle-yard, the other at Riding-gate. And it is not to be believed, that once knowing them and their convenience, they would neglect to make uſe of them; or having uſed, would relinquiſh them. Beſides, as it appears from undoubted authorities they procured workmen from the Continent to conſtruct their capital buildings "according to the Roman manner," this alone would be ſufficient to confute that ill-grounded opinion; and at the ſame time proves, that what we commonly call Saxon, is in reality Roman Architecture.

This was the ſtyle of building practiſed all over Europe; and it continued to be uſed by the Normans, after their arrival here, till the introduction of what is called the modern Gothic, which was not till about the end of the reign of Henry II. ſo that there ſeems to be little or no grounds for a diſtinction between the Saxon and Norman Architecture. Indeed, it is ſaid, the buildings of the latter were of larger dimenſions both in height and area; and they were conſtructed with a ſtone brought from Caen in Normandy, of which their workmen were peculiarly fond: but this was ſimply an alteration in the ſcale and materials, and not in the manner of the building. The ancient parts of moſt of our cathedrals are of this early Norman work.—The characteriſtic marks of this ſtyle are theſe. The walls are very thick, generally without buttreſſes; the arches, both within and without, as well as thoſe over the doors and windows, ſemicircular, and ſupported by very ſolid, or rather clumſy, columns, with a kind of regular baſe and capital: in ſhort, plainneſs

neſs and ſolidity conſtitute the ſtriking features of this method of building. Nevertheleſs, the architects of thoſe days ſometimes deviated from this rule; their capitals were adorned with carvings of foliage, and even animals; and their maſſive columns decorated with ſmall half columns united to them, and their ſurfaces ornamented with ſpirals, ſquares, lozenge net work, and other figures, either engraved or in relievo. Various inſtances of theſe may be ſeen in the cathedral of Canterbury, particularly the under-croft, the monaſtery at Lindis-farn or Holy Iſland, the cathedral at Durham, and the ruined choir at Orford in Suffolk.

SECT. IX. Of the Modern Gothic or Saracens Style.

To what country or people the modern Gothic, or the ſtyle of building with pointed arches ſo called, owes its origin, ſeems by no means ſatisfactorily determined. Some have imagined it may poſſibly have taken its riſe from thoſe arcades we ſee in the early Norman or Saxon buildings or walls, where the wide ſemicircular arches croſs and interſect each other, and form at their interſection a narrow and ſharp-pointed arch. But it is more generally conjectured to be of Arabian extraction, and to have been introduced into Europe by ſome perſons returning from the Cruſades in the Holy Land. Sir Chriſtopher Wren was of that opinion, and it has been ſubſcribed to by moſt writers who have treated on this ſubject.

The marks which conſtitute the character of Gothic, or Saracenical Architecture, are its numerous and prominent buttreſſes, its lofty ſpires and pinnacles, its large and ramified windows, its ornamental niches or canopies, its ſculptured ſaints, the delicate lace-work of its fretted roofs, and the profuſion of ornaments laviſhed indiſcriminately over the whole building; but its peculiar diſtinguiſhing characteriſtics are, the ſmall cluſtered pillars and pointed arches formed by the ſegments of two interſecting circles; which arches, though laſt brought into uſe, are evidently of more ſimple and obvious conſtruction than the ſemicircular ones; two flat ſtones, with their tops inclined to each other and touching, form its rudiments; a number of bows ſtuck into the ground oppoſite each other, and tied together at the top, in order to form a bower, exactly deſcribe it: whereas a ſemicircular arch appears the reſult of deeper contrivance, as conſiſting of more parts; and it ſeems leſs probable that chance, from whence all theſe inventions were firſt derived, ſhould throw ſeveral wedge-like ſtones between two ſet perpendiculars ſo as exactly to fit and fill up the interval.

Biſhop Warburton, in his notes on Pope's Epiſtles, in the octavo edition, has the following ingenious obſervations on this ſubject:—"Our Gothic anceſtors had juſter and manlier notions of magnificence, on Greek and Roman ideas, than theſe mimics of taſte, who profeſs to ſtudy only claſſic elegance; and becauſe the thing does honour to the genius of thoſe barbarians, I ſhall endeavour to explain it. All our ancient churches are called without diſtinction Gothic, but erroneouſly. They are of two ſorts; the one built in the Saxon times, the other in the Norman. Several cathedral and collegiate churches of the firſt ſort are yet remaining, either in whole or in part; of which this was the original. When the Saxon kings became Chriſtians, their piety (which was the piety of the times) conſiſted chiefly in building churches at home, and performing pilgrimages abroad, eſpecially to the Holy Land; and theſe ſpiritual exerciſes aſſiſted and ſupported one another; for the moſt venerable as well as moſt elegant models of religious edifices were then in Paleſtine. From theſe the Saxon builders took the whole of their ideas, as may be ſeen by comparing the drawings which travellers have given us of the churches yet ſtanding in that country, with the Saxon remains of what we find at home; and particularly in that ſameneſs of ſtyle in the latter religious edifices of the knights temporals (profeſſedly built upon the model of the church of the Holy Sepulchre at Jeruſalem), with the earlier remains of our Saxon edifices. Now the architecture of the Holy Land was Grecian, but greatly fallen from its ancient elegance. Our Saxon performance was indeed a bad copy of it, and as much inferior to the works of St. Helene and Juſtinian, as theirs were to the Grecian models they had followed: yet ſtill the footſteps of ancient art appeared in the circular arches, the entire columns, the diviſion of the entablature into a ſort of architrave, frize, and corniche, and a ſolidity equally diffuſed over the whole maſs. This, by way of diſtinction, I would call the Saxon Architecture. But our Norman works had a very different original. When the Goths had conquered Spain, and the genial warmth of the climate, and the religion of the old inhabitants had ripened their wits and inflamed their miſtaken piety, both kept in exerciſe by the neighbourhood of the Saracens, through emulation of their ſervice, and averſion to their ſuperſtition, they ſtruck out a new ſpecies of Architecture, unknown to Greece and Rome, upon original principles, and ideas much nobler than what had given birth even to claſſical magnificence. For this northern people having been accuſtomed, during the gloom of paganiſm, to worſhip the deity in groves (a practice common to all nations); when their new religion required covered edifices, they ingeniouſly projected to make them reſemble groves, as nearly as the diſtance of Architecture would permit; at once indulging their old prejudices, and providing for their preſent conveniences, by a cool receptacle in a ſultry climate; and with what ſkill and ſucceſs they executed the project by the aſſiſtance of Saracen architects, whoſe exotic ſtyle of building very luckily ſuited their purpoſe, appears from hence, that no attentive obſerver ever viewed a regular avenue of well grown trees intermixing their branches overhead, but preſently put him in mind of the long viſto through the Gothic cathedral; or even entered one of the larger and more elegant edifices of this kind, but it preſented to his imagination an avenue of trees; and this alone is what can be truly called the Gothic ſtyle of building. Under this idea of ſo extraordinary a ſpecies of Architecture, all the irregular tranſgreſſions againſt art, all the monſtrous offences againſt nature, diſappear; every thing has its reaſon, every thing is in order, and an harmonious whole ariſes from the ſtudious application of means proper and proportionate to the end. For could the arches be otherwiſe than pointed, when the workmen were to imitate that curve which branches of two oppoſite trees make by their inſertion with one another? or could the columns be otherwiſe than ſplit into diſtinct ſhafts, when they were to repreſent the ſtems of a clump of trees growing cloſe together? On the ſame principles they formed the ſpreading ramification of the ſtone-work in the windows, and the ſtained glaſs in the interſtices; the one to repreſent the branches, and the other the leaves of an opening grove, and both concurred to preſerve that gloomy light which inſpires religious reverence and dread. Laſtly, we ſee the reaſon of their ſtudied averſion to apparent ſolidity in theſe ſtupendous maſſes, deemed ſo abſurd by men accuſtomed to the apparent as well as real ſtrength of Grecian architecture. Had it been only a wanton exerciſe of the artiſt's ſkill, to ſhew he could give real ſtrength without the appearance of any, we might indeed admire his ſuperior ſcience, but we muſt needs condemn his ill judgment. But when one conſiders, that this ſurpriſing lightneſs was neceſſary to complete the execution of his idea of a ſylvan place of worſhip, one cannot ſufficiently admire the ingenuity of the contrivance. This too will account for the contrary qualities in what I call the Saxon Architecture. Theſe artiſts copied, as has been ſaid, from the churches in the Holy Land, which were built on the models of the Grecian Architecture, but corrupted by prevailing barbariſm; and ſtill farther depraved by a religious idea. The firſt places of Chriſtian worſhip were ſepulchres and ſubterraneous caverns, low and heavy from neceſſity. When Chriſtianity became the religion of the ſtate, and ſumptuous temples began to be erected, they yet, in regard to the firſt pious ages, preſerved the maſſive ſtyle, made ſtill more venerable by the church of the Holy Sepulchre; where this ſtyle was, on a double account, followed and aggravated."

SECT. X. Riſe and Progreſs of Architecture in Britain.

In Britain, before the Roman invaſion, the natives appear to have had no better lodgings than thickets, dens, and caves. Some of theſe caves, which were their winter-habitations, and places of retreat in time of war, were formed and rendered ſecure and warm by art, like thoſe of the ancient Germans, which are thus deſcribed by Tacitus: "They are uſed to dig deep caves in the ground and cover them with earth, where they lay up their proviſions, and dwell in winter for the ſake of warmth. Into thoſe they retire alſo from their enemies, who plunder the open country, but cannot diſcover theſe ſubterranean receſſes." Some of the ſubterraneous, or earth-houſes, as they are called, are ſtill remaining in the weſtern Iſles of Scotland and in Cornwall. The ſummer habitations of the moſt ancient Britons were very ſlight; and, like thoſe of the Finnians, conſiſted only of a few ſtakes driven into the ground, interwoven with wattles, and covered over with the boughs of trees.

When Julius Cæſar invaded Britain, the inhabitants of Cantium (Kent), and of ſome other parts in the ſouth, had learned to build houſes a little more ſubſtantial and convenient. "The country (ſays Cæſar) abounds in houſes, which very much reſemble thoſe of Gaul." The firſt ſtep towards this improvement ſeems to have been that of daubing the wattled walls of their houſes with clay, to fill up the chinks, and make them warmer. "The Germans uſed for this purpoſe a kind of pure reſplendent earth of different colours, which had an appearance of painting at a diſtance;" but the Gauls and Britons choſe rather to white-waſh the clay after it was dry with chalk. Inſtead of the boughs of trees, they thatched theſe houſes with ſtraw, as a much better ſecurity againſt the weather. They next proceeded to form the walls of large beams of wood, inſtead of ſtakes and wattles. This ſeems to have been the mode of building in Britain, when it was firſt invaded by the Romans. "The Britons (ſays Diodorus Siculus, who was cotemporary with Cæſar) dwelt in wretched cottages, which are conſtructed of wood, and covered with ſtraw." Theſe wooden houſes of the ancient Gauls and Britons were not ſquare but circular, with high tapering roofs, at the top or center of which was an aperture for the admiſſion of light and emiſſion of ſmoke. Thoſe of Gaul are thus deſcribed by Strabo: "They build their houſes of wood, in the form of a circle, with lofty tapering roofs." The foundations of ſome of the moſt magnificent of theſe circular houſes were of ſtone, of which there are ſome veſtiges ſtill remaining in Angleſey and other places. It was probably in imitation of theſe wooden houſes, that the moſt ancient ſtone edifices, of which there are ſtill ſome remains in the weſtern iſlands of Scotland, were built circular, and have a large aperture at the top.

When the Britons were invaded by the Romans, they had nothing among them anſwering to our ideas of a city or town, conſiſting of a great number of contiguous houſes, diſpoſed into regular ſtreets, lanes, and courts. Their dwellings, like thoſe of the ancient Germans, were ſcattered about the country, and generally

ſituated

ſituated on the brink of ſome rivulet for the ſake of water, and on the ſkirt of ſome wood or foreſt for the conveniency of hunting and paſture for their cattle. As theſe inviting circumſtances were more conſpicuous in ſome parts of the country than others, the princes and chiefs made choice of theſe places for their reſidence; and a number of their friends and followers, for various reaſons, built their houſes as near to them as they could with conveniency. This naturally produced an ancient Britiſh town, which is deſcribed by Cæſar and Strabo in the following manner: "From the Caſſi he learnt that the town of Caſſivelaun was at no great diſtance; a place defended by woods and marſhes, in which very great numbers of men and cattle were collected. For what the Britons call a town, is a tract of woody country, ſurrounded by a mound and ditch, for the ſecurity of themſelves and their cattle againſt the incurſions of their enemies." "The foreſts of the Britons are their cities; for when they have encloſed a very large circuit with felled trees, they build with it houſes for themſelves and hovels for their cattle. Theſe buildings are very ſlight, and not deſigned for long duration." The palaces of the Britiſh princes were probably built of the ſame materials, and on the ſame plan, with the houſes of their ſubjects, and differed from them only in ſolidity and magnitude.

Though the communication between this iſland and the continent was more free and open after the firſt Roman invaſion than it had been before, and ſome of the Britiſh princes and chieftains even viſited Rome, then in its greateſt glory; it doth not appear that the people of Britain made any conſiderable improvements in their manner of building for at leaſt a hundred years after that invaſion. For when the renowned Caractacus was carried priſoner to Rome, A. D. 52, and obſerved the beauty and magnificence of the buildings in that proud metropolis of the world, he is ſaid to have expreſſed great ſurprize, "That the Romans, who had ſuch magnificent palaces of their own, ſhould envy the wretched cabbins of the Britons."

It muſt appear very ſurprizing that the ancient Britons, when they were ſo ignorant of Architecture, were capable of erecting (if indeed it was erected by them) ſo ſtupendous a fabric as that of Stonehenge on Saliſbury plain. A frabric which hath been the admiration of all ſucceeding ages, and hath outlaſted all the ſolid and noble ſtructures which were erected by the Romans in this iſland. See the article CARNNEDDE.

Of another very extraordinary ſpecies of building ſeveral remains are found in the Highlands of Scotland. They conſiſt of ruins; the walls of which, inſtead of being cemented with lime or ſome other ſimilar ſubſtance, or of being raiſed with dry ſtones, (as was the method before cement came into uſe), are deſcribed as having been vitrefied, or the ſtones run and compacted together by the force of fire. Concerning the origin, uſe, &c. of theſe buildings, different opinions have been formed; and even the reality of them as works of contrivance has been called in queſtion.

But for whatever purpoſes, or by whatever means, the above and other ſimilar ſtructures of a peculiar nature were erected, we have ſufficient evidence that the people of Britain, before they were ſubdued and inſtructed by the Romans, had but a rude knowledge of Architecture, and were very meanly lodged. As ſoon, however, as the Romans began to form ſettlements and plant colonies in this iſland, a ſudden and ſurpriſing change enſued in the ſtate of architecture. For that wonderful people were as induſtrious as they were brave, and made haſte to adorn every country that they conquered. The firſt Roman colony was planted at Camelodunum, A. D. 50; and when it was deſtroyed by the Britons in their great revolt under Boadicia, only eleven years after, it appears to have been a large and well-built town, adorned with ſtatues, temples, theatres, and other public edifices.

The Romans not only built a prodigious number of ſolid, convenient, and magnificent ſtructures for their own accommodation, but they exhorted, encouraged, and inſtructed the Britons to imitate their example. This was one of the arts which Agricola, the moſt excellent of the Roman governors, employed to civilize the Britons, and reconcile them to the Roman government. "The following winter, (ſays Tacitus) was ſpent by Agricola in very ſalutary meaſures. That the Britons, who led a roaming and unſettled life, and were eaſily inſtigated to war, might contract a love to peace and tranquillity, by being accuſtomed to a more pleaſant way of living, he exhorted and aſſiſted them to build houſes, temples, courts, and market-places. By praiſing the diligent, and reproaching the indolent, he excited ſo great an emulation among the Britons, that after they had erected all thoſe neceſſary edifices in their towns, they proceeded to build others merely for ornament and pleaſure, as porticoes, galleries, baths, banqueting-houſes, &c." From this time, which was A. D. 80, to the middle of the fourth century, Architecture, and all the arts immediately connected with it greatly flouriſhed in this iſland; and the ſame taſte for erecting ſolid, convenient, and beautiful buildings, which had long prevailed in Italy, was introduced into Britain. Every Roman colony and free city (of which there was a great number in this country) was a little Rome encompaſſed with ſtrong walls, adorned with temples, palaces, courts, halls, baſiliſks, baths, markets, aqueducts, and many other fine buildings, both for uſe and ornament. The country every where abounded with well-built villages, towns, forts, and ſtations; and the whole was defended by that high and ſtrong wall, with its many towers and caſtles, which reached from the mouth of the river Tine on the eaſt to the Solway Firth on the weſt. This ſpirit of building, which was introduced and encouraged by the Romans, ſo much improved the taſte and encreaſed the number of the Britiſh builders, that in the third century this iſland was famous for the great number and excellence of its architects and artificers. When the emperor Conſtantius, father of Conſtantine the Great, rebuilt the city of Autun in Gaul, A. D. 296, he was chiefly furniſhed with workmen from Britain "which, (ſays Eumenius) very much abounded with the beſt artificers."

Not very long after this period, Architecture, and all the arts connected with it, began to decline very ſenſibly in Britain, and in all the provinces of the weſtern empire. This was partly owing to the building of Conſtantinople, which drew many of the moſt famous architects and other artificers into the eaſt, and partly to the irruptions and depredations of the barbarous nations.

The final departure of the Romans was followed by the almoſt total deſtruction of Architecture in this iſland. For the unhappy and unwarlike people whom they left behind, having neither ſkill nor courage to defend the numerous towns, forts, and cities which they poſſeſſed, they were ſeized by their ferocious invaders, who firſt plundered, and then deſtroyed them. By this means, the many noble ſtructures with which Provincial Britain had been adorned by the art and induſtry of the Romans, were ruined or defaced in a very little time; and the unfortunate Britons were quite incapable of repairing them, or of building others in their room. That long ſucceſſion of miſeries in which they were involved by the Scots, Picts, and Saxons, deprived them of the many uſeful arts which they had learned from their former maſters and lodged them once more in foreſts, dens, and caves, like their ſavage anceſtors. The moſt wanton and extenſive devaſtations were thoſe committed by the Anglo Saxons; among whom it ſeems to have been a maxim to deſtroy all the towns and caſtles which they took from their enemies, inſtead of preſerving them for their own uſe.

It cannot be ſuppoſed, that a people who wantonly demoliſhed ſo many beautiful and uſeful ſtructures had any taſte for the arts by which they had been erected. The truth is that the Anglo Saxons at their arrival in this iſland were almoſt totally ignorant of theſe arts; and like all the other nations of Germany, had been accuſtomed to live in wretched hovels, built of wood or earth, and covered with ſtraw or the branches of trees: nor did they much improve in the knowledge of Architecture for 200 years after their arrival. During that period, maſonry was quite unknown and unpractiſed in this iſland; and the walls, even of cathedral churches were built of wood. "There was a time, (ſays Venerable Bede) when there was not a ſtone church in all the land; but the cuſtom was to build them all of wood. Finan, the ſecond Biſhop of Lindisfarne, or Holy Iſland, built a church in that iſland A. D. 652, for a cathedral which yet was not of ſtone, but of wood, and covered with reeds; and ſo it continued till Eadbert, the ſucceſſor of St. Cuthbert, and ſeventh biſhop of Lindisfarne, took away the reeds, and covered it all over both roof and walls, with ſheets of lead." The firſt cathedral of York was built of the ſame materials; and a church of ſtone was eſteemed a kind of prodigy in thoſe times that merited a place in hiſtory. "Paulinus the firſt biſhop of York, built a church of ſtone in the city of Lincoln, whoſe walls (ſays Bede) are ſtill ſtanding, though the roof is fallen down; and ſome healing miracles are wrought in every year, for the benefit of thoſe who have the faith to ſeek them."

There does not ſeem to have been ſo much as one church of ſtone, nor any artiſts who could build one, in all Scotland; at the beginning of the eighth century. For Naitan, king of the Picts, in his famous letter to Ceolfred, abbot of Weremouth, A. D. 710, earneſtly entreats him to ſend him ſome maſons to build a church of ſtone in his kingdom, in imitation of the Romans; which he promiſes to dedicate to the honour of the apoſtle Peter, to whom the abbey of Weremouth was dedicated: and we are told by Bede, who was then living in that abbey, that the reverend abbot Ceolfred granted this pious requeſt, and ſent maſons according to his deſire.

Maſonry was reſtored, and ſome other arts connected with it introduced into England, towards the end of the ſeventh century, by two clergymen who were great travellers, and had often viſited Rome, where they had acquired ſome taſte for theſe arts. Theſe were the famous Wilfred, biſhop of York, and afterwards of Hexham, and Benedict Biſcop, founder of the abbey of Weremouth. Wilfred, who was one of the moſt ingenious, active, and magnificent prelates of the ſeventh century, was a great builder, and erected ſeveral ſtructures at York, Rippon, and Hexham, which were the admiration of the age in which he flouriſhed. The cathedral of Hexham, which was one of theſe ſtructures, is thus deſcribed by his biographer: "Having obtained a piece of ground at Hexham from Queen Etheldreda, he there founded a moſt magnificent church, which he dedicated to the bleſſed apoſtle, St. Andrew. As the plan of this ſacred ſtructure ſeems to have been inſpired by the ſpirit of God, it would require a genius much ſuperior to mine to deſcribe it properly. How large and ſtrong were the ſubterraneous buildings, conſtructed of the fineſt poliſhed ſtones! how magnificent the ſuperſtructure, with its lofty roof ſupported

by

by many pillars, its long and high walls, its ſublime towers, and winding ſtairs! In one word, there is no church on this ſide of the Alps ſo great and beautiful.

This admired edifice, of which ſome veſtiges are ſtill remaining, was built by maſons and other artificers brought from Rome by the munificence of its generous founder. Benedict Biſcop was the cotemporary and companion of Wilfred in ſome of his journeys and had the ſame taſte for the arts. He made no fewer than ſix journeys to Rome, chiefly with a view of collecting books, pictures, ſtatues, and other curioſities, and of perſuading artificers of various kinds to come from Italy and France and ſettle in England. Having obtained a grant of a conſiderable eſtate from Egfrid, king of Northumberland, near the mouth of the river Were, he there founded a monaſtery A. D. 674. "About a year after the foundations of this monarchy were laid, Benedict croſſ.d the ſea into France, where he collected a number of Maſons, and brought them over with him, in order to build the church of his monaſtery of ſtone, after the Roman manner, of which he was a great admirer.

His love to the apoſtle Peter, to whom he deſigned to dedicate his church, made him urge theſe workmen to labour ſo hard, that maſs was celebrated in it about a year after it was founded. When the work was far advanced, he ſent agents into France to procure if poſſible ſome glaſs makers, a kind of artificers quite unknown in England, and to bring them over to glaze the windows of his church and monaſtery. Theſe agents were ſucceſsful, and brought ſeveral glaſs-makers with them; who not only performed the work required by Benedict, but inſtructed the Engliſh in the art of making glaſs for windows, lamps, drinking-veſſels, and other uſes."

But though theſe arts of building edifices of ſtone, with windows of glaſs, and other ornaments, were thus introduced by theſe two prelates in the latter part of the ſeventh century, they do not ſeem to have flouriſhed much for ſeveral centuries. It appears from many incidental hints in our ancient hiſtorians, that ſtone buildings were ſtill very rare in the eighth and ninth ages; and that when any ſuch buildings were erected, they were the objects of much admiration. When Alfred the Great, towards the end of the ninth century, formed the deſign of rebuilding his ruined cities, churches and monaſteries, and of adorning his dominions with more magnificent ſtructures, he was obliged to bring many of his artificers from foreign countries. "Of theſe (as we are told by his friend and companion Aſſerius) he had an almoſt innumerable multitude, collected from different nations; many of them the moſt excellent in their ſeveral arts."

In the other parts of this iſland Architecture was, as might naturally be imagined, in a ſtill leſs flouriſhing ſtate. It appears indeed to have been almoſt entirely loſt among the poſterity of the ancient Britons after they retired to the mountains of Wales. The chief palace of the kings of Wales, where the nobility and wiſe men aſſembled for making laws, was called the white palace, becauſe the walls of it were woven with white wands; which had the bark peeled off. By the laws of Wales, whoever burnt or deſtroyed the king's hall or palace was obliged to pay one pound and eighty-pence, beſides one hundred and twenty-pence for each of the adjacent buildings, which were eight in number; viz. the dormitory, the kitchen, the chapel, the granary, the bake-houſe, the ſtore-houſe, the ſtable, and the dog-houſe. From hence it appears, that a royal reſidence in Wales, with all its offices, when theſe laws were made, was valued at five pounds and eighty-pence of the money of that age, equal in quantity of ſilver to ſixteen pounds of our money, and in efficacy to one hundred and ſixty. This is certainly a ſufficient proof of the meanneſs of thoſe buildings which were only of wood. Even the caſtles in Wales, in this period, that were built for the ſecurity of the country, appear to have been conſtructed of the ſame materials; for the laws required the king's vaſſals to come to the building of theſe caſtles with no other tools but an axe.

The arts of building do not ſeem to have been much better underſtood by the Scots and Picts than by the ancient Britons in the former part of this period. When Finan, the ſecond biſhop of Lindisfarne, built a church of wood in that Iſland A. D. 652, he is ſaid to have done it *more Scotorum*, after the manner of his countrymen the Scots; and it hath been already obſerved, that Naitan king of the Picts was obliged to bring maſons from Northumberland when he reſolved to build a church of ſtone in his dominions A. D. 710. After this laſt period, it is probable that the Picts, and perhaps the Scots, began to learn and practiſe the art of maſonry; becauſe there are ſtill ſome ſtone buildings of a very ſingular conſtruction, and great antiquity, to be ſeen in Scotland. Theſe buildings are all circular; though of two kinds ſo different from each other, that they ſeem to be the works of different ages and of different nations.

The largeſt of theſe ſtructures are in a very extraordinary taſte of Architecture; and are thus deſcribed by a modern antiquary, who viewed them with no little attention. "Having arrived at the barrack of Glenelg, I was conducted to the remains of thoſe ſtupendous fabrics, ſeated about two miles from thence, in a valley called Glenbeg, in which four of them anciently ſtood. Two of theſe are now almoſt quite demoliſhed, the third is half fallen down, the fourth is almoſt entire. The firſt I met with lies towards the north ſide of the valley, and is called Caſtle Chalamine, or Malcom's Caſtle. It ſtands upon a conſiderable eminence, and affords us a fine proſpect of the iſland of Iſky, and a good part of the ſea-coaſt. The foundation of this only appears: as alſo of that other, on the eaſt end of the valley, called Caſtle Chonel. About a quarter of a mile further, upon the bank of a rivulet which paſſes through the middle of the glen, ſtands the third fabric, called Caſtle Tellve. I found it compoſed of ſtones without cement; not laid in regular courſes, after the manner of elegant buildings, but rudely and without order. Thoſe toward the baſe were pretty large, but aſcending higher, they were thin and flat, ſome of them ſcarce exceeding the thickneſs of an ordinary brick. I was ſurprized to find no windows on the outſide, nor any manner of entrance into the fabric, except a hole towards the weſt, at the baſe, ſo very low and narrow, that I was forced to creep in upon hands and knees, and found that it carried me down four or five ſteps below the ſurface of the ground. When I was got within, I was environed betwixt two walls, having a cavity or void ſpace which led me round the whole building. Oppoſite to the little entry on the outſide was a pretty large door in the ſecond or inner wall, which led me into the area or inner court. When I was there, I perceived that one half of the building was fallen down, and thereby had the opportunity of ſeeing a complete ſection. The two walls join together at the top, round about, and have formed a large void ſpace or area in the middle.

This art received very great improvements in the 12th century; which indeed may be called the age of Architecture; when the rage for building was more violent in England than at any other time. The great and general improvements that were made in the fabrics of houſes and churches in the firſt years of this century, are thus deſcribed by a cotemporary writer. "The new cathedrals and innumerable churches that were built in all parts, together with the many magnificent cloiſters and monaſteries, and other apartments of monks, that were then erected, afford a ſufficient proof of the great felicity of England in the reign of Henry I. The religious of every order, enjoying peace and proſperity, diſplayed the moſt aſtoniſhing ardour in every thing that might increaſe the ſplendor of divine worſhip. The fervent zeal of the faithful prompted them to pull down houſes and churches every where, and rebuild them in a better manner. By this means the ancient edifices that had been raiſed in the days of Edgar, Edward, and other Chriſtian kings, were demoliſhed, and others of greater magnitude and magnificence, and of more elegant workmanſhip, were erected in their room, to the glory of God."

As the prodigious power of religious zeal, whatever turn it happens to take, when it is thoroughly heated, is well known, it may not be improper to give one example of the arts employed by the clergy and monks of this period, to inflame the pious ardour of the kings, nobles, and people, for building and adorning churches. When Joffred Abbot of Croyland reſolved to rebuild the church of his monaſtery in a moſt magnificent manner, A. D. 1166, he obtained from the Archbiſhops of Canterbury and York, a bull diſpenſing with the third part of all penances for ſin to thoſe who contributed any thing towards the building of that church. This bull was directed not only to the king and people of England, but to the kings of France and Scotland, and to all other kings, earls, barons, archbiſhops, biſhops, abbots, priors, rectors, preſbyters, and clerks, and to all true believers in Chriſt, rich and poor, in all Chriſtian kingdoms. To make the beſt uſe of this bull, he ſent two of his moſt eloquent monks to proclaim it over all France and Flanders, two other monks into Scotland, two into Denmark and Norway, two into Wales, Cornwall, and Ireland, and others into different parts of England. "By this means (ſays the hiſtorian) the wonderful benefits granted to all the contributors to the building of this church were publiſhed to the very ends of the earth; and great heaps of treaſure and maſſes of yellow metal flowed in from all countries upon the venerable Abbot Joffred, and encouraged him to lay the foundations of his church." Having ſpent about four years in collecting mountains of different kinds of marble from quarries both at home and abroad, together with great quantities of lime, iron, braſs, and other materials for building, he fixed a day for the great ceremony of laying the foundation, which he contrived to make a very effectual mean of raiſing the ſuperſtructure: For on the long-expected day, the feaſt of the Holy Virgins Felicitas and Perpetua, an immenſe multitude of earls, barons, and knights, with their ladies and families, of abbots, priors, monks, nuns, clerks, and perſons of all ranks, arrived at Croyland to aſſiſt at this ceremony. The pious Abbot Joffred began by ſaying certain prayers, and ſhedding a flood of tears on the foundation. Then each of the earls, barons, knights, with their ladies, ſons, and daughters, the abbots, clerks, and others, laid a ſtone, and upon it depoſited a ſum of money, a grant of lands, tithes, or patronages, or a promiſe of ſtone, lime, wood, labour, or carriages, for building the church.

After this the abbot entertained the whole company, amounting to 5000 perſons, at dinner. To this entertainment they were all entitled; for the money, and grants of different kinds, which they had depoſited on the foundation-ſtones, were alone ſufficient to have raiſed a very noble fabric. By ſuch arts as theſe the clergy inſpired kings, nobles, and people of all ranks, with ſo ardent a ſpirit for theſe pious works, that in the courſe of this period almoſt

all the facred edifices in England were rebuilt, and many hundreds of new ones raſed from the foundation. Nor was this ſpirit confined to England, but prevailed as much in Scotland in proportion to its extent and riches. King David I. alone, beſides ſeveral cathedrals and other churches, built no fewer than thirteen abbeys and priories, ſome of which were very magnificent ſtructures. The ſacred Architecture of the Anglo-Normans in the beginning of this period did not differ much in its ſtyle and manner from that of the Anglo-Saxons; their churches being in general plain, low, ſtrong, and dark; the arches both of the doors and windows ſemicircular, with few or no ornaments. By degrees, through much practice, our Architects, who were all monks or clergymen, improved in their taſte and ſkill, and ventured to form plans of more noble, light, and elevated ſtructures, with a great variety of ornaments; which led to that bold magnificent ſtyle of building, commonly, though perhaps not very properly, called the later Gothic. It is not improbable that our monkiſh Architects were aſſiſted in attaining this ſtyle of buildings by models from foreign countries, or by inſtructions from ſuch of their own number, as had viſited Italy, France, Spain, or the Eaſt. But the origin of this ſtyle of Architecture has been already conſidered, and the characters by which it is diſtinguiſhed from the ancient Gothic have alſo been deſcribed: Its firſt appearance in England was towards the latter end of the reign of King Henry II. But it was not at once thoroughly adopted; ſome ſhort ſolid columns and ſemicircular arches being retained and mixed with the pointed ones: as for example, in the weſt end of the old Temple Church and at York, were under the choir there remains much of the ancient work, the arches of which are but juſt pointed and riſe on ſhort round pillars. The Temple Church of London is of ancient foundation, ſome have delivered that Dunwallo Molmutius, a king here in Britain, about the year of the world 5748, anno domini 34, built here a temple, to which, as to ſome other places, he aſſigned ſanctuary privileges; and that he was there buried, with ſeveral others of the Britiſh kings. But for that excellent ſtructure now ſtanding, it is of a far later extraction; being built by the Knights Templars in the reign of Henry the ſecond, anno 1185, and dedicated to Heraclius, patriarch, teſtified by an inſcription over one of the doors for that purpoſe. The entrance is through a circular tower, of Saxon Architecture, and the nave, or body of the church, is of the Saracenic, or improved Gothic.

In the reign of Henry III. however, this manner of building ſeems to have gained a complete introduction; the circular giving place to the pointed arch, and the maſſive column yielding to the ſlender pillar. Indeed, like all novelties, when once admitted, the rage of faſhion made it become ſo prevalent, that many of the ancient and ſolid buildings, erected in former ages, were taken down in order to be re-edified in the new taſte, or had additions patched to them, of this mode of Architecture. Henry the third, who founded the Domus Converſorum, near London, for the convert Jews, gave ſeven hundred marks for the building of a church, with other convenient ſtructures, for the converted. But upon the baniſhment of that people, the houſe was annexed to the Maſter of the Rolls, by patent; and the church, now known by the name of the Chapel of the Rolls, in Chancery-lane. *Cart.* 16, *H.* 3. *M.* 10.

The preſent cathedral church of Saliſbury was begun early in this reign, and finiſhed in the year 1258. It is entirely in the Saracenic ſtyle; and, according to Sir Chriſtopher Wren, may be juſtly accounted one of the beſt patterns of Architecture of the age in which it was built. Its excellency is undoubtedly in a great meaſure owing to its being conſtructed on one plan; whence ariſes that ſymmetry and agreement of parts, not to be met with in many of our other cathedral churches; which have moſtly been built at different times, and in a variety of ſtyles. From this time till the reign of Henry VIII. the faſhionable pillars in churches were of Purbec marble, very ſlender and round, encompaſſed with marble ſhafts a little detached, having each a capital adorned with foliage, which joining, formed one elegant capital for the whole pillar. The windows were long and narrow, with pointed arches and painted glaſs, which were introduced about that time, or at leaſt became more common. In this century alſo they began to delight in lofty ſteeples, with ſpires and pinnacles. In the fourteenth century, the pillars conſiſted of an aſſemblage of ſhafts not detached, but united, forming one ſolid and elegant column; the windows, eſpecially thoſe in the eaſt and weſt ends, were greatly enlarged, divided into ſeveral lights by ſtone mullions running into ramifications above, and forming numerous compartments in various fanciful ſhapes. Thoſe windows, filled with ſtained glaſs of the moſt lively colours, repreſenting kings, ſaints, and martyrs, and their hiſtories, made a moſt ſolemn and glorious appearance. There were ſeveral other variations, eſpecially in the taſte of the carvings and other ornaments, which are too minute for general hiſtory.

As to the ſtate of civil Architecture during the ſame period: The houſes of the common people in the country, and of the lower burgeſſes in towns and cities, were very little improved in their ſtructure, that moſt numerous and uſeful order of men being much depreſſed in the times we are now delineating. Even in the capital city of London, all the houſes of mechanics and common burgeſſes were built of wood, and covered with ſtraw or reeds, towards the end of the 12th century. But the palaces, or rather caſtles, of the Anglo-Norman kings, barons, and prelates, were very different from the reſidences of perſons of the ſame rank in the Anglo-Saxon times. For this we have the teſtimony of a perſon of undoubted credit, who was well acquainted with them both. "The Anglo-Saxon nobles (ſays William of Malmſbury) ſquandered away their ample revenues in low and mean houſes; but the French and Norman barons are very different from them, living at leſs expence, but in great and magnificent palaces." The truth is, that the rage of building fortified caſtles, was no leſs violent among the Norman princes, prelates, and barons, than that of building churches. To this they were prompted, not only by the cuſtom of their native country, but alſo by their dangerous ſituation in this iſland. Surrounded by multitudes, whom they had depreſſed and plundered, and by whom they were abhorred, they could not think themſelves ſafe without the protection of deep ditches and ſtrong walls. The conqueror himſelf was ſenſible, that the want of fortified places in England had greatly facilitated his conqueſt, and might facilitate his expulſion; and therefore he made all poſſible haſte to remedy this defect, by building very magnificent and ſtrong caſtles in all the towns within the royal demeſnes. "William (ſays Matthew Paris) excelled all his predeceſſors in building caſtles, and greatly harraſſed his ſubjects and vaſſals with theſe works." All his earls, barons, and even prelates, imitated his example: and it was the firſt care of every one who received the grant of an eſtate from the crown, to build a caſtle upon it for his defence and reſidence. The diſputes about the ſucceſſion in the following reigns, kept up this ſpirit for building great and ſtrong caſtles. William Rufus was ſtill a greater builder than his father. "This William (ſays Henry Knyghton) was much addicted to building royal caſtles and palaces, as the caſtles of Dover, Windſor, Norwich, Exeter, the palace of Weſtminſter, and many others teſtify, nor was there any king of England before him that erected ſo many and ſuch noble edifices." Henry I. was alſo a great builder both of caſtles and monaſteries. But this rage for building never prevailed ſo much in any period of the Engliſh hiſtory as in the turbulent reign of king Stephen, from A. D. 1135 to A. D. 1154. "In this reign (as we are told by the author of the Saxon Chronicle) every one who was able built a caſtle: ſo that the poor people were worn out with the toil of theſe buildings, and the whole kingdom was covered with caſtles." This laſt expreſſion will hardly appear too ſtrong, when we are informed, that beſides all the caſtles before that time in England, no fewer than 1115 were raiſed from the foundation in the ſhort ſpace of 19 years.

The caſtles, monaſteries, and greater churches of this period, were generally covered with lead, the windows glazed; and when the walls were not of aſhler, they were neatly plaſtered, and whitewaſhed on both ſides. The doors, floors, and roof, were commonly made of oak planks and beams, exactly ſmoothed and jointed, and frequently carved. It is hardly neceſſary to obſerve, that the building one of theſe great magnificent caſtles, monaſteries, or churches, of which there were many in England, muſt have been a work of prodigious expence and labour; and that the Architects and Artificers, by whom that work was planned and executed, muſt have attained conſiderable dexterity in their reſpective arts. Several of theſe Architects have obtained a place in hiſtory, and are highly celebrated for their ſuperior ſkill. William of Sens, Architect to Archbiſhop Lanfranc in building his cathedral, is ſaid, by Gervaſe of Canterbury, to have been a moſt exquiſite artiſt both in ſtone and wood. He made not only a model of the whole cathedral, but of every particular piece of ſculpture and carving, for the direction of the workmen; and invented many curious machines for loading and unloading ſhips, and conveying heavy weights by land, becauſe all the ſtones were brought from Normandy. Matthew Paris ſpeaks even in a higher ſtrain of Walter of Coventry, who flouriſhed towards the end of this period, when he ſays, that "ſo excellent an Architect had never yet appeared, and probably never would appear, in the world." This encomium was undoubtedly too high; but it is impoſſible to view the remains of many magnificent fabrics, both ſacred and civil, that were erected in this period, without admiring the genius of the Architects by whom they were planned, and the dexterity of the workmen by whom they were executed.

The abbeys, cathedrals, and college buildings, erected in the improved ſtyle, were many, and ſome of them extremely grand; and if the Architects of that day had not the happineſs of adopting the ſimplicity and proportion of the Greek orders, they were, however ſo lucky as to ſtrike out a thouſand graces, and effects, which rendered their buildings magnificent, yet genteel, vaſt yet light, venerable and picturesque; for inſtance, the cathedral at Rheims, and ſeveral of the cathedrals in England.

It is difficult for the nobleſt Grecian Temple to convey half ſo many impreſſions on the mind as a cathedral does, of the beſt Gothic or Saracenic Architecture; a proof of ſkill in the Architects, and of addreſs in the prieſts who erected them, the latter exhauſted their knowledge of the paſſions in compoſing edifices, whoſe pomp, mechaniſm, vaults, tombs, painted windows, gloom, and perſpectives, infuſed ſuch ſenſations of romantic devotion, that they were happy in finding artiſts, capable of executing ſuch machinery; we muſt have taſte to be ſenſible of the beauties of Grecian Architecture; we only want paſſions to feel Gothic: In St. Peter's, or St. Paul's, we are convinced they were built by great

Princes

Princes. In Weſtminſter Abbey, and Gothic cathedrals, we think not of the builder, the religion of the place makes the firſt impreſſion; and though ſtripped of its altars and ſhrines, it is nearer converting us to popery, than all the regular pageantry of Roman domes. Gothic churches infuſe ſuperſtition; Grecian admiration; the papal ſee amaſſed its wealth by Gothic cathedrals, and diſplays it in Grecian temples; certainly there is no compariſon between the rational beauties of regular Architecture, and the unreſtrained licentiouſneſs of that which is called Gothic; yet it is certain, the perſons who executed the latter, had much more knowledge of their art, more taſte, more genius, and more propriety than we chuſe to imagine. There is a magic hardneſs in the execution of ſome of ſome of their works, which would not have ſuſtained themſelves if dictated by mere caprice.

There is a tradition that Sir Chriſtopher Wren went once a year to ſurvey the roof of the chapel of King's College, Cambridge, and ſaid, that if any man would ſhew him where to place the firſt ſtone, he would engage to build ſuch another. That there is great grace in ſeveral places, even in their cluſters of ſlender pillars, and in the application of their ornaments; though the principles of the latter are ſo confined, that they may almoſt all be reduced to the trefoil, extended and varied; it is not neceſſary to appeal to the edifices themſelves. It is ſufficient to obſerve, that Inigo Jones, Sir Chriſtopher Wren, and Mr. Kent, &c. who certainly underſtood beauty, blundered into the heavieſt and clumſieſt compoſitions, whenever they aimed at imitations of the Gothic, particularly at Lincoln's Inn Chapel, the ſteeple of the church at Warwick, the King's Bench in Weſtminſter Hall, the ſcreen at Glouceſter, Eſher in Surrey, &c. &c. is an art deſpicable in which a great maſter cannot ſhine.

Conſidering how ſcrupulouſly our Architects confine themſelves to antique precedent, perhaps ſome deviations into Gothic may a little relieve them from that ſervile imitation; that is, that they ſhould ſtudy both taſtes, not blend them, as we ſee in many inſtances. Where Architects make additions or alterations, differing from the ſtyle of the original building; as if they meant to record every alteration with the ſervile faſhion of the day, however ridiculous; at leaſt, externally, the ſtyle ſhould be preſerved. Architecture is an extenſive field, and it is a pity that the art ſhould be reſtrained too much, as, it is evident, it contains ſufficient variety to furniſh infinite ſcenes of ſingular beauty. The application of loggia's arcades, terraces, and flights of ſteps, at different ſtages of a building, would contribute much to magnificence. It is true, our climate, and the expence of building in England, are great reſtrictions on imagination; but when we talk of the extent of which Architecture is capable, we may ſuppoſe that pomp and beauty are the principal objects; we ſpeak of palaces, public buildings, and houſes of nobility; not of ſmall houſes, &c.

It is certain that the Gothic or Saracenic taſte remained in vogue till toward the end of the reign of Henry the Eighth, but ſoon after the Grecian ſtyle was introduced; and no wonder when ſo many Italians were entertained in the King's ſervice. They had ſeen that Architecture revived in their own country in all its purity; but whether they were not maſters of it, or that it was neceſſary to introduce the innovation by degrees, it certainly did not at firſt obtain full poſſeſſion, it was plaiſtered upon Gothic, and made a barbarous mixture (ſimilar to the introduction of the Saracenic with the Saxons and Normans). Regular columns, with ornaments neither Grecian nor Gothic, and half embroidered with foliage, were crammed over frontiſpieces, facades, chimnies, &c. and loſt all grace, by wanting ſimplicity. This mungrel ſpecies laſted till late in the reign of James the Firſt.

The beginning of reformation in building, ſeems owing to Hans Holbein: his porch at Wilton, though purer than the work of his ſucceſſors, is of the baſtard ſort: but the ornaments and proportions of his works are graceful and well choſen. Henry had actually an Italian, whom, it is ſuppoſed, introduced regular Architecture: but it is doubted whether he or Holbein firſt arrived in England. He was called John of Padua: and his very office ſeems to intimate ſomething novel in his practice. He was termed *Deviſor of his Majeſty's buildings.*

In the beginning of the reign of Henry VIII. or rather towards the latter end of that of Henry VII. when brick building became common, a new kind of low pointed arch grew much in uſe: it was deſcribed from four centers, was very round at the haunches, and the angle at the top was very obtuſe. This ſort of arch is to be found in every one of Cardinal Wolſey's buildings; alſo at Weſt Sheen; an ancient brick gate at Mile End, called King John's Gate; and in the great gate of the palace of Lambeth. From this time Gothic Architecture began to decline; and was ſoon after ſupplanted by a mixed ſtyle, if one may venture to call it one; wherein the Grecian and Gothic, however diſcordant and irreconcileable, are jumbled together. Concerning this mode of building, Mr. Warton, in his obſervations on Spencer's Fairy Queen, has the following anecdotes and remarks:

"Although the Roman or Grecian Architecture did not begin to prevail in England till the time of our communication with the Italians, and our imitation of their manners, produced ſome ſpecimens of that ſtyle much earlier. Perhaps the earlieſt was Somerſet Houſe in the Strand, built about the year 1549, by the Duke of Somerſet, uncle to Edward VI. The monument of Biſhop Gardiner, in Wincheſter cathedral, made in the reign of Mary, about 1555, is decorated with Ionic pillars. Theſe verſes of Spencer,

> ——————————Did riſe
> On ſtately pillars, fram'd after the Doric guiſe,

bear an alluſion to ſome of the faſhionable improvements in building, which at this time were growing more and more into eſteem. Thus alſo Biſhop Hall, who wrote about the ſame time, viz. 1598:

> There findeſt thou ſome ſtately Doricke frame,
> Or neat Ionicke work.——————

But theſe ornaments were often abſurdly introduced into the old Gothic ſtyle; as in the magnificent portico of the ſchools at Oxford, erected about the year 1613; where the builder, in a Gothic edifice, has affectedly diſplayed his univerſal ſkill in the modern Architecture, by giving us all the five orders together. However, moſt of the great buildings of Queen Elizabeth's reign have a ſtyle peculiar to themſelves both in form and finiſhing; where, though much of the old Gothic is retained, and great part of the new taſte is adopted, yet neither predominates; while both, thus diſtinctly blended, compoſe a fantaſtic ſpecies, hardly reducible to any claſs or name. One of its characteriſtics is the affectation of large and loſty windows: where, ſays Bacon, "you ſhall have ſometimes fair houſes ſo full of glaſs, that one cannot tell where to come to be out of the ſun."

To return now to our general hiſtory, and to conclude: In the 15th and 16th centuries, when learning of all kinds began to revive, the chaſte Architecture of the Greeks and Romans ſeemed as it were to be recalled into life. The firſt improvements in it began in Italy, and owed their exiſtence to the many ruins of the ancient Roman ſtructures that were to be found in that country, from whence an improved method of building was gradually brought into the other countries of Europe: and though the Italians for a long time retained the ſuperiority as Architects over the other European nations; yet, as men of genius travelled from all quarters into Italy, where they had an opportunity of ſeeing the originals from whence the Italians copied, Architects have ariſen in other nations equal, if not ſuperior, to any that ever appeared in Italy. So that Architecture was not brought to any great degree of perfection till the reign of Charles the Firſt, when Inigo Jones recovered the full powers of Grecian Architecture; he was ſucceeded by Sir Chriſtopher Wren, who died in 1723, and left St. Paul's, with many other capital buildings, as his monuments and ſtandards for ſucceeding ages; very little violation of that true taſte has been committed, except by Sir John Vanburgh and his diſciples, who built priſons for dwelling-houſes; and we may boaſt to this day, that the purity of Grecian and Roman Architecture, together with elegant, uſeful, and convenient habitations, are as well known and practiced in this country, as in either Greece or Rome, in its flouriſhing ſtate: which our modern churches, public buildings, ſquares, ſtreets, bridges, pantheon, ſcreens, colonades, noblemens ſeats, and private houſes, teſtify.

PART. II.

PRINCIPLES OF ARCHITECTURE.

SECTION I. Invention, Taste, and Judgment.

We ſhall next view Architecture as one of the fine arts; which will lead us to the examination of ſuch buildings, and parts of buildings, as are calculated ſolely to pleaſe the eye. Variety prevails in the works of nature; but art requires to be guided by rule and compaſs. Hence it is, that in ſuch works of art as imitate nature, the great art is, to hide every appearance of art; which is done by avoiding regularity, and indulging variety. But in works of art that are original, and not imitative, ſuch as Architecture, ſtrict regularity and uniformity ought to be ſtudied, ſo far as conſiſtent with utility. Utility was its original deſtination, and ſtill continues to be its principal end. Experience, however, has taught us, that Architecture is capable of exciting a variety of agreeable feelings. Of theſe, utility, grandeur, regularity, order, and proportion, are the chief.

Article I. *Invention.*

Invention is indiſputably neceſſary to the purpoſe of deſign; the arrangement of rooms or apartments for oratory, ſtate, public buſineſs, routs, viſitors, retiring, eating, reading, ſtudy, dreſſing, living, ſleeping, and other purpoſes, together with their appendages and inferior offices of all denominations required to be annexed thereto, whether of a public or private nature, connection; convenience and good arragement, are the great eſſentials.

Article II. *Taſte.*

Taſte for conſtructing and introducing of forms that pleaſe and faſcinate the beholder, with regard to the plan, elevation, ſection, convenience, and beautiful proportions. As to the plan: the arrangement, proportion, and decoration of rooms for the purpoſes they are intended ſeparately; and connected, reſpectively. As to the elevation, character ſuitable to the purpoſe the building is intended for; correctneſs in the ſtyle of Architecture made choice of; harmony in the whole maſs of building; and beautiful proportional form of the conſtituent parts of which it is compoſed; if to

advance,

advance, or recede, to be well connected; in which much optical knowledge muſt be obſerved. Artiſts who deal in the beautiful, love to entertain the eye; palaces and ſumptuous buildings, in which intrinſic beauty may be fully diſplayed, give them an opportunity of exerting their taſte. But ſuch a propenſity is peculiarly unhappy with regard to private dwelling-houſes; becauſe, in theſe, relative beauty cannot be diſplayed to perfection, without hurting intrinſic beauty.

Article III. *Judgment.*

Judgment, geometrical and philoſophical; the geometrical conſiſts in conſtructing the building upon true principles, that the Architect may form his deſign, ſo as it may be put into execution with firmneſs and durable materials, and that the artiſt makes the beſt of ſuch as are attainable. The philoſophical conſiſts in the knowledge of the quality of materials of all kinds, and to judge what are moſt proper for the intended purpoſe, and of foundations natural and artificial; alſo earths, waters, metals, timber, &c. "An ingenious author on the ſubject of proportions of external and internal objects, ſays, that proportion requires our niceſt application to attain. To ſee on a conſiderable eminence the length of a front trifling, and the height diſproportioned, would appear as abſurd, as to behold a front in a vale long and extended, and elevated only one ſtory. And this choice muſt likewiſe be dependent upon rules; for as the jarring of inſtruments by blind chance cannot poſſibly pleaſe the ear, ſo the diſproportion of the parts of any object muſt naturally ſhock the eye; and in both unerring rules muſt ſo proportion the ſounds, and diſpoſe the parts, as the whole may be in a complete harmony.

With reſpect to buildings of every kind, one rule, dictated by utility, is, that they be firm and ſtable. Another dictated by beauty is, that they alſo appear ſo to the eye: for every thing that appears tottering, and in hazard of tumbling down, produceth in the ſpectator the painful emotion of fear, inſtead of the pleaſing emotion of beauty; and accordingly it ſhould be the great care of the artiſt, that every part of his edifice appear to be well ſupported. The unwearied propenſity to make a houſe regular as well as convenient, obliges the Architect, in ſome articles, to ſacrifice convenience to regularity; and, in others, regularity to convenience; and accordingly the houſe which turns out neither regular nor convenient, never fails to diſpleaſe. Nothing can be more evident, than that the form of a dwelling houſe ought to be ſuited to the climate; yet no error is more common than to copy in Britain the form of Italian houſes, not forgetting even thoſe parts that are purpoſely contrived for collecting air, and for excluding the ſun: witneſs our colonnades and logios, deſigned by the Italians to gather cool air, and exclude the beams of the ſun, conveniencies which the climate of this country does not require.

Architecture being a uſeful as well as a fine art, leads us to diſtinguiſh buildings, and parts of buildings, into three kinds, viz. what are intended for uſe only, what for ornament ſolely, and what for both. Buildings intended for utility ſolely, ought in every part to correſpond preciſely to that intention; the leaſt deviation from uſe, though contributing to ornament, will be diſagreeable; for every work of uſe being conſidered as a mean to an end, its perfection as a mean is the capital circumſtance, and every other beauty in oppoſition is neglected as improper. On the other hand, in ſuch things as are intended ſolely for ornament, as columns, obeliſks, triumphal arches, &c. beauty alone ought to be regarded. The principal difficulty in Architecture lies in combining uſe and ornament. In order to accompliſh theſe ends, different and even oppoſite means muſt be employed; which is the reaſon why they are ſo ſeldom united in perfection; and hence, in buildings of this kind, the only practicable method is, to prefer utility to ornament, according to the character of the building: in palaces and ſuch buildings as admit of a variety of uſeful contrivances, regularity ought to be preferred, but in dwelling houſes that are too ſmall for variety of contrivance, utility ought to prevail, neglecting regularity as far it ſtands in oppoſition to convenience.

SECTION II. Beauty ariſing from Prorortion.

It is ludicrous to obſerve writers acknowledging the neceſſity of accurate proportions, and yet differing widely about them. Laying aſide reaſoning and philoſophy, one fact univerſally agreed on ought to have undeceived them, that the ſame proportion which pleaſe in a model, are not agreeable in a large building: a room forty-eight feet in length, and 24 in breadth and height, is well proportioned: but a room twelve feet wide and high, and 24 long, approaches to a gallery.

For illuſtrating this point, we ſhall add a few examples of the agreeableneſs of different proportions. In a ſumptuous edifice, the capital rooms ought to be large, otherwiſe they will not proportioned to the ſize of the building: for the ſame reaſon a very large room is improper in a ſmall houſe. But in things thus related, the mind requires not a preciſe or ſingle proportion, rejecting all others: on the contrary, many different proportions are equally agreeable. It is only when a proportion becomes looſe and diſtant, that the agreeableneſs abates, and at laſt vaniſhes. Accordingly, in buildings, rooms of different proportions are found to be equally agreeable, even where the proportion is not influenced by utility. With regard to the proportion the height of a room ſhould bear to the length and breadth, it muſt be extremely arbitrary, conſidering the uncertainty of the eye as to the height of a room when it exceeds 16 or 17 feet. In columns, again, every Architect muſt confeſs that the proportion of height and thickneſs varies betwixt 8 diameters and 10, and that every proportion between theſe two extremes is agreeable. Beſides, there muſt certainly be a further variation of proportion, depending on the ſize of the column. A row of columns 10 feet high, and a row twice that height, requires different proportions: The intercolumniations muſt alſo differ in proportion according to the height of the row.

Proportion of parts is not only itſelf a beauty, but is inſeparably connected with a beauty of the higheſt reliſh, that of concord and harmony: which will be plain from what follows: A room, the parts of which are all finely adjuſted to each other, ſtrikes us not only with the beauty of proportion, but with a pleaſure far ſuperior. The length, the breadth, the height, the windows, raiſe each of them a ſeparate emotion. Theſe emotions are ſimilar; and, though faint when ſeparately felt, they produce in conjunction the emotion of concord or harmony, which is very pleaſant. On the other hand, where the length of a room far exceeds the breadth, the mind comparing together parts ſo intimately connected, immediately perceives a diſagreement or diſproportion which diſguſts. Hence a long gallery, however convenient for exerciſe, is not an agreeable figure of a room.

External proportion is very much to be attended to, in the country particularly, and where the whole, or any part of the building becomes an object on the approach, or ſeen by paſſengers; but in town the caſe is generally different, as few houſes are detached; but where they are, or made conſpicuous, a very nice obſervation, and regard to proportion, becomes neceſſary; as in ſeveral houſes in Pall-mall; the Squares; Mr. Wyat's houſe, facing Queen Ann-ſtreet; the end houſe of Stratford-place; and the like: but in general the town houſes are carried up ſimilar to the reſt that compoſe a ſtreet or ſquare, and then become a part of the whole compoſition; which whole ſhould be contrived to harmonize, and make one handſome general effect of elevation; as the ſides of Bedford Square; and Mr. Shepherd's intended idea of Groſvenor Square, when he began the North Side; Portland Place, &c.

SECTION III. Intrinsic and Relative Beauty.

In conſidering attentively the beauty of viſible objects, we diſcover two kinds:—The firſt may be termed *intrinſic* beauty, becauſe it is diſcovered in a ſingle object, without relation to any other. The ſecond may be termed *relative* beauty, being founded on a combination of relative objects. Architecture admits of both kinds. We ſhall firſt give a few examples of relative beauty. The proportions of a door are determined by the uſe to which it is deſtined. The door of a dwelling houſe, which ought to correſpond to the human ſize, is confined to ſeven or eight feet in height, and three or four in breadth. The proportions proper for a ſtable or coach-houſe are different. The door of a church ought to be wide, in order to afford an eaſy paſſage for a multitude; and its height muſt be regulated by its wideneſs, that the proportion may pleaſe the eye. The ſize of the windows ought always to be proportioned to that of the room they are deſtined to illuminate; for if the apertures be not large enough to convey light to every corner, the room muſt be unequally lighted, which is a great deformity. Steps of ſtairs ſhould likewiſe be accommodated to the human figure, without regarding any other proportion: they are accordingly the ſame in large and in ſmall buildings, becauſe both are inhabited by men of the ſame ſize.

We ſhall next conſider intrinſic beauty, blended with that which is relative. A cube itſelf is more agreeable than a parallelopipedon: this conſtantly holds in ſmall figures: but a large building in the form of a cube is lumpiſh and heavy: while a parallelopipedon, ſet on its ſmaller baſe, is more agreeable on account of its elevation. Hence the beauty of Gothic towers. But if this figure were to be uſed in a dwelling-houſe, to make way for relative beauty, we ſhould immediately perceive that utility ought chiefly to be regarded: and this figure, inconvenient by its height, ought to be ſet on its larger baſe: the loftineſs in this caſe would be loſt: but that loſs will be more than ſufficiently compenſated by the additional convenience. Hence the form of buildings ſpread more upon the ground than raiſed in height, is always preferred for a dwelling-houſe.

In buildings deſtined chiefly or ſolely to pleaſe the eye, regularity and proportion are eſſentially neceſſary, becauſe they are the means of producing intrinſic beauty. But a ſkilful artiſt will not confine his view to regularity and proportion: he will alſo ſtudy congruity, which is perceived when the form and ornaments of a ſtructure are ſuited to the purpoſe for which it is appointed. Hence every building ought to have an expreſſion ſuited to its deſtination. A palace ought to be ſumptuous and grand: a private dwelling, neat and modeſt: a play-houſe, gay and ſplendid: and a monument, gloomy and melancholy. A heathen temple has a double deſtination: It is conſidered as a houſe dedicated to ſome divinity: therefore it ought to be grand, elevated, and magnificent. It is alſo conſidered as a place of worſhip: and therefore ought to be ſomewhat dark and gloomy, becauſe dimneſs or obſcurity produces that tone of mind which is favourable to humility and devotion. Columns, beſides their chief deſtination of being ſupports,

ſupports contribute to that peculiar expreſſion which the deſtination of a building requires. Columns of different proportions ſerve to expreſs loftineſs, lightneſs, &c. as well as ſtrength. Situation may alſo contribute to expreſſion: Conveniency regulates the ſituation of a private dwelling-houſe; but the ſituation of a palace ought to be lofty. This leads to a queſtion, Whether the ſituation, where there happens to be no choice, ought, in any meaſure, to regulate the form of the edifice? The connection between a great houſe and a neighbouring field, though not extremely intimate, demands however ſome congruity. It would, for example, diſpleaſe us to find an elegant building thrown away upon a wild uncultivated country: congruity requires a poliſhed field for ſuch a building. The old Gothic form of building was well ſuited to the rough uncultivated regions where it was invented; but was very ill adapted to the fine plains of France and Italy.

The late Sir William Chambers, who erected the buildings on Somerſet Place, publiſhed, in the year 1768, a magnificent work, entitled "A Treatiſe on Civil Architecture," wherein he has laid down proportions and meaſurements different from thoſe followed by moſt of the architects in Europe, but now principally adopted in England. From the proportions as laid down in the above mentioned work, we ſhall give ſome extracts in the following ſections.

SECT. IV. The respective Parts which compose the various Orders of Architecture with their Embellishments.

The parts which compoſe an order may be diſtributed into two different claſſes, in the firſt of which may be ranged all that have any analogy to the primitive huts, and repreſent ſome part that was neceſſary in their conſtruction. Such are the ſhaft of the column, with the plinth of its baſe, and the abacus of its capital, repreſenting the upright trees, with the ſtones on which they were placed, and thoſe that covered them; likewiſe the architrave and triglyphs repreſenting the beams and joiſts; the mutules, modillions, and dentils, which all of them repreſent the rafters, or ſome other pieces of timber uſed to ſupport the covering; and the corona, repreſenting the bats of materials that compoſed the covering. All theſe may be properly diſtinguiſhed by the name of eſſential members. For repreſentation of moſt of the eſſential members here ſpecified, ſee Plate VI. as attached to Fig. I. II. and III. The ſubſervient parts, contrived for the uſe and ornament of the former, and commonly called mouldings, may conſtitute the ſecond claſs.

The eſſential parts were moſt probably the only ones uſed, even in the firſt ſtone building; for the architects of thoſe early times had certainly very imperfect ideas of beauty in the productions of art, and therefore contented themſelves with barely imitating the rude model before them; but coming in time to compare the works of their own hands with animal and vegetable productions, each ſpecies of which is compoſed of a vaſt diverſity of forms affording an inexhauſtible fund of amuſement to the mind; they could not but conceive a diſguſt at the frequent repetition of ſquare figures in their buildings; and therefore thought of introducing certain intermediate parts, which might ſeem to be of ſome uſe, and at the ſame time be ſo formed as to give a more variegated, and a more pleaſing appearance to the whole compoſition; and this in all probability was the origin of mouldings.

There are eight regular mouldings in ornamenting columns: the fillet, liſtel, or ſquare; the aſtragal, or bead; the torus, or tore; the ſcotia, mouth, or caſement; the echinus, ovolo, or quarter-round; the inverted cyma, talon, or ogee; the cyma, cyma recta, or cymatium; the cavetto, or hollow. The names of theſe allude to their forms, and their forms are adapted to the purpoſes for which they are intended.

The ovolo and talon as they are ſtrong at their extremities, are fit for ſupports: the cyma and cavetto, though improper for that purpoſe, being weak in their extreme parts, and terminating in a point, are well contrived for coverings to ſhelter other members; for the tendency of their contour is very oppoſite to the direction of falling water; which for that reaſon cannot glide along their ſurface, but muſt neceſſarily drop. The torus and aſtragal being ſhaped like ropes, are intended to bind and fortify the parts on which they are employed: but the uſe of the fillet and ſcotia, is only to ſeparate and diſtinguiſh other mouldings, to give a graceful turn to the profile, and to prevent that confuſion which would be occaſioned by joining ſeveral curved members together. For repreſentation of the mouldings, ſee Plate VI. Fig. 2.

That the inventors of theſe mouldings meant to expreſs ſomething by their different figures will ſcarcely be denied; and that theſe were their deſtinations may be deduced, not only from their figures, but from the practice of the ancients in their moſt eſteemed works: for if we examine the Pantheon, the Three Columns, the temple of Jupiter Tonans, the fragments of the frontiſpiece of Nero, the baſilica of Antoninus, the forum of Nerva, the arches of Titus and Septimius Severus, the theatre of Marcellus, and indeed almoſt every antient building, either at Rome, or in other parts of Italy and France, it will be found that, in all their profiles, the cyma and the cavetto are conſtantly uſed as finiſhings, and never applied where ſtrength is required; that the ovolo and talon are always employed as ſupporters to the eſſential members of the compoſition, ſuch as the modillions, dentils, and corona; that the chief uſe of the torus and aſtragal is to fortify the tops and bottoms of columns, and ſometimes pedeſtals, where they are frequently cut in the form of ropes, as on the Trajan column, in the temple of Concord, and on ſeveral fragments both at Rome and at Niſmes in Languedoc; and that the ſcotia is employed only to ſeparate the members of baſes, for which purpoſe the fillet is likewiſe uſed, not only in baſes but in all kinds of profiles.

There are various manners of deſcribing the contours of the mouldings: but the ſimpleſt and beſt is to form them of quadrants of circles by which means the different depreſſions and ſwellings will be ſtrongly marked, the tranſitions made without any angle, and the projections be agreeable to the doctrine of Vitruvius, and the practice of the ancients; thoſe of the ovolo, talon, cyma, and cavetto, being equal to their height; that of the ſcotia to one third thereof; and thoſe of the curved parts of the torus and aſtragal to one half of it.

On particular occaſions, however, it may be neceſſary ſometimes to encreaſe and at other times to diminiſh theſe projections, according to the ſituation or other circumſtances attending the profile: when it ſo happens, the ovolo, talon, cyma, and cavetto may either be deſcribed from the ſummits of equilateral triangles, or compoſed of quadrants of the ellipſis; the latter of which is to be preferred, becauſe it produces a ſtronger oppoſition of light and ſhade, and by that means makes the figure more diſtinct. The ſcotia may likewiſe be formed of elliptical portions, or of quadrants of the circle, by which means its projection may either be encreaſed or diminiſhed: but the curved part of the torus and aſtragal muſt always be ſemicircular, and the encreaſe in their projection be by ſtraight lines.

In ſome antiques, and likewiſe in various modern buildings, where the parts are far removed from the eye, or where, from the extraordinary ſize of the ſtructure, it hath not been practicable to give every member its due projection, recourſe hath been had to artifice in order to produce the deſired effect.

An aſſemblage of eſſential parts and mouldings is termed a profile; and on the choice, diſpoſition, and proportions of theſe, depend the beauty or deformity of the profile. The moſt perfect are ſuch as are compoſed of few mouldings, varied both in form and ſize, fitly applied with regard to their uſes, and ſo diſpoſed that the ſtraight and curved ones ſucceed each other alternately. In every profile there ſhould be a predominant member, to which all the others ought to be ſubſervient, and ſeem made either to ſupport, to fortify, or to ſhelter it from the weather; this predominant member ought always to be one of the eſſential ones: thus in a cornice, the corona is principal, the cyma or cavetto cover it, and the modillions, dentils, ovolo, and talon ſupport it.

Ornaments in architecture require a very nice diſcrimination, and much judgment in the architect to apply them, that they may be ornaments at all; they conſiſt of ſeveral claſſes; viz. blank doors, blank windows, &c. for ſake of ſymmetry; ruſtics, pilaſters, columns, arches, intercolumniations, baluſtrades, facias, bas and alto relievos in tablets and medallions, niches, vaſes, ſtatues, &c. Tablets, medallions with bas and alto relievos, ſtatues, buſts, niches, and vaſes, ſhould be very carefully introduced; alſo enriched ceilings, mouldings, foliage, &c. as in general we ſee them ſtuck about ſo profuſely and improperly, that they become a ſacrifice to ornament; the late improvement in the art of moulding and caſting ornaments in plaiſter, compoſition, and artificial ſtone, have rendered them ſo common, and ſo miſapplied, that it is offenſive to true taſte.

When ornaments are employed to adorn the mouldings, ſome of them ſhould be left plain, in order to form a proper repoſe: for, when all are enriched, the figure of the profile is loſt. Variety of enrichments muſt not be carried to an exceſs. In architecture they are only acceſſaries; and therefore they ſhould not be too ſtriking, nor capable of long detaining the attention from the main object. Thoſe of the mouldings in particular ſhould be ſimple and uniform, and never compoſed of more than two different repreſentations upon each moulding: which ought to be cut equally deep, formed of the ſame number of parts, and nearly of the ſame dimenſions, in order to produce one even uninterrupted tint through the whole, that ſo the eye may not be too ſtrongly attracted by any particular part. When frizes, or other large members are to be enriched, the ornaments may be ſignificant, and ſerve to indicate the uſe of the building, or the qualities and actions of the owner: but it is a fooliſh cuſtom to croud every part with arms, creſts, cyphers, and mottos: for the figures of theſe hings are generally bad, and betray an unbecoming vanity in the patron of the ſtructure.

When objects are near, and liable to cloſe inſpection, every part of the ornament ſhould be expreſſed, and well finiſhed; but when they are much exalted, the detail may be ſlightly touched, or entirely neglected; for it is ſufficient if the general form be diſtinct, and the principal maſſes ſtrongly marked. A few rough ſtrokes, from the hand of a ſkilful maſter, are

more effectual than the moſt elaborate finiſhings of an artleſs imitator. For the ornaments introduced to embelliſh the ſeveral mouldings, &c. ſee Plate VI.—For their application, ſee Plate III. IV. and V.

SECT. V. Orders of Architecture in General.

An order conſiſts of two principal members, the column and the entablature; each of which is compoſed of three principal parts. Thoſe of the column are the baſe, the ſhaft, and the capital; and thoſe of the entablature are the architrave, the frize, and the cornice. All theſe are ſubdivided into many leſſer parts, whoſe number, form, and dimenſions characterize each order, and expreſs the degree of ſtrength, delicacy, richneſs, or ſimplicity peculiar to it.

Of the five orders, three are called Grecian; the Doric, the Ionic, and the Corinthian: and two Latin; the Tuſcan, and the Compoſite. The Grecian orders are diſtinguiſhed from the Latin by their deſtination as well as by their ornaments. It has been diſputed whether any new order can be added to theſe: ſome hold the affirmative, and give for inſtances the Tuſcan and the Compoſite; others maintain, that theſe properly are not diſtinct orders, but only the original orders with ſome ſlight variation. The only circumſtances that can ſerve to diſtinguiſh one order from another, are the form of the column, and its deſtination. To make the firſt a diſtinguiſhing mark, without regard to the other, would multiply orders without end. Deſtination is more limited, and it leads us to diſtinguiſh three kinds of orders; one plain and ſtrong, for the purpoſe of ſupporting plain and maſſy buildings; one delicate and graceful, for ſupporting buildings of that character; and between theſe, a third, for ſupporting buildings of a mixed nature. So that, if deſtination alone is to be regarded, the Tuſcan is of the ſame order with the Doric, and the Compoſite with the Corinthian. The ornaments of theſe three orders ought to be ſuited to the purpoſe for which they are intended. Plain and ruſtic ornaments would not be a little diſcordant with the elegance of the Corinthian order; and ſweet and delicate ornaments not leſs ſo with the ſtrength of the Doric.

The ſimpleſt and moſt ſolid of all the Orders is the Tuſcan. It is compoſed of few parts, devoid of ornaments, and of a conſtruction ſo maſſive, that it ſeems capable of ſupporting the heavieſt burden: whence it is, by Sir H. Wotton, compared to a ſturdy labourer in homely apparel.

The Doric is next in ſtrength to the Tuſcan; and, being of a grave, robuſt, and maſculine aſpect, is by Scamozzi called the Herculean. As it is the moſt ancient of all the Orders, it retains more of the ſtructure of primitive huts than any of the reſt; having triglyphs in its frize to repreſent the ends of the joiſts; and mutules in its cornice, to repreſent the rafters; its column being likewiſe, in various antiques, executed without a baſe, in imitation of the trees uſed in the firſt buildings, without any plinths to raiſe them above the ground.

The Ionic is of a more ſlender make than either of the abovementioned orders. Its appearance is ſimple, yet graceful and majeſtic; its ornaments are few, nor is there any thing exaggerated, or remarkably ſtriking, in any of its parts: ſo that it is not improperly compared to a ſedate matron, in decent rather than magnificent attire.

The Corinthian, ſays Sir H. Wotton, is a column laſciviouſly decked, like a wanton courtezan. Its proportions are extremely elegant. It is divided into a great variety of members, and enriched with a profuſion of ornaments. Scamozzi calls it the Virginal: and indeed it has all the delicacy in its make, with all the gaiety, gaudineſs, and affectation in its dreſs, peculiar to young girls.

The Compoſite is, properly ſpeaking, only a ſpecies of the Corinthian; and therefore retains, in a great meaſure, the ſame character.

Columns, in the opinion of Scamozzi, ſhould not be leſs than ſeven of their diameters in height, nor more than ten; the former being a good proportion in the Tuſcan, and the latter in the Corinthian order. The practice of the ancients, in their beſt works, is conformable to this precept; for which reaſon, according to the doctrine of Vitruvius, the Tuſcan columns are ſeven diameters in height, the Doric eight, and the Ionic nine, (which Palladio and Vignola have followed) and the Corinthian and Compoſite ten; which laſt is a mean between the proportions obſerved in the Pantheon, and in the Three Columns, both which are accounted excellent models of the Corinthian order.

The height of the entablature, in all the Orders, is made one quarter of the height of the column; which was the common practice of the ancients, who, in all ſorts of entablatures, ſeldom exceeded or fell much ſhort of that meaſure. Nevertheleſs Palladio, Scamozzi, Alberti, Barbaro, Cataneo, de L'Orme, and others of the modern architects, have made their entablatures much leſs in the Ionic, Compoſite, and Corinthian orders, than in the Tuſcan or Doric. This, on ſome occaſions, may be not only excuſeable, but highly commendable, particularly where the intercolumniations are large, (as in a ſecond or third order,) or in private houſes, or inſide decorations, where lightneſs may be preferred to dignity, and where expence, and every impediment to the conveniency of the fabric, is carefully to be avoided: but to ſet entirely aſide a proportion, which ſeems to have had the general approbation of the ancient artiſts, is preſuming too far.

Of the manners uſed by architects to determine the dimenſions of the mouldings, and the leſſer parts that compoſe an order, the ſimpleſt, readieſt, and moſt accurate is by the module, or ſemi-diameter of the column, taken at the bottom of the ſhaft, and divided into thirty minutes.

Monſieur Blondel, in his book entitled *Reſolution des quatre principaux Problêmes d'Architecture*, teaches various manners of diminiſhing columns; the beſt and ſimpleſt of which is by means of the inſtrument which Nicomedes invented to deſcribe the firſt conchoid: for this, being applied at the bottom of the ſhaft, performs at one ſweep both the ſwelling and the diminution; giving ſuch a graceful form to the column, that it is univerſally allowed to be the moſt perfect practice hitherto diſcovered. The columns in the Pantheon, accounted the moſt beautiful among the antiques, are made in this manner; as appears by the exact meaſures of one of them to be found in *Deſgodet's Antiquities of Rome*. In the remains of antiquity the quantity of the diminution is various; but ſeldom leſs than one eighth of the inferior diameter of the column, nor more than one ſixth of it. The laſt of theſe is by Vitruvius eſteemed the moſt perfect. As to the parts of a column, a bare uniform cylinder, without a capital, appears naked; and without a baſe, appears too tickliſhly placed to ſtand firm; it ought therefore to have ſome finiſhing at the top and bottom: hence the three chief parts of a column, the ſhaft, the baſe, and the capital. Nature undoubtedly requires proportion among theſe parts, but it admits of variety of proportion. Vitruvius and ſome of the elder writers ſeem to think, that the proportions of columns were derived from the human figure, the capital repreſenting the head, the baſe the feet, and the ſhaft the body. The intention of the firſt five plates being to give an exact idea of the orders of the ancients, they are repreſented under ſuch proportions as appear to have been moſt in uſe in the eſteemed works of the Romans; who, in the opinion of Leo. Bap. Alberti, and other eminent writers, carried architecture to its perfection. It muſt not however be imagined that the ſame general proportions will on all occaſions ſucceed. They are chiefly collected from the temples and public ſtructures of antiquity, and may by us be employed in churches, palaces, and other buildings of magnificence, where majeſty, and grandeur of manner may be extended to their utmoſt limits, and where, the whole body being generally large, the parts require an extraordinary degree of boldneſs, to make them diſtinctly perceptible from the proper point of view; but in leſs conſiderable edifices, and under various circumſtances, other proportions may be preferable.

EXPLANATION of PLATE I. II. III. IV. and V.

To give a comprehenſive idea of the five orders of architecture, we have devoted a ſeparate plate to illuſtrate each of the orders; and to give a general idea of the whole, we have introduced columns of each order accompanying an arch with proper dreſſings bearing the general proportion of the orders to which they belong with their impoſts and archivolts. The plates give a general idea of the effect of arches, agreeably to the proportions which are moſt commonly followed throughout Europe. Several others, beſides the ſemicircular, are frequently employed; a ſegment of almoſt every portion under a ſemicircle, and alſo elliptical arches having three centers of variety of proportions, may be ſeen in many inſtances in the new buildings in and about this metropolis.

By devoting a ſeparate plate to each of the orders, we have thereby been enabled to diſplay, in a connected point of view and on an extenſive ſcale, front and profile views of the reſpective columns, portico's, and pedeſtals of each of the orders, with their component parts richly embelliſhed. We have alſo repreſented the impoſts and architraves of each of the orders, except the Tuſcan, on a more extenſive ſcale, and in a detached point of view, thereby to ſhew more diſtinctly the proportions and meaſurements of the reſpective parts, and the ornaments which embelliſh them. The plates are divided by modules and parts, each module being a ſemidiameter divided into eighteen parts; each of the proportions are accurately figured on the firſt five plates of this ſyſtem. The ornaments with which they are decorated ſerve to ſhew a variety of deſigns, and the parts to which they may with propriety be introduced. But theſe ornaments ſhould be applied agreeably to the purpoſe and intention of the building.

EXPLANATION of PLATE VI.

In this plate we have repreſented the five orders, agreeable to the proportions laid down by the late Sir William Chambers: and to explain more particularly the various names by which the ſeveral parts of the pillars are denominated; we have in Fig. II. attached the deſcriptions and letters of reference. We have alſo, in the ſame plate, given various ornaments to embelliſh the reſpective orders.

Art. 1. *Of the Tuſcan Order, according to the Proportions of Sir William Chambers.* See Plate VI. Fig. 1.

There are no remains of a regular Tuſcan order among the antiques: the doctrine of Vitruvius concerning it is obſcure:

and

and the profiles of Palladio, Scamozzi, Serlio, de l'Orme, and Vignola, are all imperfect. The deſign here annexed is chiefly imitated from Vignola's, who in this order hath been almoſt univerſally followed: even Inigo Jones, who was ſo cloſe an adherer to Palladio, having employed Vignola's profile in York ſtairs, and others of his buildings; but as the cornice appears far inferior to the reſt of the compoſition, we have not ſcrupled to reject it, and in its place ſubſtitute that of Scamozzi, with ſuch alterations as were evidently neceſſary to render it perfect. The height of the column is fourteen modules, or ſeven diameters, and that of the whole entablature three and a half modules: which being divided into ten equal parts, three of them are for the height of the architrave, three for the frize, and the remaining four for the cornice, the capital is in height one module; the baſe, including the lower cincture of the ſhaft, is alſo one module; and the ſhaft, with its upper cincture and aſtragal, twelve modules.

The Tuſcan order admits of no ornaments of any kind; on the contrary it is ſometimes cuſtomary to repreſent, on the ſhaft of its column, ruſtic cinctures: as at the Pitti of Florence, the Luxembourg at Paris, York-ſtairs in London, and many other buildings of note. This practice, however, though frequent, and to be found in the works of ſeveral celebrated architects, is ſeldom to be adopted, as it hides the natural figure of the column, alters its proportions, and deſtroys the ſimplicity of the whole compoſition. There are few examples of theſe bandages in the remains of antiquity; and, in general, it will be adviſeable to avoid them in all large compoſitions; reſerving the ruſtic work for the intercolumniation, where it may be employed with great propriety, to produce an oppoſition, which will render the aſpect of the whole diſtinct and ſtriking. But in ſmaller works, whoſe parts are few, and therefore eaſily comprehended, they may be ſometimes tolerated. Le Clerc thinks they are proper for gates of citadels and priſons, whoſe entrance ſhould be dreadful; and they are likewiſe fit for gates of gardens or parks, grottos, fountains, and baths, where elegance of form, and neatneſs of workmanſhip, would be out of character. De L'Orme, who was exceedingly fond of theſe cinctures, hath employed them in ſeveral parts of the Thuilleries, covered with arms, cyphers, and other enrichments. This is quite abſurd: for they can never be conſidered in any other light, than as parts which, to avoid expence and trouble, were left unfiniſhed. We likewiſe find, in different parts of the Louvre, vermiculated ruſtics, of which the tracks repreſent flower de luces, and other regular figures: a practice more unnatural than the former; though Monſieur Daviler gravely tells us that it ſhould always be done with propriety, and expreſs a relation to the owner of the ſtructure; that is, the figures ſhould repreſent his arms, creſt, mottos, cyphers, &c.

The Tuſcan order, carrying with it an idea of ſtrength and ruſtic ſimplicity, is very proper for rural uſes, and may be employed in farm-houſes, ſtables, and dog-kennels; green-houſes, grottos, fountains, gates of parks and gardens; and, in general, in all places where magnificence is not required, and expence is to be avoided. Serlio recommends the uſe of it in priſons, arſenals, treaſuries, ſea-ports, and gates of fortified places; and Le Clerc obſerves, that though the Tuſcan order, as treated by Vitruvius, Palladio, and ſome others, ought to be entirely rejected; yet according to the compoſition of Vignola, there is a beauty in its ſimplicity which recommends it to eſteem, and entitles it to a place both in private and public buildings; even in royal palaces, to adorn the lower apartments, offices, ſtables, and other places that require ſtrength and ſimplicity, where richer and more delicate orders would be improper.

In conformity to the doctrine of Vitruvius, and to the almoſt general practice of all the moderns, the height of the Tuſcan column is ſeven diameters, or fourteen modules; a proportion which is very proper for rural or military works, where an appearance of extraordinary ſolidity is required: but in town buildings, intended for civil purpoſes, or in interior decorations, the height of the column may be fourteen and a half, or even fifteen modules, as Scamozzi makes it; which augmentation may be made in the ſhaft, without changing any meaſures either in the baſe or capital; nor need the entablature be altered; for, as it is compoſed of few parts, it will be ſufficiently bold, though its height be a little leſs than one quarter of the height of the column.

Art. 2. *Of the Doric Order.* See Plate VI. Fig. 2.

As this profile of Vignola's is compoſed in a greater ſtyle, and in a manner more characteriſtic of the order, than any other, it is here given as a model; having, in the general form and proportions, adhered ſtrictly to the original; though in particular members it is varied, when obſervation ſhewed they might be improved. Perfect proportion in architecture, if conſidered only with regard to the relations between the different objects in a compoſition, and as far as it relates merely to the pleaſure of the ſight, ſeems to conſiſt in this; that thoſe parts, which are either principal or eſſential, ſhould be ſo contrived as to catch the eye ſucceſſively, from the moſt conſiderable to the leaſt, according to their degrees of importance in the compoſition, as well as impreſs their images on the mind before it is affected by any of the ſubſervient members; yet that theſe ſhould be ſo placed as not to be entirely abſorbed by the former, but capable of raiſing diſtinct ideas likewiſe, and ſuch as may be adequate to the purpoſes for which theſe parts are deſigned. The different figures and ſituations of the parts may, in ſome degree, contribute toward this effect: for ſimple forms will operate more ſpeedily than thoſe that are complicated, and ſuch as project will be ſooner perceived than thoſe that are more retired. But dimenſion ſeems to be the predominant quality, or that which acts moſt powerfully on the ſenſe: and this can only be diſcovered by experience. When therefore any number of parts, arranged in a particular manner, and under particular proportions, excite, in the generality of judicious ſpectators, a pleaſing ſenſation, it will be prudent on every occaſion, where the ſame circumſtances ſubſiſt, to obſerve exactly the ſame proportions, notwithſtanding they may in themſelves appear irregular and unconnected.

It may perhaps be objected that the proportions here eſtabliſhed, though good on one occaſion, may on others be faulty. But this objection will be groundleſs, with regard to capitals and entablatures: their ſituation, with reſpect to the order to which they belong, is conſtantly the ſame; and the point of view being more or leſs diſtant, according to the ſize or elevation of the order, the apparent magnitudes of their parts will conſtantly bear nearly the ſame proportion to each other, even though they ſhould be exalted to a ſecond or third ſtory. With regard to baſes, indeed, their being placed on pedaſtals, or immediately on the ground, will occaſion ſome difference in their appearance; and when they are raiſed to a ſecond ſtory, their figure and apparent proportions will be conſiderably altered. Nevertheleſs, it doth not ſeem neceſſary to vary their dimenſions in either of theſe caſes: for in the former of the two the alteration would be trifling; and, in the latter, the object is ſo far removed from the eye, that the ſpectator is rather occupied in conſidering the general maſs, than in examining its particular parts, which, on account of their diſtance, are not diſtinctly perceptible.

The height of the Doric column, including its capital and baſe, is ſixteen modules, and the height of the entablature four modules; the latter of which being divided into eight parts, two of them are for the architrave, three for the frize, and three for the cornice. In moſt of the antiques, the Doric column is executed without a baſe: Vitruvius likewiſe makes it without one; the baſe, according to that author, having been firſt employed in the Ionic order, to imitate the ſandal, or covering of a woman's foot. Scamozzi blames this practice; and moſt of the moderns have been of his opinion; the greateſt part of them having employed the attic baſe in this order. Monſieur de Chambray, however, whoſe blind attachment to the antique is, on many occaſions, too evident, argues vehemently againſt this practice; which, as the order is formed upon the model of a ſtrong man, who is conſtantly repreſented bare-footed, is, according to him, very improper; and though the cuſtom of employing a baſe, in contempt of all ancient authority, hath, by ſome unaccountable and falſe notion of beauty, prevailed; he doubts not but the purer eye, when apprized of this error, will eaſily be undeceived; and as what is merely plauſible will, when examined, appear to be falſe, ſo apparent beauties, when not founded in reaſon, will of courſe be deemed extravagant.

Le Clerc's remarks on this paſſage are very judicious; and, as they will ſerve to deſtroy a notion which is too prevalent among us, for the benefit of thoſe who are unacquainted with the original, the whole paſſage is tranſlated: "In the moſt ancient monuments of this order, ſays he, the columns are without baſes; for which it is difficult to aſſign any ſatisfactory reaſon. Monſieur de Chambray, in his parallel, is of the ſame opinion with Vitruvius, and maintains that the Doric column, being compoſed upon the model of a naked, ſtrong, and muſcular man, reſembling a Hercules, ſhould have no baſe; pretending that the baſe to a column is the ſame as a ſhoe to a man. But I muſt own I cannot conſider a column without a baſe, in comparing it to a man, but I am at the ſame time ſtruck with the idea of a perſon without feet rather than ſhoes: for which reaſon I am inclinable to believe, either, that the architects of antiquity had not yet thought of employing baſes to their columns, or that they omitted them, in order to leave the pavement clear; the angles and projections of baſes being ſtumbling blocks to paſſengers, and ſo much the more troubleſome, as the architects of thoſe times frequently placed their columns very near each other: ſo that had they been made with baſes, the paſſages between them would have been extremely narrow and inconvenient: and it was doubtleſs for the ſame reaſon that Vitruvius made the plinth of his Tuſcan column round; that order, according to his conſtruction, being particularly adapted to ſervile and commercial purpoſes, where convenience is preferable to beauty. However this be, perſons of good taſte will grant, that a baſe not only gives a graceful turn to the column, but is likewiſe of real uſe; ſerving to keep it firm on its plan; and that if columns without baſes are now ſet aſide, it is a mark of the wiſdom of our architects, rather than indication of their being governed by prejudice, as ſome adorers of antiquity would inſinuate."

In

In imitation of Palladio, and all modern architects except Vignola, the Attic base in this order is used: and it is the most beautiful of any, though for variety's sake, when the Doric and Ionic orders are employed together, the base invented by Vignola, of which a profile is annexed, may sometimes be used: Bernini has used it in the colonnades of St. Peter's, and it hath been successfully applied in many other buildings.

The ancients sometimes made the shaft of the Doric column prismatic, as appears by a passage in the fourth book of Vitruvius; and at other times they adorned it with a particular kind of shallow flutings described from the centre of a square, no interval or fillet being left between them; of which sort there are now some columns to be seen at the temples of Pesto near Naples, and in the church of St. Peter in Cælis at Rome. The former of these manners hath not been imitated by any of the moderns: nor is the second very frequent; Scamozzi blames it for its want of solidity; the projecting angles between the flutings being easily broken, and very subject to moulder. Vitruvius gives the height of the Doric capital one module, and all the moderns, except Alberti, have followed his example. Nevertheless, as it is of the same kind with the Tuscan, they should both bear nearly the same proportion to the heights of their respective columns; and consequently the Doric capital ought to be more than one module, and accordingly it is so both at the Coliseum, and in the theatre of Marcellus; being in the former of these buildings upwards of thirty-eight minutes, and in the latter thirty-three minutes. The height of the whole capital is thirty-two minutes, and in the form and dimensions of the particular members there is but little deviation from the profile of the theatre of Marcellus. The frize, or neck, is enriched with husks and roses as in Palladio's design, and as it has been executed by Sangallo at the Farnese, and by Cigoli in the cortile of the Strozzi at Florence, as well as in several buildings of note in this city. The projection of these husks and flowers must not exceed that of the upper cincture of the column.

The architrave is one module in height, and composed only of one fascia and a fillet, as at the theatre of Marcellus: the drops are conical, as they are in all the antiques; and not pyramidal, as they are very improperly made by most of our English workmen. The frize and cornice are each of them one module and a half in height: the metope is enriched with a bull's skull, adorned with a garland of beads; in imitation of those on the temple of Jupiter Tonans, at the foot of the Capitol. In some antique fragments, and in a greater number of modern buildings, the metopes are alternately enriched with these ox-skulls, and pateras; but they may be filled with any other ornaments of good forms, and frequently with greater propriety. Thus, in military structures, heads of Medusa, or the furies; thunderbolts, and other symbols of horror, may be introduced: likewise helmets, daggers, and garlands of laurel, or oak. But spears, swords, quivers, bows, cuirasses, shields, and the like, must be avoided; because the real dimensions of these things are too considerable to find admittance in such small compartments; and representations in miniature always carry with them an idea of littleness. In sacred buildings, cherubs, chalices, and garlands of palm or olive, may be employed; likewise doves or other symbols of moral virtues; and in private houses, crests and badges of dignity, may sometimes be suffered, though seldom; and indeed never, when they are of such formal and insipid figures, as stars and garters, crowns, coronets, mitres, truncheons, and the like; the bad effects of which may be seen at the treasury in St. James's Park, and in many other places.

Too much variety in the ornaments of the metopes must be avoided, for fear of destroying the unity of the composition: and it is best never to introduce more than two different representations, which could not consist of above one, or at most two objects, each, of simple forms, and not overcharged with ornaments. In the disposition of these, care must be taken to place them with symmetry; those on the right corresponding with those on the left; wherefore, when a triglyph happens to be in the middle of a front, it becomes necessary to couple the middle ones, by filling the two metopes, on each side of the central triglyph, with the same sort of ornaments: (as at the gate of Burlington-House) disposing the rest alternately throughout the whole front, as usual. It is likewise to be observed, that the ornaments of the metopes are not to project so much as at Bow-Church, and at General Wade's house in Burlington-gardens; where they are far more striking than the triglyphs, which ought to be predominant; being essential and principal parts in the composition. Palladio, in the basilica of Vicenza, has given to the most elevated parts of the ox-skulls and pateras very little more projection than that of the triglyph, and in this he has copied the ancients, who seldom or never gave more projection to any ornament than that of the border in which it was enclosed; as appears by those inimitable fragments in the Villa Medici, and many others in different parts of Rome. The channels of the triglyph in their plan commonly form a right angle: but, to give them more effect, a narrow channel may be cut in the inner angle from top to bottom, and quite to the solid of the frize.

In the cornice we have deviated very little from the original. Le Clerc, who, in his Doric profile, has imitated that of Vignola, makes the mutules as broad as the capital of the triglyph. Mr. Gibbs hath followed his example; and they have been executed in this manner at a couple of doors to houses on the north-side of Lincoln's Inn Fields. But Vignola's method is preferable, who makes them only as broad as the triglyph. The ornaments of the Soffit are nearly the same as those of Vignola: they should be entirely wrought in the solid of the corona, and have no projection beyond it. There is no necessity for cutting them deep. In most of Palladio's buildings, they do not enter above two minutes, and that is sufficient.

Of all the orders the Doric is most difficult to distribute, on account of the large intervals between the triglyphs. At the Coliseum they are omitted; and so they are in the colonades of St. Peter's and in several other buildings at Rome. This indeed obviates the difficulty; but it likewise deprives the order of one of its principal ornaments, without which it is very little preferable to the Tuscan. The ancients employed the Doric in temples dedicated to Minerva, to Mars, and to Hercules; whose grave and manly dispositions suited well with the character of this order. Serlio says it is proper for churches dedicated to our Saviour, St. Paul, St. Peter, or any other Saints remarkable for their fortitude in exposing their lives for the christian faith. Le Clerc recommends the use of it in all kinds of military structures; as arsenals, gates of fortified places, guard-houses, &c. and it may likewise be employed in the houses of generals, or other martial men, in mausoleums erected to their memory, or in triumphal bridges and arches built to celebrate their victories.

The height of the Doric column here is sixteen modules: which, in buildings where majesty is required, is a good proportion; but in others it may be more slender. Thus Vitruvius makes the doric column in porticos higher by half a diameter than in temples; and most of the modern architects have on some occasions followed his example. In private houses therefore it may be 16½, 16¼, or 16⅓ modules high; and in interior decorations even seventeen modules, and sometimes a trifle more; which encrease in the height may be made entirely on the shaft, as in the Tuscan order, without changing either the base or capital. The entablature may remain unaltered; for it will be sufficiently high.

Art. 3. *Of the Ionic Order.* See Plate VI. Fig. 3

Among the ancients, the form of the Ionic profile appears to have been more positively determined, than that of any other order; for in all the antiques at Rome (the temple of Concord excepted) it is exactly the same, and agreeable to the description Vitruvius hath given of it. The modern artists have likewise been unanimous in their opinion; all of them, excepting Palladio and his imitators, having employed the dentil, cornice, and the other parts of the profile, nearly as they are found in the Coliseum, the temple of Fortune, and the theatre of Marcellus. The height of the column is eighteen modules, and that of the entablature four modules and a half, or one quarter of the height of the column, as in the other orders; which is a trifle less than in any of the regular antique Ionics. The base is Attic, as in all the antiques, and the shaft of the column may be plain, or fluted with twenty-four flutings, or twenty only, as at the temple of Fortune; whose plan may be a trifle more than a semi-circle, as at the temple of Jupiter Tonans, and the forum of Nerva, because they then appear more distinct; and the fillet, or interval between them, must not be broader than one third of the breadth of a fluting, nor narrower than one quarter thereof. The ornaments of the capital are to correspond with the flutings of the shaft; and there must be an ove above the middle of each fluting. The volutes are to be traced according to Goldman's method, which is the best.

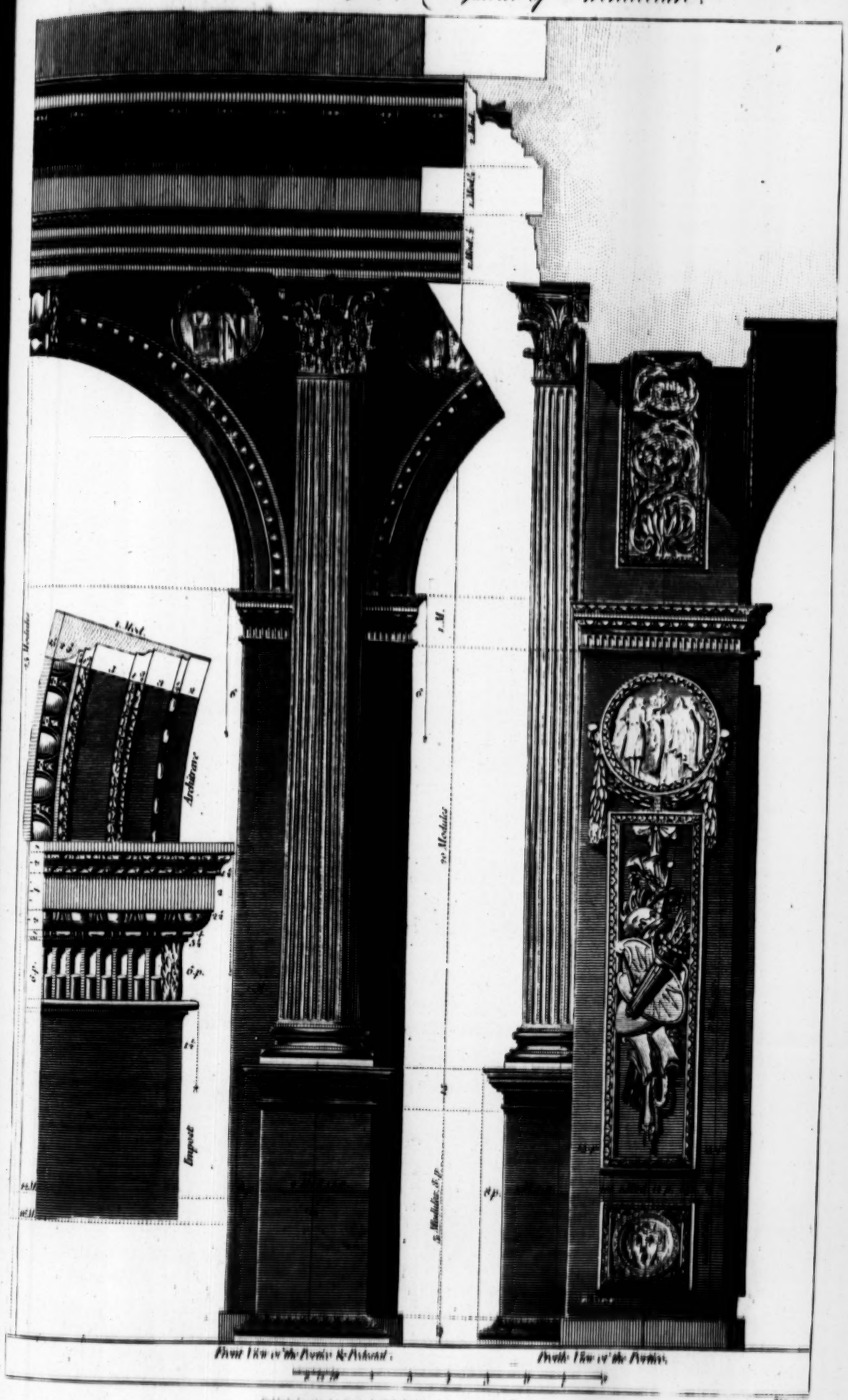
The three parts of the entablature bear the same proportion to each other, in this as in the Tuscan order. The frize is plain, as being most suitable to the simplicity of the rest; and the cornice is almost an exact copy from Vignola's design, in which there is a grandeur of style that none of his competitors have arrived at. In interior decorations, where much delicacy is required, the height of the entablature may be reduced even to one fifth of the column, by observing the same method, and making the module only four fifths of the semi-diameter.

As the Doric order is particularly affected in buildings dedicated to male saints, so the Ionic is used in such as are erected to female saints of the matronal state. It is likewise employed in halls of justice, in libraries, colleges, and other structures, that have any relation to arts or letters, in private houses and in palaces, to adorn the women's apartments, and, says Le Clerc, in all places consecrated to peace and tranquillity. The ancients used it in temples dedicated to Juno, to Bacchus, to Diana, and other deities, whose dispositions held a medium between the severe and effeminate.

Art. 4. *Of the Corinthian Order.* See Plate VI. Fig. 4

The most perfect model of the Corinthian order, among the antiques at Rome, is generally allowed, upon the whole, to be the three columns in the Campo Vaccino; the remains, as it is thought, of the temple of Jupiter Stator. Palladio in his fourth

Corinthian Order) See System of Architecture.



Front View of the Portico & Pedestal.

Profile View of the Portico.

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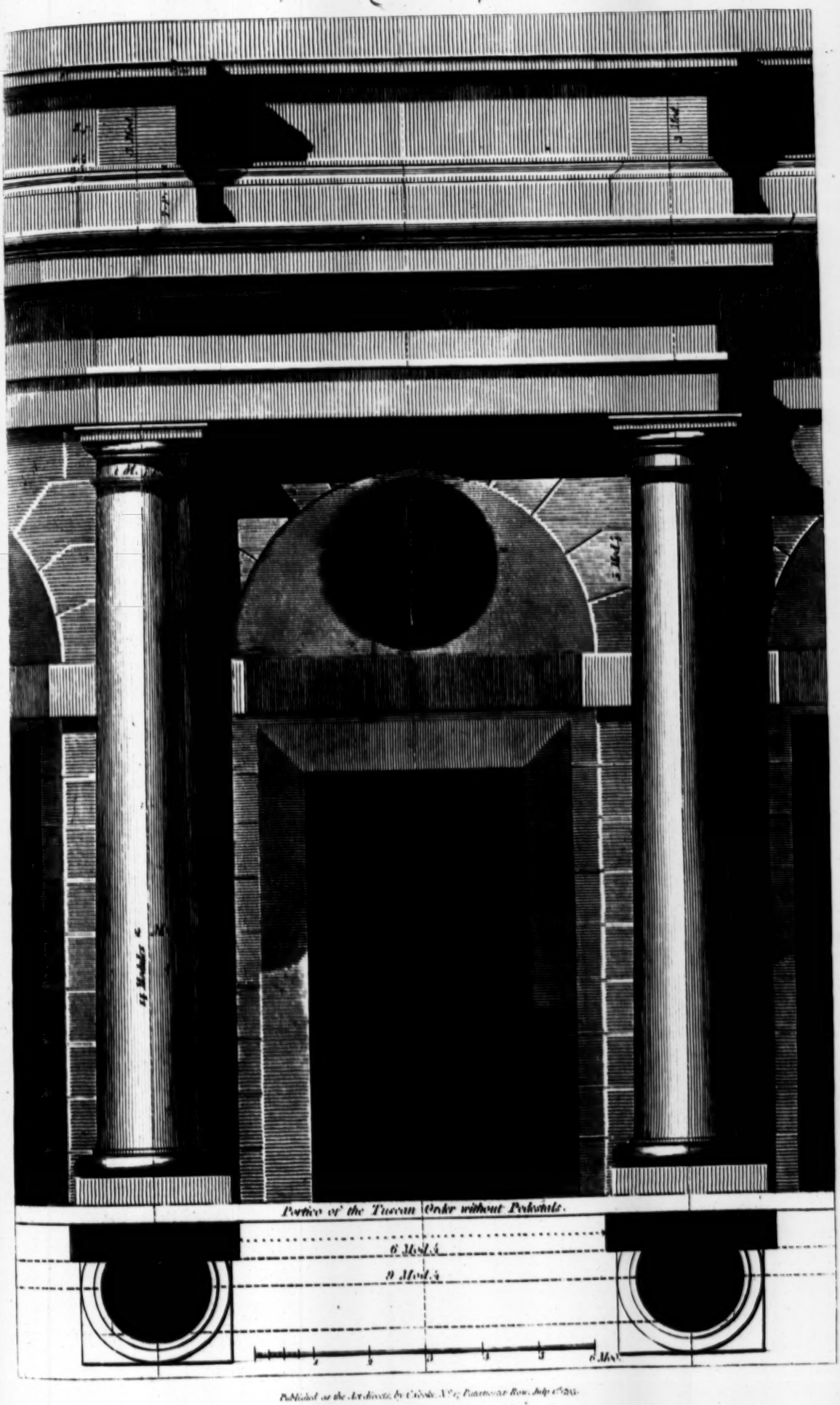
Tuscan Order – See System of Architecture.



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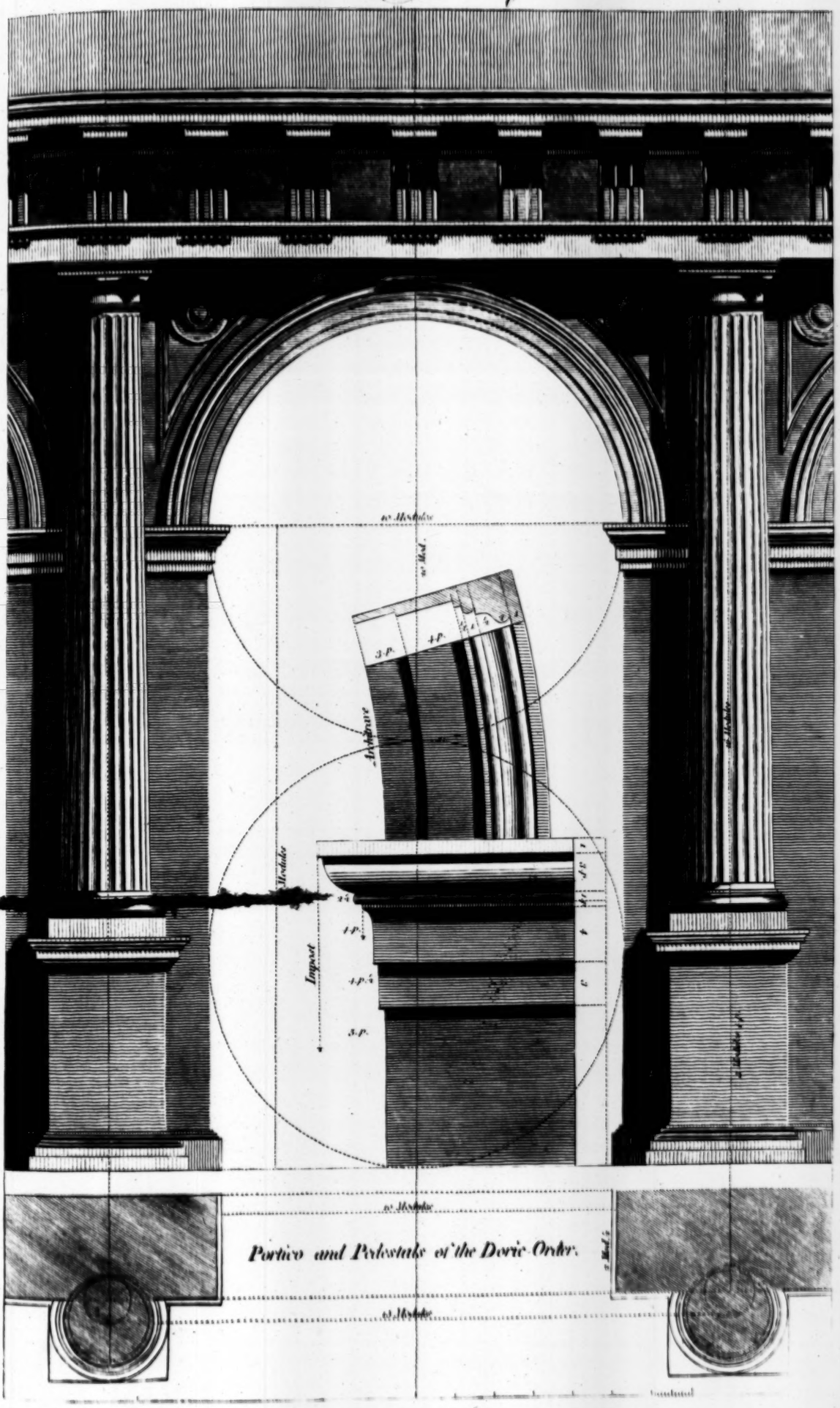
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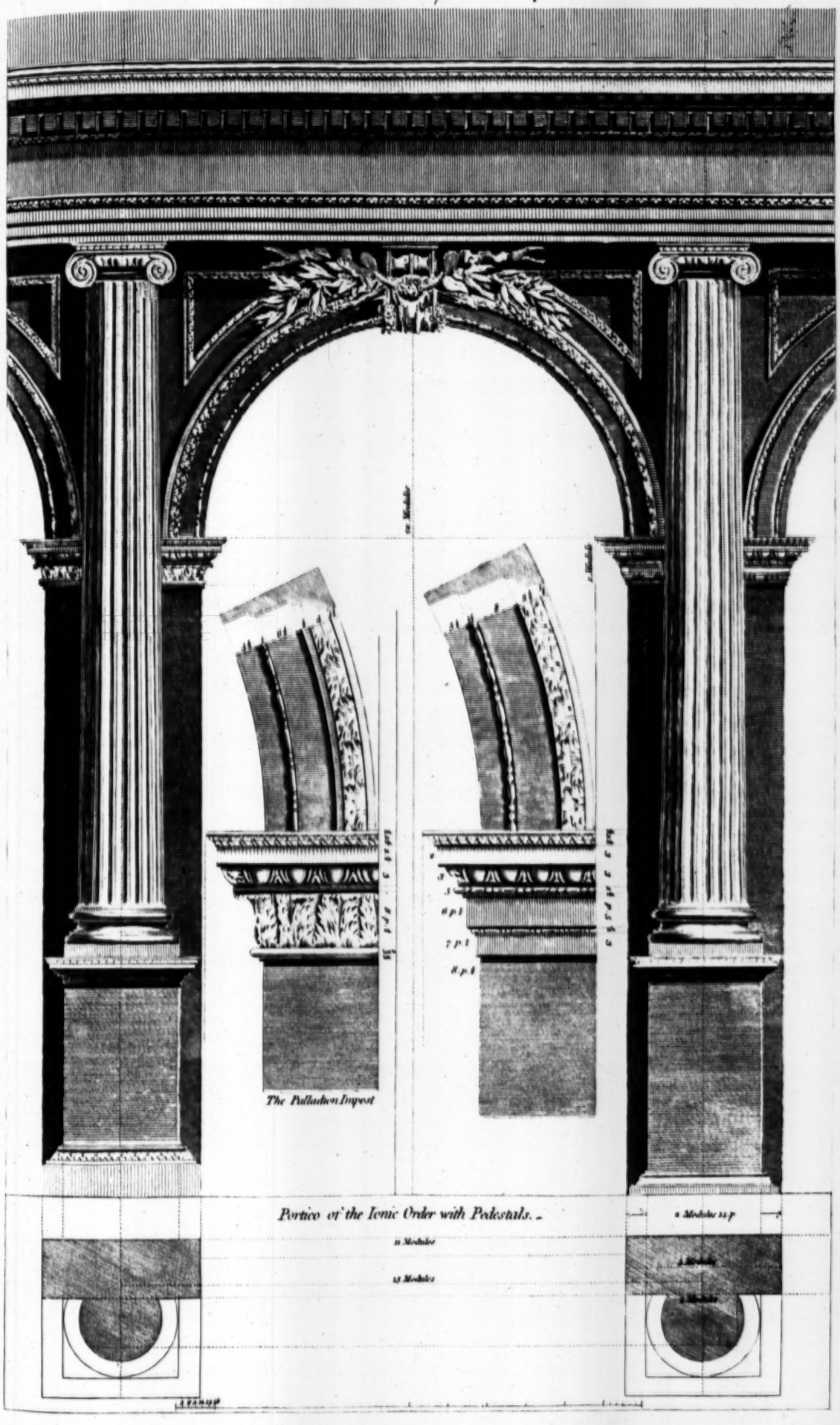

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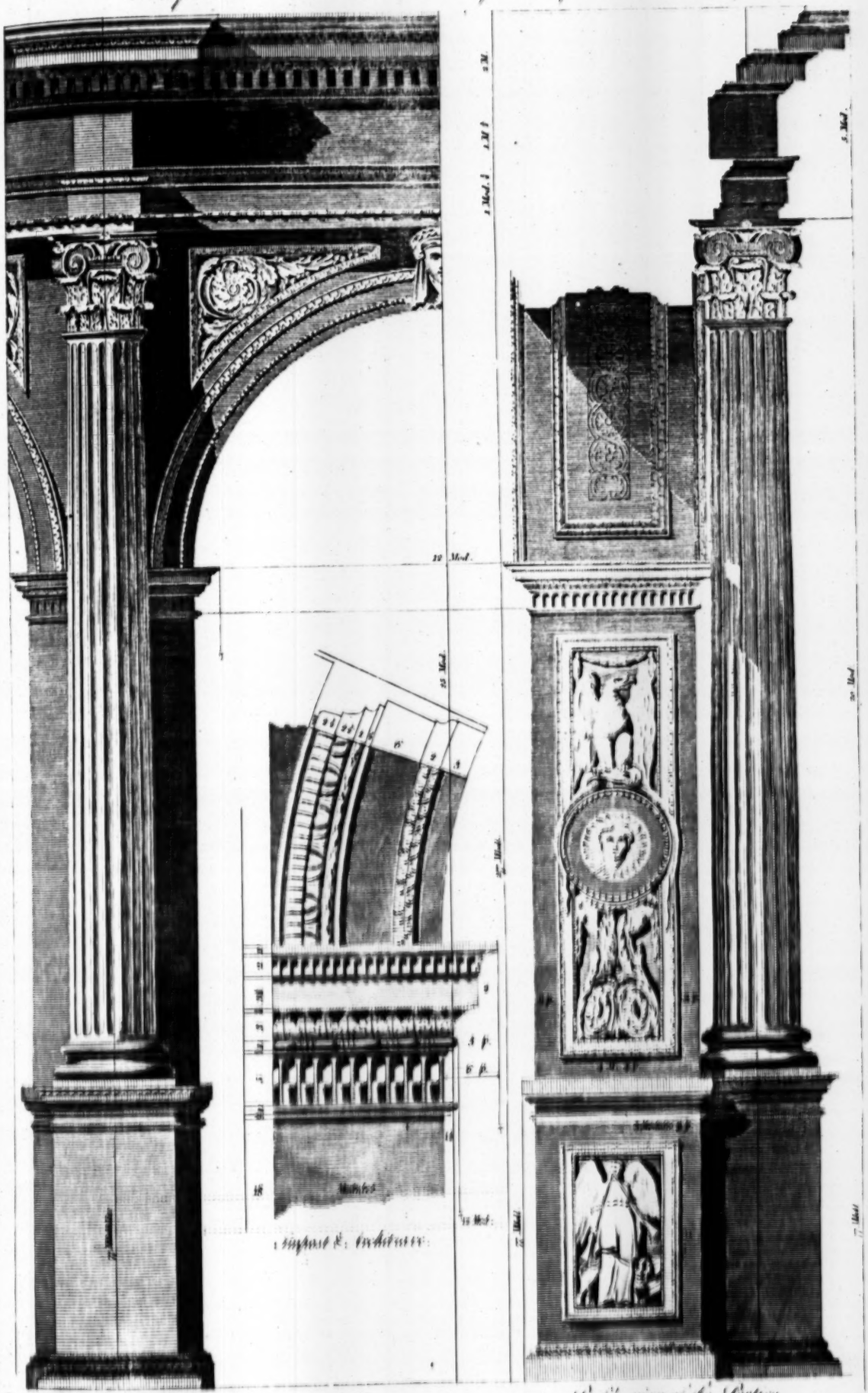
Composite Order. — See System of Architecture



Front view of the Portico & Pedestal

Profile view of the Portico

Published According to Act of Parliament by C. Cooke No. 12 Paternoster Row [illegible]

Orders of Architecture according to Sir William Chambers.

See the System.

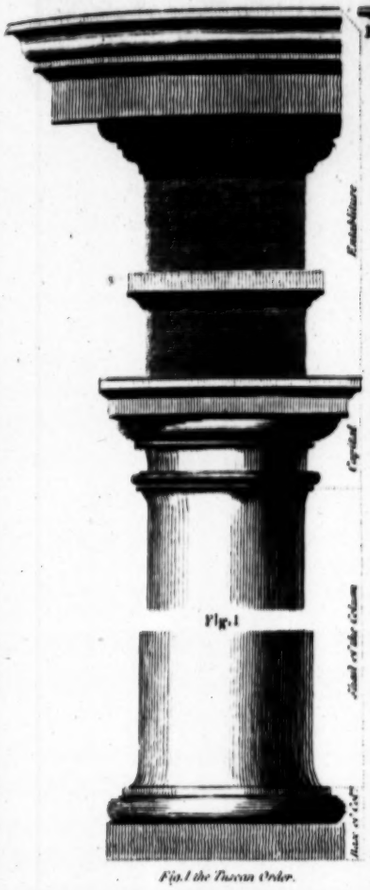


Fig. 1

Fig. 1 the Tuscan Order.

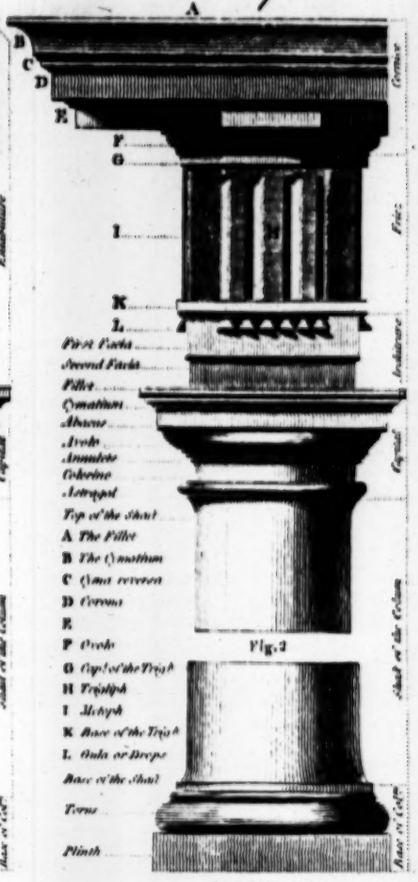


Fig. 2

Fig. 2 the Doric Order.

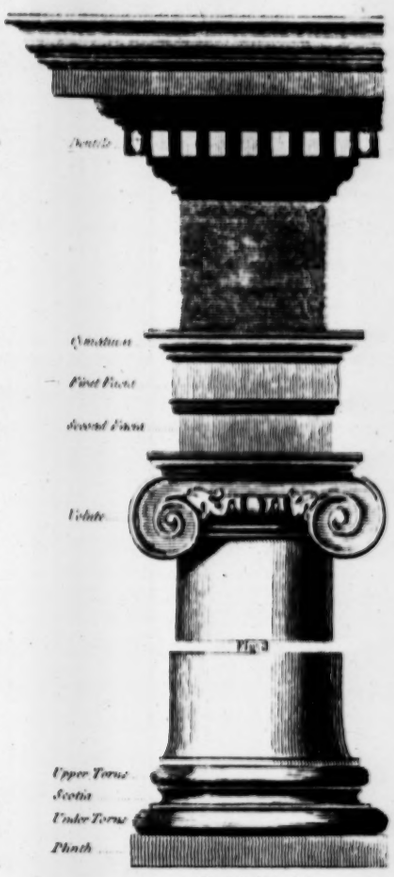


Fig. 3

Fig. 3 the Ionic Order.

Fig. 5

Fig. 5 the Composite Order.

Button

Ornament for the Astragale.

Ornament for the Cyma.

Ornament for the flat members.

Ornament for the Ogee.

Ornament for the Ovolo.

Ornament for the Torus.

Ornament for the Cavetto.

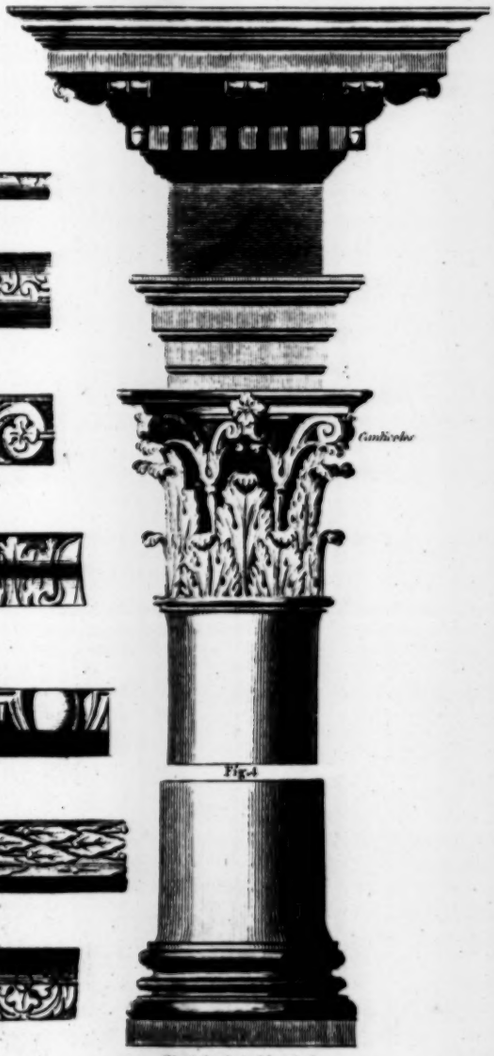


Fig. 4

Fig. 4 the Corinthian Order.

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Taylor sculp.

fourth book, where he gives the profile at large, acknowledges that he never had ſeen any work better executed, or more delicately finiſhed; that all its parts are beautifully formed, well proportioned, and artfully combined; which two laſt qualities are taken to be ſignified by his *Beniſſimo Inteſi*. With theſe favourable ſentiments it is remarkable, that, in his deſign of the Corinthian order, he hath ſo far deviated from this excellent original as ſcarcely to leave the ſmalleſt ſhadow of reſemblance to it.

The column is twenty modules high, and the entablature five; which proportions are a medium between thoſe of the Pantheon and of the Three Columns. The baſe of the column may either be Attic or Corinthian: they are both beautiful. Palladio and Scamozzi have employed the Attic baſe, enriched with aſtragals: but ſo frequent a repetition of the ſame form hath a bad effect, as may be ſeen at the church of St. Martin's in the Fields, and at the Bank.

If the entablature be enriched, the ſhaft of the column may be fluted: provided it be not compoſed of variegated marble: for a diverſity of colours renders even ſmooth ſurfaces confuſed, and ornaments of ſculpture only ſerve to make the confuſion greater. The flutings may be filled to one third of their height with cablings, as in the inſide of the Pantheon; which will ſtrengthen the lower part of the column, and make it leſs liable to injury. But if the columns are not within reach, or ſubject to be hurt by paſſengers, theſe are better omitted: for the general hue of the column will then be more even. In ſome very rich buildings, the cablings are compoſed of reeds, ribbands, huſks, flowers, &c. (at the Thuilleries in Paris there are ſome exquiſitely wrought by Jean Gougeon's own hand,) but it is better to reſerve ſuch niceties for interior decorations. In the exterior, whatever doth not contribute to the general effect of the whole building, is in a great meaſure uſeleſs, and an expence that might more judiciouſly be employed in places where it would be more attended to. In general, exceſſive ornaments, though they encreaſe the magnificence of a building, always deſtroy the grandeur of its effect. The parts that in themſelves are large, and ſo formed and diſpoſed as to receive broad maſſes and ſtrong impreſſions of light and ſhade, will of courſe excite great ideas: but if they are broken into a number of ſmall diviſions, and their ſurface ſo varied as to catch a thouſand impreſſions of light, demi-tint, and darkneſs, the whole will be confuſed, trifling, and incapable of cauſing any grand emotions.

The capital is enriched with olive-leaves, as almoſt all the antiques at Rome of this order are; the acanthus being ſeldom employed but in the Compoſite. De Cordemoy, however, prefers the acanthus; and obſerves that the flexible ſprigs, which accompany the leaves of that plant, may more naturally be ſuppoſed to form the contour of the volutes, than the ſtiff branches of a laurel or olive. It is ſtrange, ſays he, that people ſoon ceaſe to eſteem what is natural: nature and reaſon muſt always be violated, and we prefer a confuſed jumble of little pointed leaves of the olive or laurel, to the ſimple and graceful contours of the acanthus. With regard to the manner of tracing and working the capital, the deſigns, together with what is ſaid on the ſame head under the Compoſite order, will ſufficiently explain it.

The diviſions of the entablature bear the ſame proportion to each other as in the Tuſcan, Ionic, and Compoſite orders. The frize is enriched with a baſs relief, compoſed from various fragments in the Villa Medici at Rome. The parts and ornaments of the cornice are all regularly diſpoſed: the coffers in the ſoffit of the corona are ſquare, and the borders round them alike on all ſides; as they are at the arch of Titus, and as Palladio hath made them: a precaution which Vignola neglected.

The Corinthian entablature may be reduced to two ninths, or one fifth of the height of the column, by the ſame rule as in the Ionic and Compoſite orders. But when it is neceſſary to make it ſo ſmall as one fifth, it will be beſt to uſe the Ionic entablature, as Palladio hath done in the periſtyle of the Olympic Theatre at Vicenza, and in many others of his buildings; or to retrench the dentils of the cornice, as in Serlio's and Scamozzi's profiles; the part of the cornice under the modillion-band being compoſed only of the ovolo and ogee ſeparated by a fillet; as at the temples of Trevi and of Sciſi in Umbria, mentioned by Palladio in his fourth book.

The Corinthian order is proper for all buildings, where delicacy, gaiety, and magnificence are required. The ancients uſed it in temples dedicated to Venus, Flora, Proſerpine, and Nymphs of the Fountains; becauſe the flowers, leaves, and volutes, that adorned it, ſeemed well adapted to the delicacy of theſe deities. As it is the moſt magnificent of all the orders, it is extremely proper for palaces, public ſquares, and churches dedicated to the Virgin Mary, or other virgin ſaints; and on account of its gaiety it may likewiſe be uſed in theatres, banqueting-rooms, and all places conſecrated to mirth and pleaſure. Several ſorts of leaves are applied to compoſe the capitals of the Corinthian and Compoſite columns, viz. the acanthus, parſley, olive, laurel, oak, &c. &c. Sketches of ſome of thoſe leaves appear in the plate of the orders.

Art. 5. *Of the Compoſite Order.* See Plate VI. Fig. 5.

Strictly ſpeaking, the ancients had but four orders: the Compoſite was not conſidered by them as a diſtinct production. Vitruvius expreſsly tells us, Book IV. Chap. I. that on Corinthian columns other capitals of various kinds were employed; which nevertheleſs ought not to change the names of the columns, becauſe the proportions remained ſtill the ſame. The moderns, however, have ranked the Compoſite with the four orders mentioned by Vitruvius; having, among the great number of capitals to be met with in the remains of antiquity, choſen for a model that which hath been uſed in the triumphal arches, in the temple of Bacchus, and the baths of Dioclesian; rather, as agreeing more with the deſcription of Vitruvius, (who obſerves that they were compoſed of the Ionic, Doric, and Corinthian) than from any preference in point of beauty to many others.

It doth not appear that the ancients affected any particular form of entablature to this capital. Sometimes the cornice is entirely plain, as in the temple of Bacchus, at others, as in the arch of Septimius Severus, it is enriched with dentils, differing very little from the Ionic; and in the arch of Titus there are both dentils and modillions; the whole form of the profile being the ſame with the Corinthian, as executed in the antiques at Rome.

The height of the column is twenty modules, and that of the entablature five: the baſe is Attic, and it meaſures the ſame as in the Doric and Ionic orders; but as the module is leſs, all its parts are of courſe more delicate. The ſhaft is enriched with flutings, which may be to the number of twenty, or twenty-four, as in the Ionic order: for there is no reaſon why their number ſhould be augmented. The module is leſs; the flutings will therefore be leſs likewiſe, and correſpond exactly with the character of the reſt of the compoſition.

The capital is of the ſame kind that all the moderns have employed in this order, and enriched with leaves of the acanthus, as all the antique capitals of this ſort are. With regard to the method of tracing it, few directions will ſuffice: for the deſigns are all exactly figured. The curvatures of the abacus are deſcribed from the ſummits of equilateral triangles; the projection of the volutes is determined by a line drawn from the extremity of the aſtragal to the extremity of a horn of the abacus; and the projection of the leaves is determined by another line drawn from the fillet below the aſtragal, parallel to the former. The manner of executing both theſe, and all other enriched capitals, is, generally ſpeaking, bad. The Engliſh workmen, however, muſt not be accuſed of want of capacity: a great number of them are excellent, and, in neatneſs of execution, outdo, perhaps, thoſe of any other country whatever: but, from the parſimony of their employers, and, in ſome degree, for want of perfect ſkill and facility in deſigning, their performances are often flat, without intention or effect; in ſhort, to the laſt degree, inſipid.

Many, even of our greateſt architects, have too much neglected the detail; having employed their attention wholly on the general diſpoſition of their compoſitions. This neglect, though authorized by great examples, ought by no means to be imitated: it is the buſineſs of the architect to attend to the minuteſt object, as well as to the moſt conſiderable. If the entire execution of the fabric be left to his direction, the faults that are committed will be ſtated to his account: and therefore it will be prudent in him to chuſe good workmen, and to furniſh them with proper models and preciſe inſtructions; in which he will ſhew the extent of his capacity, and diſtinguiſh himſelf from the common herd of thoſe who aſſume the title of architects. The moſt maſterly diſpoſition, incorrectly executed, can only be conſidered as a ſketch in painting, or as an excellent piece of muſic performed by country fidlers.

The foot of the leaves of the capital muſt not project beyond the upper part of the ſhaft of the column, as at St. Carlo in the Corſo at Rome, and at the Banqueting-houſe in London; for nothing is uglier: neither is the lower row of them to bend forwards, as in many of the antiques, and in ſome modern buildings, becauſe they then hide a great part of the upper leaves, and give a diſagreeable form to the whole capital. The different bunches that compoſe the leaves muſt be ſtrongly marked, and maſſed in a diſtinct manner. The ſprigs, that ſpring from between the upper ones, are to be kept flat upon the vaſe; and the ornaments of the volutes are not to project beyond the fillets that encloſe them. Theſe are all the directions that can well be given in writing: but thoſe who would excel in works of this kind, muſt conſult Nature, and thoſe buildings, ancient or modern, in which they have been executed with care and judgment.

The parts of the entablature bear the ſame proportion to each other, as in the Ionic and Tuſcan orders. The architrave is nearly the ſame with thoſe of Palladio, Vignola, and the Baſilica of Antoninus. The frize is enriched with foliages, in imitation of thoſe at Nero's frontiſpiece; whoſe moſt prominent parts ought never to project beyond the uppermoſt moulding of the architrave.

The cornice is imitated from Scamozzi, and differs from the Corinthian only in the modillions, which are flat. The ſoffit of the intervals between the dentils muſt be hollowed upwards, behind the little fillet in front, as they are in moſt of the antiques; which occaſions a dark ſhade, that marks the dentils more diſtinctly: and the ſame muſt be obſerved in the Ionic and Corinthian orders. The roſes in the ſoffit of the corona are not to project beyond its horizontal ſurface; and care muſt be taken not to vary them ſo much as at St. Peter's or the Vatican, becauſe the unity of the compoſition ſuffers thereby. The modillions or dentils might with almoſt as much propriety be varied: it will be beſt therefore to make them all alike, as they are in moſt of the antiques, and at Earl Spencer's houſe in the Green Park; that ſo they may not ſtrike the beholders as diſtinct objects, but as parts of one great whole. Or they may be of two kinds, which occaſions more variety, and no confuſion: for the ideas ſucceed each other ſo rapidly, that the third takes place before the firſt is in any degree obliterated; ſo that nearly the ſame effect is produced as by a continued ſucceſſion of the ſame object. But though this variety be allowable in ſmall objects, which the eye peruſes at a ſingle glance, and in ſuch as are merely acceſſory, and do not influence the general form of the compoſition; yet it is by no means to be tolerated in columns, and other large or eſſential parts, which, from the number of their conſtituent points, are not conveyed to the mind at once, either with eaſe or perfect clearneſs; and therefore, if varied, cannot fail of exciting confuſed ideas.

The Romans uſed the Compoſite order more frequently in their triumphal arches than in any other buildings; meaning, as Serlio ſuppoſes, to expreſs their dominion over thoſe nations that invented the orders of which this is compoſed. It may, ſays Le Clerc, be uſed with propriety, wherever elegance and magnificence are to be aſſembled; but it is more particularly adapted for buildings intended to commemorate any ſignal event, or to celebrate the virtues and actions of conquerors or legiſlators: becauſe the capitals, and other ornaments, may be compoſed of emblems and alluſive repreſentations; which is agreeable to the cuſtom of the ancients; as appears by multitudes of fragments of capitals, and other members of architecture, to be ſeen in different parts of Rome.

The Compoſite entablature may be reduced to two ninths of the column, (which, to avoid fractions, I ſhall call four modules and a half) by making the module only nine tenths of the ſemi-diameter, and obſerving the meaſures as in the deſign; and there will be a dentil in the outer angle, as in the Ionic order. It may likewiſe, if required, be reduced to one fifth, by making the module four fifths of the ſemi-diameter: though, in caſes where it is neceſſary to diminiſh it ſo much, it will be beſt to employ the Ionic cornice; which, being compoſed of fewer parts, will ſtill retain an air of grandeur, notwithſtanding the ſmallneſs of the whole maſs.

Moſt authors give the laſt place to the Compoſite order, as being the laſt invented, and a compound, which of courſe ought to be preceded by all the ſimples. I have followed Scamozzi's method; his arrangement appearing to me the moſt natural: for his orders ſucceed each other according to their degrees of ſtrength, and in the progreſſion that muſt abſolutely be obſerved whenever they are employed together.

SECT. VI. PILASTERS.

THESE differ from columns only in their plan; which is a ſquare, as that of a column is round. Their baſes, capitals, and entablatures, have the ſame parts, with the ſame heights and projections, as thoſe of columns: they are alſo diſtinguiſhed in the ſame manner, by the names of Tuſcan, Doric, Ionic, Corinthian, and Compoſite. The column is undoubtedly more perfect than the pilaſter. However, they may be employed with great propriety on many occaſions. Some authors declaim againſt pilaſters, becauſe, according to them, they do not admit of diminution. But this is a miſtake; there are many inſtances, in the remains of antiquity, of their being diminiſhed. Scamozzi always gave his pilaſters the ſame diminution as his columns: Palladio and Inigo Jones have likewiſe diminiſhed them in many of their buildings.

Pilaſters where uſeful.

Pilaſters are employed in churches, galleries, halls, and other interior decorations, to ſave room; for, as they ſeldom project beyond the ſolid wall above one quarter of their diameter, they do not occupy near ſo much ſpace as columns. They are likewiſe uſed in exterior decorations; ſometimes alone, inſtead of columns, on account of their being leſs expenſive; and ſometimes they accompany columns, being placed behind them to ſupport the architraves, where they enter the building, as in the Pantheon at Rome; or, in the ſame line with them, to fortify the angles, as in the portico of Septimius. When pilaſters are uſed alone, they ſhould project one quarter of their diameter beyond the walls. When placed behind columns, eſpecially if they be very near them, they need not project above one eighth of their diameter. But, when placed on a line with columns, their projection muſt be regulated by that of the columns; and conſequently, it can never be leſs than a ſemidiameter, even when the columns are engaged as much as poſſible.

The ſhafts of pilaſters are frequently adorned with flutings, in the ſame manner as thoſe of columns; the plan of which may be a trifle more than a ſemi-circle: their number muſt be ſeven on each face, which makes them nearly of the ſame ſize with thoſe of columns. The intervals, or fillets, muſt either be one third or one fourth of the fluting in breadth. The capitals of pilaſters are profiled nearly in the ſame manner as thoſe of columns.

SECT. VII. ATTICS.

THESE very properly follow the pilaſters; being nothing more than ſquare pillars with their cornices. They had their origin in Athens, where it was for many ages a rule in building to conceal the roof. For this purpoſe, nothing ſerved ſo well as a kind of low or little order ranged in a continued line, ſingly, or with the interruption of balluſters; which riſing above the reſt of the work and before the roof, hid it perfectly, and placed ſomething agreeable in view. The place of Attics, therefore, is at the uppermoſt extremity of a building, to which they ſerve as a crown, or very properly make a finiſhing for the other orders when they have been uſed in the ſtructure. The muſt never ſtand under any thing except ſuch ornaments as are placed at the very top. Theſe Attics ſhould never exceed in height one third of the height of the order on which they are placed, nor be leſs than one quarter of it. The baſe, dye, and cornice, of which they are compoſed, may bear the ſame proportions to each other as thoſe of pedeſtals do; and the baſe and cornice may be compoſed of the ſame mouldings as thoſe pedeſtals. Sometimes the Attic is continued throughout; at others, it projects, and forms a pilaſter over each column of the order. The breadth of this pilaſter is ſeldom made narrower than the upper diameter of the column below it, and never broader. Its projection may be equal to one quarter of its breadth.

SECT. VIII. PERSIANS, CARYATIDES, AND TERMINI.

BESIDES columns and pilaſters, it is ſometimes cuſtomary to employ repreſentations of the human figure, to ſupport entablatures in buildings. The male figures are called *Perſians*; and the female, *Carians*, or *Caryatides*.

Art. 1. *Origin of Perſians.*

The *Perſians* are ſo called from a victory gained over the Perſians by Pauſanias, who having brought home ſpoils and trophies to the Athenians, they fixed upon Perſian figures for thoſe which ſhould ſupport entablatures, and thus kept in mind that there were once Perſian ſlaves in Athens. To repreſent theſe conquered people in the loweſt ſtate poſſible, they loaded them with the heavieſt entablature, viz. that of the Doric order. In proceſs of time, however, other figures beſides thoſe of Perſians were introduced, and other entablatures put over them; but the name was ſtill retained.

Art. 2. *Origin of Caryatides.*

The proper Caryatides are women dreſſed in long robes, after the Aſiatic manner; and the origin of the device was as follows. The Carians had been long at war with the Athenians; but being at length totally vanquiſhed, their wives were led away captives; and, to perpetuate the memory of this event, trophies were erected, in which figures of women, dreſſed in the Caryatic manner, were uſed to ſupport entablatures like the Perſians; and though other female figures were afterwards uſed in the ſame manner, the name of *Caryatides* was always retained.

Art. 3. *Origin of Termini.*

Termini are ſometimes employed, inſtead of Perſians or Caryatides, to ſupport the entablatures of monuments, chimney-pieces, and ſuch like compoſitions. Theſe figures owe their origin to the ſtones uſed by the ancients to mark the limits of particular poſſeſſions. Numa Pompilius, to render theſe inviolable, conſecrated the terminus into a deity, and inſtituted feſtivals and ſacrifices to his honour. In a ſhort time, what was formerly only large upright ſtones, were repreſented in human ſhape: and afterwards introduced as ornaments to temples and other buildings. The termini are now principally uſed as ornaments for gardens and fields.

Art. 4. *The Proportions of the Caryatides and Perſians.*

The Caryatides, or female figures, ſhould never much exceed the human ſize. But the Perſians, or male figures, may be of any ſize; and the larger the better, as they will ſtrike the beholder with the greater awe and aſtoniſhment. Perſians may be uſed with propriety in arſenals, galleries of armour, &c. under the figures of captives, heroic virtues, &c. Their entablature ought to be Doric, and bear the ſame proportion to them as to columns of the ſame height. The entablature for Caryatides ought to be either Ionic or Corinthian, according as the character of the figures is more or leſs delicate.

The ancients made frequent uſe of Perſians and Caryatides, and delighted in diverſifying them a thouſand ways. The modern artiſts have followed their example; and there is a great variety

variety of compoſitions of this kind to be met with in different parts of Europe. Indecent attitudes, diſtorted features, and all monſtrous productions, ought to be avoided, of which there are many examples in Gothic buildings. On the contrary, the attitudes ſhould be ſimple and graceful, the countenance always pleaſing, though varied and ſtrongly marked agreeable to the nature of the object repreſented.

SECT. IX. PEDESTALS.

MOST writers conſider the *Pedeſtal* as a neceſſary part of the order, without which it is not complete. It is indeed a matter of little importance whether it be conſidered in that light, or as a diſtinct compoſition: we ſhall therefore treat of a pedeſtal as a diſtinct body, having no more connection with the order than an Attic, a baſement, or any other part with which it may on ſome occaſions be aſſociated.

A pedeſtal conſiſts of three principal parts; the baſe, the dye, and the cornice. The dye is always nearly of the ſame figure; being conſtantly either a cube or a parallelopipedon: but the baſe and cornice are varied and adorned with more or fewer mouldings, according to the ſimplicity or richneſs of the compoſition in which the pedeſtal is employed. Hence pedeſtals are, like columns, diſtinguiſhed by the names of *Tuſcan*, *Doric*, *Ionic*, *Corinthian*, and *Compoſite*.

Art. 1. *Pedeſtals where proper.*

Some authors are averſe to pedeſtals, and compare a column raiſed on a pedeſtal to a man mounted on ſtilts; imagining that they were introduced merely from neceſſity, and for want of columns of a ſufficient length. It is indeed true, that the ancients often made uſe of artifices to lengthen their columns; as appears by ſome that are in the Baptiſtery of Conſtantine at Rome; the ſhafts of which, being too ſhort for the building, were lengthened and joined to their baſes by an undulated ſweep, adorned with acanthus leaves. Nevertheleſs, there are many occaſions where pedeſtals are evidently neceſſary: and ſome in which the order, were it not raiſed, would loſe much of its beautiful appearance. Thus, in the inſides of churches, if the columns that ſupport the vault were placed immediately on the ground, their ſeats would hide their baſes and a good part of their ſhafts; and in the theatres of the ancients, if the columns of the ſcene had been placed immediately on the ſtage, the actors would have hid a part of them from the audience. In anterior decorations, a pedeſtal diminiſhes the parts of the order, which otherwiſe might perhaps appear too clumſy, and hath the advantage of placing the column in a more favourable view, by raiſing its baſe nearer the level of the ſpectator's eye. In a ſecond order of arcades, there is no avoiding pedeſtals; as without them it is impoſſible to give the arches any tolerable proportion.

Art. 2. *The Proportions of Pedeſtals.*

With regard to the proportion that pedeſtals ought to bear to that of the columns they ſupport, it is by no means fixed. Both the ancients and moderns vary greatly on this head. Vignola's proportions are generally reckoned the beſt. He makes his pedeſtals in all the orders of the ſame height, viz. one third of the column; and as their breadth of courſe increaſes or diminiſhes in the ſame degree as the diameters of their reſpective columns do, the character of the order is always preſerved, which, according to any other method, is impoſſible.

As to the diviſions of the pedeſtals; if the whole height be divided into nine parts, one of them may be given to the height of the cornice, two to the baſe, and the ſix remaining to the dye. The breadth of the dye is always made equal to that of the plinth of the column. The projection of the cornice may be made equal to its height; and the baſe being divided into three parts, two of them will be for the height of the plinth, and one for the mouldings, whoſe projection muſt be leſs than that of the cornice. Theſe meaſures are common to all pedeſtals.

SECT. X. INTERCOLUMNIATIONS.

COLUMNS are either engaged, or inſulated: and, when inſulated, are either very near the wall, or at a conſiderable diſtance from it. Engaged columns, or ſuch as are near the walls of a building, are not limited in their incolumniations, as theſe depend on the breadths of the arches, windows, niches, or other decorations placed between the columns. But columns that are entirely detached, and perform alone the office of ſupporting the entablature, as in periſtyles, porches, and galleries, muſt be near each other, for the ſake both of real and apparent ſolidity.

Art. 1. *The different Intercolumniations uſed by the Ancients.*

The intercolumniations among the ancients were various. Thoſe uſed in the Ionic and Corinthian orders were the pycnoſtyle, of which the interval was equal to one diameter and a half of the column; the ſyſtyle, whoſe interval was equal to two diameters; the euſtyle, to two and a quarter; the diaſtyle to three, and the araeoſtyle to four. In the Doric order, they uſed other intercolumniations, regulating them by the triglyphs, one of which was always placed directly over the middle of each column; ſo that they were either ſyſtyle, monotriglyph, of one diameter and a half; diaſtyle, of two diameters and three quarters; or araeoſtyle, of four diameters; and the Tuſcan intervals were very wide, ſome of them being above ſeven diameters, which was very practicable, as the architraves were of wood.

Among theſe different intercolumniations, the pycnoſtyle and ſyſtyle are too narrow; for although the ancients made frequent uſe of them, that ought rather to be aſcribed to neceſſity than choice. For, as the architraves were compoſed of ſingle ſtones, extending from the middle of one column to the middle of another, it would have been difficult, eſpecially in large buildings, to find blocks of a ſufficient length for diaſtyle intervals. With regard to the araeoſtyle and Tuſcan intercolumniations, they are by much too wide, and can only be uſed in ruſtic buildings, where the architraves are of wood; neither is the diaſtyle ſufficiently ſolid in large compoſitions. The euſtyle is a medium between the narrow and broad intervals; and being at the ſame time both ſpacious and ſolid, hath been preferred to any of the reſt by the ancients as well as the moderns.

Art. 2. *Intercolumniations uſed by Vignola.*

Vignola obſerved nearly the ſame proportion in all his intercolumniations; which practice, though condemned by ſeveral writers, is certainly preferable to any other; as it preſerves the character of each Order, and maintains in all of them an equal degree of real ſolidity. Setting aſide therefore the pycnoſtyle and ſyſtyle diſpoſitions on account of their want of ſpace, and the araeoſtyle for its deficiency in point of ſtrength, it may be eſtabliſhed, that the diaſtyle and euſtyle intercolumniations (the latter of which, on moſt occaſions, ought to have the preference) may be employed in all the orders without diſtinction, excepting the Doric; in which the moſt perfect interval is ditriglyph; neither the monotriglyph, nor the araeoſtyle, being to be ſuffered but in caſes of neceſſity.

Sometimes, on account of the windows, doors, niches, and other decorations, which correſpond with the intercolumniations of the periſtyle, or gallery, it is not poſſible to make the intervals ſo narrow as euſtyle, or even as diaſtyle: wherefore the moderns, authoriſed by ſome few examples of the ancients, where grouped columns are employed, have invented a manner of diſpoſing them, called by Perrault *araeoſtyle*, which admits of a larger interval, without any detriment to the apparent ſolidity of the building. This kind of diſpoſition is compoſed of two ſyſtyle intercolumniations; the column that ſeparates them being approached towards one of thoſe at the extremities, ſufficient room only being left between them for the projection of the capitals; ſo that the great ſpace is three diameters and a half wide, and the little one half a diameter.

In periſtyles, galleries, or porticos, all the intercolumniations muſt be equal; but in a logio, or porch, the middle interval may be broader than the others by a triglyph or modillion, or three or four dentils; unleſs the columns at the angles be coupled, or grouped with pilaſters; in which caſe, all the intervals ſhould be of the ſame dimenſions. When buildings are very ſmall, as is frequently the caſe in temples and other inventions uſed for ornamenting gardens, the intercolumniations may be broader, in proportion to the diameter of the columns, than uſual; becauſe, when they are nearer each other than three feet, there is hardly room for a bulky perſon to paſs between them.

SECT. XI. ARCHES.

ARCHES are not ſo magnificent as colonnades; but they are more ſolid and leſs expenſive. They are proper for triumphal entrances, gates of cities, of palaces, of gardens, of parks, and in general for all openings that require an extraordinary breadth.

Art. 1. *The Manner of adorning Arches.*

There are various manners of adorning arches. Sometimes their piers are ruſticated; ſometimes they are adorned with pilaſters, termini, or caryatides; and ſometimes they are made ſufficiently broad to admit niches or windows. The circular part of the arch is either ſurrounded with ruſtic key-ſtones, or with an archivolt enriched with mouldings; which, in the middle, is ſometimes interrupted by a conſole, a maſk, ſerving at the ſame time as a key to the arch, and as a ſupport to the architrave of the order. The archivolt is ſometimes ſupported by an impoſt at the head of the pier; and at others by columns placed on each ſide of it, with a regular entablature, or architrave and cornice. There are likewiſe inſtances of arcades without piers, the arches being turned on ſingle columns, as in the temple of Faunus at Rome. This practice, however, ought to be ſeldom imitated, as it is neither ſolid nor handſome.

When arches are large, the key-ſtone ſhould never be omitted, but cut in the form of a conſole, and carried cloſe under the ſoffit of the architrave, which on account of its extraordinary length, requires a ſupport in the middle. The impoſts of arches ſhould never be omitted; at leaſt, if they be, a platform ought to ſupply their place. If columns are employed without pedeſtals in arcades, they ſhould always be raiſed on a plinth. In all arches, the circular part ought not to ſpring immediately from the impoſt, but take its riſe at ſuch a diſtance

above

above it as is neceſſary in order to have the whole curve ſeen at the proper point of view.

Art. 2. *Proportions.*

The void or aperture of arches ſhould never be higher nor much lower, than double their breadth; the breadth of the pier ſhould ſeldom exceed two thirds, nor be leſs than one third, of the breadth of the arch; and the angular pier ought to be broader than the others, by one half, one third, or one fourth; the impoſt ſhould not be more than one ſeventh, nor leſs than one ninth of the aperture; and the archivolt muſt not be more than one eighth, nor leſs than one tenth of it. The breadth of the conſole muſt, at the bottom, be equal to that of the archivolt; and its ſides muſt be drawn from the center of the arch: the length of it muſt not be leſs than one and a half of its ſmalleſt breadth, nor more than double. The thickneſs of the pier depends on the breadth of the portico; for it muſt be ſtrong enough to reſiſt the preſſure of its vault. But with regard to the beauty of the building, it ſhould not be leſs than one quarter of the breadth of the arch, nor more than one third.

SECT. XII. Orders above Orders.

When, in a building, two or more orders are employed, one above another, the laws of ſolidity require the ſtrongeſt ſhould be placed lowermoſt. Hence the Tuſcan muſt ſupport the Doric, the Doric the Ionic, the Ionic muſt ſupport the Compoſite or Corinthian, and the Compoſite the Corinthian.

This rule, however, is not always ſtrictly adhered to. Moſt authors place the Compoſite above the Corinthian. There are likewiſe examples where the ſame order is repeated, as in the theatre of Statilus Taurus, and the Coliſeum; and others, where an intermediate order is omitted, and the Ionic placed on the Tuſcan, or the Corinthian on the Doric. But none of theſe practices ought to be imitated. In placing columns above one another, the axis of all the columns ought to correſpond, or be in the ſame perpendicular line, at leaſt in front.

Proportions of Columns placed above each other.

With regard to the proportions of columns placed above each other, Scamozzi's rule, That the lower diameter of the ſuperior column ſhould conſtantly be equal to the upper diameter of the inferior one, is univerſally eſteemed the beſt, and gives all the columns the appearance of one long tapering tree, cut into ſeveral pieces. According to this rule, the Doric column will be to the Tuſcan, as $13\frac{1}{3}$ to 14; the Ionic to the Doric, as 15 to 16; the Compoſite or Corinthian to the Ionic, as $16\frac{2}{3}$ to 18; and the Corinthian to the Compoſite, as $16\frac{2}{3}$ to 20.

In Britain there are few examples of more than two ſtories of columns in the ſame aſpect; and though in Italy, and other parts of Europe, we frequently meet with three, and ſometimes more; yet it is a practice by no means to be imitated; for there is no poſſibility of avoiding many ſtriking inconſiſtencies, or of preſerving the character of each order in its intercolumnial decorations.

SECT. XIII. Baſements.

Inſtead of employing ſeveral orders one above the other in a compoſition, the ground-floor is ſometimes made in the form of a *baſement*, on which the order that decorates the principal ſtory is placed. The proportion of theſe baſements is not fixed, but depends on the nature of the rooms on the ground-floor. In the palace of the Porti in Vicenza, the height of the baſement is equal to that of the order. In ſome buildings, its height exceeds two thirds of that of the order; and, in others, only half the height of the order. It is not, however, adviſable to make the baſement higher than the order it ſupports: neither ſhould it be lower than one half of the order.

Decorations, &c. of Baſements.

The uſual method of decorating baſements is with ruſtics of different kinds. The beſt, where neatneſs and finiſhing is aimed at, are ſuch as have a ſmooth ſurface. Their height, including the joint, ſhould never be leſs, nor much more, than half a module of the order placed on the baſement. Their figure may be from a ſquare to a ſeſquialtera; and their joints may be either ſquare or chamfered. The ſquare ones ſhould not be broader than one eighth of the height of the ruſtic, nor narrower than one tenth; and their depth muſt be equal to their breadth; thoſe that are chamfered muſt form a rectangle; and the breadth of the whole joint may be from one fourth to one third of the height of the flat ſurface of the ruſtic.

SECT. XIV. Pediments.

Pediments, among the Romans, were uſed only as coverings to their ſacred buildings, till Cæſar obtained leave to cover his houſe with a pointed roof, after the manner of temples. In the remains of antiquity we meet with two kinds of pediments, the triangular and the circular. The former of theſe are promiſcuouſly applied to cover ſmall or large bodies: but the latter, being of a heavier figure, are never uſed but as coverings to doors, niches, windows, or gates. As a pediment repreſents the roof, it ſhould never be employed but as a finiſhing to the whole compoſition.

The ancients introduced but few pediments into their buildings, uſually contenting themſelves with a ſingle one to adorn the middle or principal part. But ſome of the moderns, and particularly the Italians, have been ſo immoderately fond of them, that their buildings frequently conſiſt of almoſt nothing elſe. The girder being a neceſſary part in the conſtruction of a roof, it is an impropriety to intermit the horizontal entablature of a pediment, by which it is repreſented, to make room for a niche, an arch, or a window. In regular architecture, no other form of pediments can be admitted, beſides the triangular and circular. Both of them are beautiful; and when a conſiderable number of pediments are introduced, as when a range of windows are adorned with them, theſe two figures may be uſed alternately, as in the niches of the Pantheon, and in thoſe of the temple of Diana at Niſmes.

The proportion of pediments depends upon their ſize; for the ſame proportions will not do in all caſes. When the baſe of the pediment is ſhort, its height muſt be increaſed; and when the pediment is long, the height muſt be diminiſhed. The beſt proportion for the height is from one fifth to one fourth of the baſe, according to the extent of the pediment, and the character of the body it covers. The materials of the roof muſt alſo be attended to; for if it be covered with tiles, it will be neceſſary to raiſe it more than one quarter of the baſe, as was the cuſtom of the ancients in their Tuſcan temples. The tympan is always on a line with the front of the frize; and when large, admits of various ornaments.

SECT. XV. Ballustrades.

Ballustrades are ſometimes of real uſe in buildings, and at other times they are only ornamental. Such as are intended for uſe, as when they are employed in ſtair-caſes, before windows, or to incloſe terraces, &c. muſt always be nearly of the ſame height; never exceeding three feet and a half, nor ever leſs than three. But thoſe that are principally deſigned for ornament, as when they finiſh a building, ſhould be proportioned to the architecture they accompany: and their height ought never to exceed four fifths of the height of the entablature on which they are placed; nor ſhould it ever be leſs than two thirds thereof, without counting the zocholo or plinth, the height of which muſt be ſufficient to leave the whole balluſtrade expoſed to view.

The beſt proportion for balluſtrades is to divide the whole given height into thirteen equal parts; eight of theſe for the height of the balluſter, three for the baſe, and two for the cornice or rail; or into fourteen, (if it be required to make the balluſter leſs), giving eight parts to the balluſter, four to the baſe, and two to the rail. One of theſe parts may be called a *module*; and being divided into nine minutes, may ſerve to determine the dimenſions of the particular members.

In balluſtrades, the diſtance between two balluſters ſhould not exceed half the diameter of the balluſter meaſured in its thickeſt part, nor be leſs than one third of it. The breadth of the pedeſtals, when they are placed on columns or pilaſters, is regulated by them; the dye never being made broader than the top of the ſhaft, nor much narrower; and when there are neither columns nor pilaſters on the front, the dye ſhould not be much lower than a ſquare, and ſeldom higher. On ſtairs, or any other inclined planes, the ſame proportions are to be obſerved as on horizontal ones.

SECT. XVI. Gates, Doors, and Piers.

There are two kinds of entrances, viz. doors and gates. The former ſerve only for the paſſage of perſons on foot, but the latter likewiſe admit horſemen and carriages. Doors are uſed as entrances to churches and other public buildings, to common dwelling-houſes, and apartments; and gates ſerve for inlets to cities, fortreſſes, parks, gardens, palaces, &c. The apertures of gates being always wide, they are generally made in the form of an arch, that figure being the ſtrongeſt. But doors, which are generally of ſmall dimenſions, are commonly parallelograms, and cloſed horizontally. The general proportion for the apertures, both of gates and doors, whether arched or ſquare, is, that the height be about double the breadth.

The moſt common, and indeed almoſt the only ornaments for gates are the piers by which they are ſupported, and which were originally no more than bare poſts into which the hinges of the gate were driven. Though this, however, is the only proper uſe of piers, it muſt be concealed as much as poſſible, and they muſt ſeem as if placed there only for ornament. As they are to be fixed to the wall before the houſe, ſo they muſt alſo be proportioned to it; and as they are to be ſeen in the ſame view with the front of the houſe, their correſpondence with it is equally neceſſary. They are to be placed on a plinth, and ſomething muſt be allowed by way of ornament and finiſhing at the top. All the luxuriance of fancy may be employed in the decoration of piers: but it will be proper to obſerve this general rule, that the pier being an inferior building, it muſt never be richer than the front of the houſe. If, for inſtance, the front of the houſe is ornamented with columns of the Doric order, the Ionic muſt not be uſed in the piers; and it will be found better to omit columns altogether, than to make uſe of the Tuſcan order for piers in any caſe. If the Ionic or Corinthian

rinthian orders are employed in the front of the houſe, the Doric or Ionic may be uſed with propriety in the piers. One piece of ornament is almoſt univerſal in piers, namely, a niche with its ſeat, made as if for the conveniency of weary travellers. On this account it will be proper to raiſe the columns on pedeſtals, becauſe the continued moulding from their cap will be a good ornament under the niche. The baſe of the columns ought always to be the Attic.

Inſide-doors, however ſmall the building may be, ſhould never be narrower than two feet nine inches; nor ſhould they ever, in private houſes, exceed three feet ſix inches in breadth, which is more than ſufficient to admit the bulkieſt perſon. Their height ſhould be at leaſt ſix feet three or four inches; otherwiſe a tall perſon cannot paſs without ſtooping. In churches, palaces, &c. where there is a conſtant ingreſs and egreſs of people, the apertures muſt be larger. The ſmalleſt breadth that can be given to a gate is 8½ or 9 feet, which is but juſt ſufficient for the paſſage of a coach.

SECT. XVII. Windows.

Art. 1. *Proportions of Windows.*

The firſt conſideration with regard to windows is their ſize, which varies according to the climate, the deſtination of the building, &c. In Britain, the windows of the ſmalleſt private houſes are commonly from 3 to 3½ feet broad; and being generally twice their breadth in height, or ſomewhat more, in the principal apartments, they generally riſe to within a foot or two of the cielings of the rooms, which are frequently no higher than 10 feet, and at moſt 12 or 13. But, in more conſiderable houſes, the apartments are from 15 to 20 feet high, and ſometimes more; and in theſe the windows are from 4 to 5 and 5½ feet broad, and high in proportion. Theſe dimenſions are ſufficient for dwelling-houſes of any ſize in this country; when they are larger, they admit too much of the cold air in winter. But churches, and other buildings of that kind, may have larger windows, proportioned to the ſize of the ſtructures.

The proportions of the apertures of windows depend upon their ſituation. Their breadth in all the ſtories muſt be the ſame; but the different heights of the apartments make it neceſſary to vary the height of the windows likewiſe. In the principal floor, it may be from 2¾ of the breadth to 2½, according as the rooms have more or leſs elevation. In the ground-ſtory, where the apartments are lower, the apertures of the windows ſeldom exceed a double ſquare; and, when they are in a ruſtic baſement, they are frequently made much lower. The height of the windows of the ſecond floor may be from 1¾ of their breadth to 1⅔; and Attics and Mezzanines may be either a perfect ſquare, or ſomewhat lower.

The breaſts of all the windows on the ſame floor ſhould be on the ſame level, and raiſed above the floor from two feet nine inches to three feet ſix inches at the very moſt. When the walls are thick, the breaſts ſhould be reduced under the apertures, for the conveniency of looking out. In France, the windows are frequently carried quite down to the floor. When the building is ſurrounded with gardens, or other beautiful objects, this method renders the rooms exceedingly pleaſant. The interval between the apertures of windows depends in a great meaſure on their enrichments. The breadth of the aperture is the leaſt diſtance that can be between them; and twice that breadth ſhould be the largeſt in dwelling-houſes; otherwiſe the rooms will not be ſufficiently lighted.

Art. 2. *Windows how ornamented.*

The windows of the principal floor are generally moſt enriched. The ſimpleſt method of adorning them is, with an architrave ſurrounding the aperture, and crowned with a frize and cornice. The windows of the ground-floor are ſometimes left entirely plain, without any ornament; and at others they are ſurrounded with ruſtics, or a regular architrave with a frize and cornice. Thoſe of the ſecond floor have generally an architrave carried entirely round the aperture; and the ſame is the method of adorning Attic and Mezzanine windows: but the two laſt have ſeldom either frize or cornice; whereas the ſecond-floor windows are often crowned with both.

SECT. XVIII. Niches and Statues.

It hath been cuſtomary, in all ages, to enrich different parts of buildings with repreſentations of the human body. Thus the ancients adorned their temples, baths, theatres, &c. with ſtatues of their deities, heroes, and legiſlators. The moderns ſtill preſerve the ſame cuſtom, placing in their churches, palaces, &c. ſtatues of illuſtrious perſons, and even groups compoſed of various figures, repreſenting occurrences collected from hiſtory, fables, &c. Sometimes theſe ſtatues or groups are detached, raiſed on pedeſtals, and placed contiguous to the walls of a building, or in the middle of a room, court, or public ſquare. But they are moſt frequently placed in cavities made in the walls, called *niches*. Of theſe there are two ſorts; the one formed like an arch in its elevation, and ſemicircular or ſemielliptical in its plan; the other is a parallelogram both in its plan and elevation. The proportion of both theſe niches depends on the characters of the ſtatues, or the general form of the groups placed in them. The loweſt are at leaſt a double ſquare in height; and the higheſt never exceed 2¼ of their breadth.

Art. 1. *The Manner of decorating Niches.*

With regard to the manner of decorating niches, when they are alone in a compoſition, they are generally incloſed in a pannel, formed and proportioned like the aperture of a window, and adorned in the ſame manner. In this caſe, the niche is carried quite down to the bottom; but on the ſides and at the top, a ſmall ſpace is left between the niche and the archi-trave of the pannel. And when niches are intermixed with windows, they may be adorned in the ſame manner with the windows, provided the ornaments be of the ſame figure and dimenſions with thoſe of the windows.

Art. 2. *Statues.*

The ſize of the ſtatues depends on the dimenſions of the niches. They ſhould neither be ſo large as to have the appearance of being rammed into the niches, as in Santa Maria Majora at Rome; nor ſo narrow as to ſeem loſt in them, as in the Pantheon. The diſtance between the outline of the ſtatue and ſide of the niche ſhould never be leſs than one third of a head, nor more than one half, whether the niche be ſquare or arched; and when it is ſquare, the diſtance from the top of the head to the cieling of the niche ſhould not be greater than the diſtance on the ſides. Statues are generally raiſed on a plinth, the height of which may be from one third to one half of a head; and ſometimes, where the niches are large, the ſtatues may be raiſed on ſmall pedeſtals.

The character of the ſtatue ſhould always correſpond with the character of the architecture with which it is ſurrounded. Thus, if the order be Doric; Hercules, Jupiter, Mars, Æſculapius, and all male ſtatues, repreſenting beings of a robuſt and grave nature, may be introduced; if Ionic; then Apollo, Bacchus, &c. and if Corinthian; Venus, Flora, and others of a delicate nature, ſhould be employed.

SECT. XIX. Chimney-pieces.

Among the ancients, there are very few examples of chimney-pieces to be met with. Neither the Italians nor French have excelled in compoſitions of this kind. Britain, by being poſſeſſed of many able ſculptors at different times, has ſurpaſſed all other nations, both in taſte of deſign and workmanſhip.

The ſize of the chimney muſt be regulated by the dimenſions of the room where it is placed. In the ſmalleſt apartments, the breadth of the aperture ſhould never be leſs than three feet, or three feet ſix inches. In rooms from 20 to 24 feet ſquare, or of equal ſuperficial dimenſions, it may be from 4 to 4½ feet broad; in thoſe of 24 to 27, from 4½ to 5; and, in ſuch as exceed theſe dimenſions, the aperture may even be extended to 5½ or 6 feet.

The chimney ſhould always be ſituated ſo as to be immediately ſeen by thoſe who enter the room. The middle of the partition wall is the moſt proper place in halls, ſaloons, and other rooms of paſſage; but in drawing-rooms, dreſſing-rooms and the like, the middle of the back-wall is the beſt ſituation. In bed-rooms, the chimney is always in the middle of one of the partition walls: and in cloſets, and other very ſmall places, to ſave room it is put in a corner. Where ever two chimneys are uſed in the ſame room, they ſhould be placed either directly facing each other, if in different walls, or at equal diſtances from the centre of the wall in which they both are.

The proportion of the apertures of chimney-pieces of a moderate ſize is generally a perfect ſquare; in ſmall ones, it is a triſle higher; and in large ones, a triſle lower. Their ornaments conſiſt in architraves, frizes, cornices, columns, pilaſters, termini, caryatides, conſoles, and all kinds of ornaments of ſculpture, repreſenting animals and vegetables, &c. likewiſe vaſes, chalices, trophies of arms, &c. In deſigning them, regard muſt be had to the nature of the place where they are to be employed. Such as are intended for halls, ſaloons, guard-rooms, galleries, and other large places, muſt be compoſed of large parts, few in number, of diſtinct and ſimple forms, and having a bold relief; but chimney-pieces for drawing-rooms, dreſſing-rooms, &c. may be of a more delicate and complicated nature.

SECT. XX. The Proportions of Rooms.

The proportions of rooms depend in a great meaſure on their uſe and actual dimenſions: but, with regard to beauty, all figures, from a ſquare to a ſeſquilateral, may be employed for the plan. In internal diviſions, utility requires that the rooms be rectangular, to avoid uſeleſs ſpaces. An hexagonal figure leaves no void ſpaces; but it determines the rooms to be all of one ſize, which is both inconvenient and diſagreeable for want of variety. Though a cube be the moſt agreeable figure, and may anſwer for a room of a moderate ſize; yet, in a very large room, utility requires a different figure. Unconfined motion is the chief convenience of a great room; to obtain this, the greateſt length that can be had is neceſſary. But a ſquare room of large ſize is inconvenient. It removes chairs, tables, &c. at too great a diſtance from the hand, which, when unemployed, muſt be ranged along the ſides of the room. Uti-

lity therefore requires a large room to be a parallelogram. This figure is likewiſe beſt calculated for the admiſſion of light; becauſe, to avoid croſs-lights, all the windows ought to be in one wall; and if the oppoſite wall be at ſuch a diſtance as not to be fully lighted, the room muſt be obſcure. The height of a room exceeding nine or ten feet has little relation to utility; therefore proportion is the only rule for determining the height, when above that number of feet.

The height of rooms depends on their figure. Flat cieled ones may be lower than thoſe that are coved. If their plan be a ſquare, their height ſhould not exceed five ſixths of the ſide, nor be leſs than four fifths; and when it is oblong, their height may be equal to their breadth. But coved rooms, if ſquare, muſt be as high as broad; and when oblong, they may have their height equal to their breadth, more than one fifth, one quarter, or even one third of the difference between the length and breadth: and galleries ſhould at leaſt be in height one and one third of their breadth, and at moſt one and a half, or one and three-fifths.

The coldneſs of the Britiſh climate is a ſtrong objection to high rooms; ſo that it is not uncommon to ſee the moſt magnificent apartments not above 15, 16, or at moſt 18 feet high; though the extent of the rooms would require a much more conſiderable elevation. But where beauty is aimed at, this practice ought not to be imitated.

When rooms are adorned with an entire order, the entablature ſhould never exceed one ſixth of the whole height in flat-cieled rooms, and one ſixth of the upright part in coved ones; and when there are neither columns nor pilaſters, but only an entablature, its height ſhould not be above one ſeventh of theſe heights. If the rooms be finiſhed with a ſimple cornice, it ſhould never exceed one fourteenth, nor ever be leſs than one fifteenth part of the above mentioned height.

SECT. XXI. Cielings.

Cielings are either flat, or coved, in different manners. The ſimpleſt of the flat kind are thoſe adorned with large compartments, ſurrounded with one or ſeveral mouldings, either ſet into the cieling, or projecting beyond its ſurface: and when the mouldings that form the compartments are enriched, and ſome of the compartments adorned with well-executed ornaments, ſuch cielings have a good effect, and are very proper for common dwelling-houſes, and all low apartments. Their ornaments and mouldings do not require a bold relief; but, being near the eye, they muſt be finiſhed with taſte and neatneſs. For higher rooms, a flat cieling which has the appearance of being compoſed of various joiſts framed into each other, and forming compartments of various geometrical figures, ſhould be employed. The ſides of the joiſts forming the compartments are generally adorned with mouldings, and repreſent either a ſimple architrave, or an architrave-cornice, according to the ſize of the compartments and the height of the room.

Coved cielings are more expenſive; but they are likewiſe more beautiful. They are uſed promiſcuouſly in large and ſmall rooms, and occupy from one fifth to one third of the height of the room. If the room be low in proportion to its breadth, the cove muſt likewiſe be low; and when it is high, the cove muſt be ſo likewiſe: by which means the exceſs of the height will be rendered leſs perceptible. But, where the architect is at liberty to proportion the height of the room to its ſuperficial dimenſions, the moſt eligible proportion for the cove is one fourth of the whole height. In parallelogram-figured rooms, the middle of the cieling is generally formed into a large flat pannel. This pannel, with the border that ſurrounds it, may occupy from one half to three fifths of the breadth of the room. The figure of the cove is commonly either a quadrant of a circle or of an ellipſe, taking its riſe a little above the cornice, and finiſhing at the border round the great pannel in the center. The border projects ſomewhat beyond the coves on the outſide; and, on the ſide towards the pannel, it is generally made of ſufficient depth to admit the ornaments of an architrave, or architrave and cornice.

In Britain circular rooms are not much in uſe; but they are very beautiful. Their height muſt be the ſame with that of ſquare rooms; their cielings may be flat; but they are handſomer when coved, or of a concave form.

Arcs doubleaux, or ſoffits of arches, when narrow, are ornamented with *guilloches*, or frets; but, when broad, they may be adorned in a different manner. When the profiles of the room are gilt, the cielings ought likewiſe to be gilt. The uſual method is to gild all the ornaments, and to leave the grounds white, pearl colour, light blue, or of any other tint proper to ſet off the gilding to advantage. Painted cielings, ſo common in France and Italy, are but little uſed in Britain.

SECT. XXII. Stairs and Stair-cases.

There are many kinds of ſtair-caſes: for, in ſome, the ſteps are made ſtraight; in others, winding; in others, mixed of both. Of ſtraight ſtairs, ſome fly directly forward, others are ſquare, others triangular. Others are called *French flights*, or *winding-ſtairs*, (which in general are called *ſpiral*, or *cochle-ſtairs*); of which ſome are ſquare, ſome circular or round, and ſome elliptical or oval; and theſe again are various, ſome winding about a ſolid, others about an open newel. Stairs mixed of ſtraight and winding ſteps are alſo of various kinds; ſome are called *dog-legged*; ſome there are that wind about a ſolid newel, and others that fly about a ſquare open newel.

Great care ought to be taken in placing of the ſtair-caſe in any building; and therefore ſtair-caſes ought to be deſcribed and accounted for juſtly when the plan of a building is made. For want of this, ſometimes unpardonable errors have been committed: ſuch as having a little blind ſtair-caſe to a large houſe, or, on the other hand, a large ſpacious ſtair-caſe to a little one.

Palladio ſays, in placing ſtair-caſes, the utmoſt care ought to be taken; it being difficult to find a place convenient for them, that will not, at the ſame time, prejudice the reſt of the building. But commonly the ſtairs are placed in the angle, wing, or middle of the front.

To every ſtair-caſe are required three openings. Firſt, the door leading thereto; ſecondly, the window or windows that give light to it; and, thirdly, the landing.

Firſt, the door leading to the ſtair-caſe ſhould be ſo placed, that moſt of the building may be ſeen before you come at the ſtairs, and in ſuch a manner that it may be eaſy for any perſon to find out.

Secondly, for the windows; if there be but one, it muſt be placed in the middle of the ſtair-caſe, that thereby the whole may be enlightened.

Thirdly, the landing of ſtairs ſhould be large and ſpacious for the convenient entering into rooms: in a word, ſtair-caſes ſhould be ſpacious, light, and eaſy in aſcent. The height of large ſteps muſt never be leſs than ſix inches, nor more than ſeven inches and a half.

The breadth of ſteps ſhould never be leſs than 10 inches, nor more than 18 inches; and the length of them not leſs than three feet, nor more than 12.

Having given the foregoing extracts from the much eſteemed Treatiſe of Sir William Chambers, we ſhall proceed to conſider the practical part of this ſcience.

PART II.

PRACTICE of ARCHITECTURE.

Having thus deſcribed and given rules for the moſt generally received proportions of the different parts of buildings, both of the uſeful and ornamental kind, we muſt next give an account of the method of erecting different kinds of edifices; and here the judgment of the architect muſt neceſſarily be very much employed, as no fixed rules have been laid down by which he can be directed in all caſes. As a neceſſary preliminary, however, to the conſtruction, we muſt firſt conſider the ſituations of houſes.

Though it muſt be, in many caſes, impoſſible to chuſe ſuch a ſituation as might be agreeable either to the architect or the proprietor, yet where a choice can be made, there are certainly a great many circumſtances that will determine one ſituation to be preferable to another. Theſe circumſtances depend entirely on the perſon who is to inhabit the houſe. A farmer, for inſtance, ought to dwell in the moſt centrical part of his farm; an independent gentleman muſt regard the healthineſs, the neighbours with whom he can converſe, the proſpect from his houſe, and alſo the aſpect of the ground near it. To anſwer theſe purpoſes of health and pleaſure, an open elevated ſituation is the beſt, as the air is there pure, and the proſpect extenſive; but too elevated a ſituation is diſagreeable, as being both difficult of acceſs, and expoſed to cold and bleak winds. To build in bottoms between hills is both unhealthful and unpleaſant, the houſe being in a manner buried, and the ground near it generally marſhy from the rain-water which runs down from the hills, which renders the air unwholeſome. As a garden alſo is a very neceſſary article to a country habitation, the ſoil is by no means a matter of indifference; and therefore it may be concluded, that an elevated ſituation, on a gravelly loam, near ſome running water, is the beſt ſituation for a country houſe.

SECT. I. Foundation.

The executive part of architecture may be divided under two heads, the foundation and ſtructure. A foundation is the bottom on which the ſtructure is to be raiſed, and may be natural or artificial.

A natural foundation is ſuch as requires no artificial aſſiſtance, as ſtone, gravel, hard clay, ſand or earth, that hath been undiſturbed, called maiden; and ſuch as is ſufficient to receive and bear the intended ſtructure. The only ſecurity of a houſe, or any other building whatever, is in having a good foundation, and no error is ſo dangerous as that which is committed here; as the ſhrinking of the foundation but the breadth of a ſtraw may cauſe a rent of five or ſix inches wide in the ſuperſtructure.

Art. 1. *Qualities of the ground neceſſary to be examined.*

To guard againſt error, the qualities of the ground for a conſider-

conſiderable depth muſt be carefully obſerved. The beſt foundation is that which conſiſts of gravel or ſtone; but in order to know whether the inferior ſtrata are ſufficient for the ſupport of the building, it will be adviſable to ſink wells at ſome little diſtance. By attending to what is thrown up in digging theſe, the architect will be acquainted with what lies under the ſtony or gravelly bed which on the ſurface promiſes ſo much ſecurity, and will know what meaſures to take; or the worm borer may be uſed in ſeveral parts of the foundation, to be ſatisfied the whole is of the ſame or a ſimilar texture: this is an eſſential point, and in which the philoſophical and experimental judgment of the architect muſt be carefully exerciſed. Where the foundation is gravel, it will be proper to examine the thickneſs of the ſtratum, and the qualities of thoſe that lie under it, as they have appeared in digging. If the bed of gravel is thick, and the under ſtrata of a ſound and firm kind, there needs no aſſiſtance; if otherwiſe, we muſt have recourſe to various methods in order to ſupply the defect.

Art. 2. *Sandy or boggy Ground, how managed.*

The other matters which may occur for a foundation are clay, ſand, common earth, or rotten boggy ground. Clay will often both raiſe and ſink a foundation; yet it has a ſolidity which, with proper management, is very uſeful. The marſhy, rotten boggy ground is of all others the worſt; yet even upon this great buildings may be raiſed with perfect ſafety, provided proper care be taken. In caſe of boggy earths, or unfirm ſand, piling is one of the moſt common methods of ſecuring a foundation; and, notwithſtanding the natural diſadvantage of the earth, piles, when properly executed, are one of the firmeſt and moſt ſecure foundations. They ſhould be ſhod with iron, and drove to a depth till they reſiſt the engine or inſtrument with which they are driven, or are ſufficiently firm, and in quantity and proportion as the bottom and weight of the ſtructure may require. The tops muſt be cut off perfectly level and morticed, and a grating of timber framed thereon; the cavities filled with brick or ſome hard material, and the whole planked, for which purpoſe green timber is preferable. If the foundation ſhould be leſs uncertain, and the building not too weighty, tranſverſe pieces of timber, called ſleepers, laid at convenient diſtances, extending longer than the firſt courſes of brick or ſtone are wide, and planks laid thereon, may anſwer the purpoſe; and at all events buildings of magnitude, or great weight, ſhould be ſecured by turning reverſe arches under all the openings; and if the voids are large, the material ſhould be ſtone, if not, brick will do, as thoſe arches, if a ſegment of a circle, require a longer radius; therefore ſtone is better bond, and if not ſo ſecured, fiſſures and ſettlements in the upper arches, and other parts of the building, are frequently the conſequence.

Before the architect, however, begins to lay the foundation of the building, it will be proper to conſtruct ſuch drains as may be neceſſary for carrying off the rain, or other refuſe water that would otherwiſe be collected and lodge about the houſe.

Art. 3. *Foundation of Buildings how laid.*

The ſewers and drains being conſtructed in a manner proportioned to the ſize of the intended building, the architect may next proceed to lay the foundation of the walls. Here the firſt care muſt be, that the floor of the foundation be perfectly ſmooth and level. The Italians begin with laying over it an even covering of ſtrong oak plank; and upon that they lay, with the moſt exact care, the firſt courſe of the materials. Whether we take this method, or begin upon the naked floor, all muſt be laid with the moſt exact truth by rule and line. When the board plat is laid, a courſe of ſtone is the beſt firſt bed, and this is to be laid without mortar; for lime would make the wood decay, which otherwiſe, in a tolerably good ſoil, will laſt for ages. After this, all the courſes ſhould follow with the ſame perfect evenneſs and regularity. If the materials are brick, they ſhould be laid on with an equal, and not too great quantity of mortar: if ſtone, they ought to be placed regularly, and in the ſame ſituation in which they lay in the quarry; for many ſtones which will bear any weight flatwiſe, and in their natural poſition, are of ſuch a grain that they will ſplit otherwiſe. The joinings of the under courſe muſt be covered by the ſolid of the next courſe all the way up; and the utmoſt care muſt be taken that there be no vacuity left in the wall, for the weight will moſt certainly cruſh it in. The leſs mortar there is in a foundation, the better. Its uſe is to cement the bricks and ſtones together; and the evener they are, the leſs will be required for that purpoſe. Where mortar is uſed to fill up cavities, it becomes part of the wall; and not being of equal ſtrength with the ſolid materials, it takes from the firmneſs of the building. For the ſame reaſon, nothing can be more abſurd than to fill up a foundation with looſe ſtones or bricks thrown in at random; and where this is done, the ruin of the building is inevitable. Where the foundation of a principal wall is laid upon piles, it will be neceſſary alſo to pile the foundations of the partitions, though not ſo ſtrongly.

In foundations near the edge of waters, we ſhould always be careful to ſound to the very bottom, as many terrible accidents have happened from the ground being undermined by rivers. The ſame method is to be followed when the ground on which we build has been dug or wrought before. It ought never to be truſted in the condition in which it is left; but we muſt dig through it into the ſolid and unmoved ground, and ſome way into that, according to the weight and ſize of the intended edifice. The church of St. Peter's at Rome is an inſtance of the importance of this laſt obſervation. That church is in great part built upon the old circus of Nero; and the builders having neglected to dig through the old foundation, the ſtructure is conſequently ſo much the weaker. The walls were judged of ſtrength enough to bear two ſteeples upon the corners of the frontiſpiece; but the foundation was found too weak when it was impoſſible to remedy the defect perfectly.

Art. 4. *Drains how made.*

In making of drains for carrying off water, it will be neceſſary to make large allowances for the different quantities that may be collected at different times. It muſt alſo be conſidered, that water of this kind is always loaded with a vaſt quantity of ſediment, which by its continual falling to the bottom will be very apt to choak up the drain, eſpecially at thoſe places where there happen to be angles or corners in its courſe. The only method of preventing this is by means of certain cavities diſpoſed at proper diſtances from one another. Into theſe the ſediment will be collected, and they are for that reaſon called *ſeſpools*.

Art. 5. *Seſpools.*

The directions here neceſſary are, that they be placed at proper diſtances, be ſufficiently large, and placed ſo as to be eaſily cleaned. It is a good rule to make a ſeſpool at each place where the water enters the drain; as by this means a conſiderable quantity of ſediment will be prevented from entering the channel at all. Others are to be made at proper diſtances, eſpecially where there are any angles. They muſt be made ſufficiently large; the bigger, in moderation, the better; and they muſt alſo be covered in ſuch a manner as to be eaſily got at in order to be cleaned. But as putrid water is exceedingly noxious, it will be neceſſary to carry up a brick funnel over every ſeſpool, in order to prevent the collection of the putrid effluvia, which would otherwiſe occaſion the death of the perſon who cleaned it.

Art. 6. *Proportions of Drains.*

All drains ought to be arched over at top, and may be moſt conveniently built of brick. According to their different ſizes, the following proportions of height and thickneſs may be obſerved. If the drain is 18 inches wide, the height of the walls may be one foot, and their thickneſs nine inches; the bottom may be paved with brick laid flatwiſe, and the arch turned four inches. If the drain is 22 inches wide, the ſide walls are then to be one foot three inches in height, and the reſt conſtructed as before. If it is 14 inches wide, the height of the walls may be nine inches, and the ſweep of the arch four. A drain of a yard wide ſhould have the ſame height, and the arch turned over it ought to be 9 inches thick. Upon the ſame principles and proportions may other drains of any ſize be conſtructed.

SECT. II. STRUCTURE.

Art. 1. *Thickneſs and Diminutions of Walls, &c.*

THE thickneſs of foundation-walls in general ought to be double that of the walls which they are to ſupport. The looſer the ground, the thicker the foundation-wall ought to be; and it will require the ſame addition alſo in proportion of what is to be raiſed upon it. The plane of the ground muſt be perfectly level, that the weight may preſs equally every where; for when it inclines more to one ſide than another, the wall will ſplit. The foundations muſt diminiſh as they riſe, but the perpendicular is to be exactly kept in the upper and lower part of the wall; and this caution ought to be obſerved all the way up with the ſame ſtrictneſs. In ſome ground, the foundation may be arched; which will ſave materials and labour, at the ſame time that the ſuperſtructure has an equal ſecurity. This practice is peculiarly ſerviceable where the foundation is piled.

Art. 2. *Diminution of the Thickneſs of Walls.*

As the foundation walls are to diminiſh in thickneſs, ſo are thoſe which are built upon them. This is neceſſary in order to ſave expence, but is not abſolutely ſo to ſtrengthen the wall; for this would be no leſs ſtrong though it was continued all the way to the top of an equal thickneſs, provided the perpendicular was exactly kept. In this the ancients were very expert; for we ſee, in the remains of their works, walls thus carried up to an exorbitant height. It is to be obſerved, however, that, beſides perfect truth in their perpendiculars, they never grudged iron work, which contributed greatly to the ſtrength of their buildings. The thickneſs and diminution of walls is in a great meaſure arbitrary. In common houſes built of brick, the general diminution from the bottom to the top is one half the thickneſs at the bottom; the beginning is two bricks, then a brick and a half, and laſtly one brick, thickneſs. In larger edifices, the walls muſt be made proportionally thicker; but the diminution is preſerved much in the ſame manner. Where ſtones are uſed, regard muſt be had to their nature, and the propriety of their figures for holding one another.

thes. Where the wall is to be compoſed of two materials, as ſtone and brick, the heavieſt ought always to be placed undermoſt.

Art. 3. *Angles how fortified.*

There is one farther particular regarding the ſtrength of a plain wall, and that is, the fortifying its angles. This is beſt done with good ſtone on each ſide, which gives not only a great deal of ſtrength, but a great deal of beauty. Pilaſters properly applied are a great ſtrengthening to walls. Their beſt diſtance is about every 20 feet, and they ſhould riſe five or ſix inches from the naked of the wall. A much lighter wall of brick with this aſſiſtance, is ſtronger than a heavier and maſſier one built plain. In brick walls of every kind, it is alſo a great addition to their ſtrength to lay ſome chief courſes of a larger and harder matter; for theſe ſerve like ſinews to keep all the reſt firmly together, and are of great uſe where a wall happens to ſink more on one ſide than another.

Art. 4. *Windows improper near the Corners.*

As the openings in a wall are all weakenings, and as the corners require to be the ſtrongeſt parts, there ſhould never be a window very near a corner. Properly, there ſhould always be the breadth of the opening firm to the corner. In the moſt perfect way of forming the diminution of walls, the middle of the thinneſt part being directly over the middle of the thickeſt, the whole is of a pyramidal form; but where one ſide of the wall muſt be perpendicular and plain, it ought to be the inner, for the eaſe of the floors and croſs walls. The diminiſhed ſide, in this caſe, may be covered with a faſcia or cornice, which will at once be a ſtrength and ornament.

Art. 5. *Chimneys.*

Along with the conſtruction of walls, that of the chimneys muſt alſo be conſidered; for errors in the conſtruction of theſe will render the moſt elegant building extremely diſagreeable. The common cauſes of ſmoaking are either that the wind is too much let in above at the mouth of the ſhaft, or the ſmoke is ſtifled below; and ſometimes a higher building, or a great elevation of the ground behind, is the ſource of the miſchief; or laſtly, the room in which the chimney is may be ſo ſmall or cloſe, that there is not a ſufficient current of air to drive up the ſmoke. Almoſt all that can be done, while the walls are conſtructing, to prevent ſmoke, is, to make the chimney vent narrower at bottom than at top: yet this muſt not be carried to an extreme; becauſe the ſmoke will then linger in the upper part, and all the force of the draught will not be able to ſend it up.—As for the methods of curing ſmoky chimneys in houſes already built, ſee the article CHIMNEY.

Art. 6. *Roofs.*

After the walls are finiſhed, the roof is the next conſideration; but concerning it very little can be ſaid; only that its weight muſt be proportioned to the ſtrength of the walls. It muſt alſo be ſo contrived as to preſs equally upon the building; and the inner walls muſt bear their ſhare of the load as well as the outer ones. A roof ought neither to be too maſſy nor too light; as being neceſſary for keeping the walls together by its preſſure, which it is incapable of doing while too light; and if too heavy, it is in danger of throwing them down. Of theſe two extremes, however, the laſt is to be accounted the worſt.

Art. 7. *Floors.*

With regard to the floors, they are moſt commonly made of wood; in which caſe, it will be neceſſary that it ſhould be well ſeaſoned by being kept a conſiderable time before it is uſed. The floors of the ſame ſtory ſhould be all perfectly on a level; not even a threſhold riſing above the reſt: and if in any part there is a room or cloſet whoſe floor is not perfectly level, it ought not to be left ſo, but raiſed to an equality with the reſt; what is wanting of the true floor being ſupplied by a falſe one.

In mean houſes, the floors may be made of clay, ox blood, and a moderate portion of ſharp ſand. Theſe three ingredients, beaten thoroughly together and well ſpread, make a firm good floor, and of a beautiful colour. In elegant houſes, the floors of this kind are made of plaſter of Paris, beaten and ſifted, and mixed with other ingredients. This may be coloured to any hue by the addition of proper ſubſtances; and, when well worked and laid, makes a very beautiful floor. Beſides theſe, halls, and ſome other ground-rooms, are paved or floored with marble or ſtone; and this either plain or dotted, or of a variety of colours: but the univerſal practice of carpeting has in a great meaſure ſet aſide the beſtowing any ornamental workmanſhip upon floors. In country buildings, alſo, floors are frequently made of bricks and tiles. Theſe, according to their ſhapes, may be laid in a variety of figures; and they are alſo capable of ſome variation in colour, according to the nature of the earth from which they were made. They may be laid at any time; but for thoſe of earth or plaſter, they are beſt made in the beginning of ſummer, for the eaſe of their drying.

BRIDGES.

The proper ſituation for building bridges is eaſily known, and requires no explanation: the only thing to be obſerved is, to make them croſs the ſtream at right angles, for the eaſe of the boats that paſs through the arches, with the current of the river; and to prevent the continual ſtriking of the ſtream againſt the piers, which in a long courſe may endanger their being damaged and deſtroyed in the end.

Bridges built for a communication of high roads, ought to be ſo ſtrong and ſubſtantial as to be proof againſt all accidents that may happen, to have a free entrance for carriages, afford an eaſy paſſage to the waters, and be properly adapted for navigation, if the river admits of it. Therefore the bridge ought to be at leaſt as long as the river is wide in the time of its greateſt flood: becauſe the ſloping of the waters above may cauſe too great a fall, which may prove dangerous to the veſſels, and occaſion the under gravelling the foundation of the piers and abutments; or, by reducing the paſſage of the water too much in time of a great flood, it might break through the banks of the river, and overflow the adjacent country, which would cauſe very great damages; or if this ſhould not happen, the water might riſe above the arches, and endanger the bridge to be overſet, as has happened in many places.

Art. 1. *Form of Arches.*

The form of the arch is commonly ſemicircular; but when they are of any great width, they are made elliptical, becauſe they would otherwiſe become too high. Another advantage of much more importance is, that the quantity of maſonry of the arches is reduced in the ſame proportion as the radius of the arch is to its height. This has been done at the Pont Royal at Paris, where the middle arch is 75 feet, and its height would have been 37.5 feet, inſtead of which it is only 24 by being made elliptical. Notwithſtanding theſe advantages, however, the lateſt experiments have determined ſegments of circles to be preferable to curves of any other kind; and of theſe the ſemicircle is undoubtedly the beſt, as preſſing moſt perpendicularly on the piers.

Art. 2. *Arch-ſtones.*

The thickneſs of the arch-ſtones is not to be determined by theory, nor do thoſe authors who have written on the ſubject agree amongſt themſelves. Mr. Gautier, an experienced engineer, in his works, makes the length of the arch-ſtones, of an arch 24 feet wide, two feet; of an arch 45, 60, 75, 90 wide, to be 3, 4, 5, 6, feet long reſpectively, when they are hard and durable, and ſomething longer when they are of a ſoft nature; and this length appears preferable.

CONCLUSIVE REMARKS.

It is the province of the architect to underſtand perfectly, the quality and quantity of materials, and the preferable way of diſpoſing and uniting them, and the value of the various articles and labour requiſite thereto.

Art. I. *Wood Work.*

The carpenters or timber work comprehends all the framing of the ſtructure, ſuch as the preparing to make a ſecure artificial foundation; the bond timbers, which ſhould always be halved and dovetailed at all the angles of the buildings, and the croſs walls thereof, and the joinings ſcarfed; the lintels, laying over all the voids, or doors, windows, &c. Wood, bricks, worked in the walls, where it is found neceſſary to fix wood dreſſings in the finiſhing, as grounds, architraves, &c. Obſerve to lay the ends of all girders, or principal timbers, on piers or poſts of partions, and avoid placing them over openings, or any timbers near chimney flues; and when flues do interfere, to frame trimming joiſts, as to the front of a chimney or to the well hole of a ſtair-caſe.

The various finiſhings of wood-work within and about the ſtructure, is called the joiner's work, all which is uſually done in this country, with deal imported from Norway, Sweden, and Ruſſia; the quality and ſeaſoning of which are the principal eſſentials. Theſe are employed in floors, doors, columns, architraves, chimney-pieces, mouldings, dados, wainſcotings, linings, partitions, porticos, &c. as the ſkill of the architect ſhall direct. Sometimes the floors, doors, ſaſhes, &c. are executed in wainſcot; and ſometimes the doors and ſaſhes are of mahogany; and when ſo, thoſe materials ſhould each be of the very beſt quality. White deal ſhould never be uſed without doors; it is a cheaper article, and is moſt proper for bedchamber floors and pannelling, being leſs liable to ſhrink than yellow; the yellow is conſiderably harder, and ſaturated with turpentine, therefore more fit to endure uſe and weather.

Art. 2. *Brick Work.*

The brickwork is the next within our conſideration. moſt writers on that ſubject have preſcribed certain rules for depths under ground, and alſo thickneſſes; which rules no longer exiſt, as it is uſual to ſink till you meet with a firm foundation, and even in ſome inſtances, office buildings and ſmall houſes are erected on the ſurface of the ground; and when they are ſunk for offices under ground, if the bottom is firm, ſix or eight courſes of brick work is ſunk below the floor thereof. Obſerving to make voids over voids, and ſolids over ſolids, to make all chimney flues with eaſy ſweeps, and free from ſudden checks; and that the brick work be properly worked, perfectly level, and a cloſe joint with mortar made of quick lime, and drift ſand well incorporated; and to work reverſe arches under openings,

openings, as doors and windows, &c. with arches over the ſame, notwithſtanding the lintells, as before mentioned, as that practice was much uſed by the ancients, which may be ſeen in many of their ruins where timber is totally decayed. Alſo particular attention muſt be had to ſufficient drains and ſewers, to convey away the waſte water, ſoil, &c. and that ſlink traps be placed to prevent nauſeous ſmells. When maſonry is to be uſed with brick work, the beſt way, if poſſible, is to leave the brickwork in ſuch a manner that the ſtone may be inſerted afterwards; but when that cannot be done, bond-ſtones muſt be introduced in the wall with the brickwork, and the whole worked with leiſure, the joints very cloſe, and the mortar tough; as the number of joints in proportion to the ſtone will ſettle in ſome degree, and may deſtroy the union of the ſtone and brick, particularly in aſhler fronts, the bond and fabrick having been frequently ruined by not paying a proper attention to the management thereof.

Art. 3. *Stone Work.*

The quality of ſtone ſhould particularly engage the attention of the architect, as it frequently happens that it is impregnated with ſalts, or has been dug from too near the earthy bed of the quarry, or a ſoft ſtrata; in either caſe, it will in a little time ſcale and mutilate, which is a mortifying circumſtance after ſuch extra expence and labour. The ſtone work of Somerſet Place is an example of excellent maſonry, particularly facing the Strand. Of coverings to houſes, ſlate is by much the moſt preferable, which is executed a variety of ways, and the qualities of ſlate are ſeveral. The Weſtmoreland is conſidered the ſtrongeſt and beſt. A patent for ſlating in a ſingular manner has lately expired, and the method is much practiſed by Mr. Wyatt: for ſome reaſons it may be preferred, as it will admit the pitch of the roof to be conſiderably leſs than any other material, except lead or copper, and is a very reaſonable covering conſidering it does not require the roof to be boarded; but when it is uſed, care muſt be taken to admit ſufficient circulation of air into the roof, or it will be liable to decay.

Art. 4. *Lead Work.*

In London it becomes neceſſary to have lead or copper gutters with a parapet wall or ſtone blocking, and the water conveyed down by pipes; but in the country, dripping eves, in elevated ſituations, are to be preferred, as the autumnal ſeaſons ſo frequently ſtop the gutters and pipes, together with ſnow, &c. that capital houſes frequently ſuffer very much by the overflowing, unleſs they are ſingularly conſtructed, that the water may eſcape before it is poſſible to find its way within the building.

Many attempts have been made to introduce materials to anſwer the purpoſe of lead or copper for gutters, but none have yet had the deſired effect; caſt lead is moſt preferable, and that not too thin; nor ſhould the joints be ever ſoldered, as in either caſe the effect of weather will crack that material, and cauſe drips, which is afterwards a continual expence.

Art. 5. *Plaſtering.*

The external walls, with inſide, ſhould be battened for the plaſtering, unleſs the walls are very thick, or the bricks hard and not abſorbent; care ſhould be taken that the ſand uſed for the purpoſe is not ſalt; drift ſand is the beſt and ſhould be uſed ſoon after it is made, or the lime will otherwiſe deſtroy the hair; floated plaſtering is always to be preferred, although attended with rather more expence. Plaſter cielings made ornamental, and ſome rooms ſtuccoed and pannelled, the cornices enriched, and other ornaments introduced as medallions, tablets, &c. when done with judgment, and in a good ſtyle, and exquiſite workmanſhip, are very proper finiſhings for bettermoſt rooms. External plaſtering very ſeldom ſtands the weather, as it is rare any compoſition hitherto invented anſwers the purpoſe; one great reaſon is, that when attempted ſufficient care is not taken to prevent the wet getting into the brickwork at the back of the plaſter coat; it is evident, that plaſtering, of good ſtone lime and clean drift ſand, in proper proportions and carefully worked, will ſtand, if the walls are battened and lathed, which certainly will endure as long as the timber and lath, on which it is worked, which many inſtances in very old towns and cities in England teſtify.

Art. 6. *Mortar.*

The ancients had a kind of mortar ſo very hard and binding, that, after ſo long a duration as to this time, it is next to impoſſible to ſeparate the parts of ſome of their buildings; though there are ſome who aſcribe that exceſſive ſtrength to time, and the influence of certain properties in the air, which is, indeed, found to harden ſome bodies very ſurprizingly. The improvement of mortar is certainly an object of great importance: and different ſchemes have been ſuggeſted for giving it that degree of durability for which the mortar uſed by the ancients is ſo juſtly celebrated. But none have ſo effectually anſwered that important purpoſe, as that recommended by the ingenius Dr. Higgins in his experiments and obſervations on CALCAREOUS CEMENTS, publiſhed in octavo, 1780; from which we ſhall make the following extracts.

Dr. Higgins has made a variety of experiments in conſequence of the modern diſcoveries relating to fixed air, for the purpoſe of improving the mortar uſed in our buildings. According to this author, the perfection of lime, prepared for the purpoſe of making mortar, conſiſts chiefly in its being totally deprived of its fixed air. On examining ſeveral ſpecimens of the lime commonly uſed in building, he found that it is ſeldom or never ſufficiently burned; for they all effervesced, and yielded more or leſs fixed air, on the addition of an acid, and ſlaked ſlowly, in compariſon with well burned lime. Dr. Higgins alſo relates ſome experiments, which ſhew how very quickly lime imbibes fixed air from the atmoſphere; on its expoſure to which, it by degrees ſoon loſes thoſe characters which chiefly diſtinguiſh it from mere lime-ſtone or powdered chalk, by ſoon attracting from thence that very principle, to the abſence of which it owes its uſeful quality as a cement, and which had before been expelled from it in the burning. Hence he concludes, that, as lime owes its excellence to the expulſion of fixed air from it in the burning, it ſhould be uſed as ſoon as poſſible after it is made, and guarded from expoſure to the air, as much as poſſible, before it is uſed. It is no wonder, therefore, he ſays, that the London mortar is bad, if the imperfection of it depended ſolely on the badneſs of the lime; ſince the lime employed in it is not only bad when it comes freſh from the kiln, becauſe it is inſufficiently burned and the air has acceſs to it, but becomes worſe before it is uſed, by the diſtance and mode of its conveyance, and when ſlaked is as widely different from good lime, as it is from powdered chalk. For a ſimilar reaſon, every other cauſe which tends to reſtore to the lime the fixed air, of which it had been deprived in the burning, muſt deprave it. It muſt receive this kind of injury, for inſtance, from the water, ſo largely uſed, firſt in ſlaking the lime, and afterwards in making it into mortar: if that water contains fixed air, from which few waters are perfectly free, and which will greedily be attracted by the lime. The injury ariſing from this cauſe is prevented by the ſubſtitution of lime-water, ſo far as may be practicable or convenient.

From other experiments, made with a view of aſcertaining the beſt relative proportions of lime, ſand, and water, in the making of mortar, it appeared that thoſe ſpecimens were the beſt which contained one part of lime in ſeven of the ſand, for thoſe which contained leſs lime, and were too ſhort whilſt freſh, were more eaſily cut and broke, and were pervious to water; and thoſe which contained more lime, although they were cloſer in grain, did not harden ſo ſoon or to ſo great a degree, even when they eſcaped cracking by lying in the ſhade to dry ſlowly. It appeared farther, that mortar, which is to be uſed where it muſt dry quickly, ought to be made as ſtiff as the purpoſe will admit, or, with the ſmalleſt practicable quantity of water, and that mortar will not crack, although the lime be uſed in exceſſive quantity, provided it be made ſtiffer, or to a thicker conſiſtence than mortar uſually is.

Dr. Higgins has alſo ſhown, that though the ſetting of mortar, as it is called by the workmen, chiefly depends on the exſiccation of it, yet its induration, or its acquiring a ſtony hardneſs, is not cauſed by its drying, as has been ſuppoſed, but is principally owing to its abſorption of fixed air from the atmoſphere, and is promoted in proportion as it acquires this principle; the acceſſion of which is indiſpenſibly neceſſary to the induration of calcareous cements. In order to the greateſt induration of mortar, therefore, it muſt be ſuffered to dry gently and ſet; the exſiccation muſt be effected by temperate air, and not accelerated by the heat of the ſun or fire; it muſt not be wetted ſoon after it ſets; and afterwards it ought to be protected from wet as much as poſſible, until it is completely indurated. The entry of acidulous gas muſt be prevented as much as poſſible until the mortar is finally placed and quieſcent; and then it muſt be as freely expoſed to the open air, as the work will admit, in order to ſupply acidulous gas, and enable it ſooner to ſuſtain the trials to which mortar is expoſed in cementitious buildings, and incruſtations.

Dr. Higgins has alſo inquired into the nature of the beſt ſand or gravel for mortar, and into the effects produced by bone-aſhes, plaſter-powder, charcoal, ſulphur, &c. and he deduces great advantages from the addition of bone-aſhes, in various proportions, according to the nature of the work for which the compoſition is intended. He deſcribes a water cement or ſtucco, of his own invention, for incruſtations internal or external, exceeding, as he ſays, Portland ſtone in hardneſs, for which he obtained his majeſty's letters patent in 1779. For a copious account of preparing a cement in imitation of ſtone, for fronting of houſes, ſee the Article CEMENT in the alphabet.

Art. 7. *Glazing.*

The glazing may be done a variety of ways; cottages and inferior tenements with common glaſs in lead; the better ſort with Newcaſtle crown in ſaſhes; and the beſt wainſcot, mahogany, or metal ſaſhes, glazed with London crown or plate glaſs: in elegant rooms the latter is to be preferred, as objects ſeen from within are rendered more perfect in their appearance, and that glaſs does not eaſily admit objects to be ſeen in rooms from without.

Art. 8 *Painting.*

The article of painting is very eſſential to the preſervation of

The Binder is deſired to obſerve, that this Half-ſheet, (4 C 2) *is to follow the* ſame ſignature *in this No. it being a Duplicate Signature, given to enlarge the Syſtem of Architecture in this new edition of the work.*

timber and iron-work, and equally ſo with reſpect to ornament Stucco'd walls are rendered very light and elegant by painting, and the ſcene will admit of change whenever the rooms require freſh painting: colours diſpoſed of with harmonizing taſte in a houſe, are a very great ornament; even plainneſs, in other reſpects, is much ſet off, and enlivened by painting; but on the outſide all timber and iron-work require it for its preſervation; ſo much ſo, that it ſhould be made a conſideration in all building and repairing leaſes granted for long terms, that the tenant do paint, every ſeven years, twice at leaſt, in oil, as the caſe may require, particularly in ſouth and ſouth-weſt aſpects; external dreſſings, as architraves frontiſpieces, and cornices of wood, have a very good effect if ſanded upon the laſt coat of paint; which not only gives the appearance of ſtone, but adds to its durability.

REMARKS ESSENTIAL TO BE NOTICED BY A BUILDER.

The internal diſpoſition of town houſes requires much invention, being limited to certain proportions or claſſes within the bills of mortality, by act of parliament, which muſt be conformed to; viz. the largeſt ſizes of houſes, which are conſidered of the firſt rate, are ſuch as exceed nine ſquares of building; thoſe of the ſecond rate, from five to nine ſquares; thoſe of the third rate, from three and a half to five ſquares; and thoſe of the fourth rate, not exceeding three and a half ſquares. Under theſe limits, town houſes are to be built; which act alſo regulates the heights of them, and the thickneſs of walls; chimneys, &c. Therefore, thus fettered, the builder is to make his plan. In the firſt place the artiſt is not confined; but in the ſecond and third he is much limited, where diſpoſition of the ſtaircaſe becomes a ſerious object; in ſome of which it is at the entrance, in others between the front and back room, receiving its light by a ſky-light and open newell; and in others in the back part, at the end of a paſſage, within the entrance; all which require judicious management to make the moſt of the rooms, which generally conſiſt of three that are principal; a fitting-room or library, a dining and drawing-room. The latter, in ſecond and third-rate houſes, are uſually on the one-pair ſtory, either front or back, as the ſtaircaſe will admit; the finiſhings of ſuch houſes ſhould be neat and ornaments few; a recels for a ſideboard and groined entrance may be admitted, with plaſter cornices, and two or three enrichments at moſt, if the ſtory does not exceed twelve feet in height, without a frieze; and, in order to gain the effect of height, the ſide walls cannot be too plain, or the cornice too narrow; and an ornament or ſoffits carried round the room on the cieling, a method now much practiſed. The one to be preferred of the before-named plans, where the dimenſions will admit, is the ſtaircaſe in the center of the building, and the next is the ſtaircaſe at the entrance, both of which admit the back rooms their full extent between the walls; and, if communication is wanted into the back yard, or garden, it is generally done by the ſaſhes down to the floor, or one of the window backs opening, and framed to anſwer the others. The number of windows is generally governed by the aſpect, and openneſs of the ſituation, or the extent of the front. One or two piers in the room will be the conſequence, which are certainly conſiderations with reſpect to light, proportion, and mode of furniture, the windows in general being from three feet to four feet ſix; and five feet and upwards, if plate glaſs, as three ſquares wide are moſtly preferred, and thoſe window-heights about twice their width; but if down to the floor, they are generally more. The two-pair ſtory is ſometimes two ſquares, or twice their width, and ſometimes one ſquare and a half; the Attics, one ſquare, and ſometimes, when above a cornice, only half a ſquare, in conformance to the ſcheme of elevation.

A large and ſpacious room, which is the firſt that commonly receives us, is a bad contrivance in ſeveral reſpects. In the firſt place, when immediately from the open air we ſtep into ſuch a room, its ſize in appearance is diminiſhed by contraſt; it looks little, compared with the great canopy of the ſky. In the next place, when it recovers its grandeur, as it ſoon doth, it gives a diminutive appearance to the reſt of the houſe; paſſing from it, every apartment looks little. In the third place, by its ſituation it ſerves only for a waiting-room, and a paſſage to the principal apartments. Rejecting therefore this form, a hint may be taken from the climax in writing for another that appears more ſuitable: a handſome portico, proportioned to the ſize and faſhion of the front, leads into a waiting-room of a larger ſize, and this to the great room, all by a progreſſion of ſmall to great.

The offices, or domeſtic part of town houſes, are moſtly under the principal floor, which are frequently very offenſive, particularly the ſmell from the kitchen, and the noiſe from the ſervants hall, which, if poſſible, are frequently detached, and covered with lead or copper, and the flues run into the party wall of the main building. This is a practice moſtly followed in houſes approaching to, or about nine ſquares; if larger, the plan is more at liberty: and, in order to keep them in other reſpects ſweet, proper drains and ſlink traps are eſſential conſiderations. Moſt other conveniences depend on the circumſtances of the families they are intended for; and the arrangement of them on the judgment of the architect or builder to whom they are entruſted.

Where blank windows are neceſſary, a glazed ſaſh ſhould be fixed therein, or it no longer anſwers the intended purpoſe. Blank doors ſeldom occur but withinſide a houſe, and anſwer very well for ſcenery, to make the houſe appear larger, or for ſymmetry, to anſwer a real door, but ſhould be uſed ſparingly in rooms, unleſs very large ones, to compleat the ſymmetry of one ſide; and frequently a jib door leading to a private apartment ſhould be preferred, as the appearance of too many doors gives an idea of cold, and looks uncomfortable. Ruſtic baſements to buildings frequently produce a happy effect; alſo ruſtic quoins. They are either ſquare or champhered; but when applied to the ſhafts of columns they look very heavy, as in ſome of the works of Meſſrs. Gibbs, Shepherd, and others; alſo the projecting key-ſtones to arches, as is ſeen in Groſvenor-ſquare, South Audley-ſtreet, &c. Pilaſters and columns, when properly applied, are the moſt graceful ornaments in building; they are conſidered ornamental when attached or inſulated; and they muſt be properly ſupported, and alſo appear to ſupport their entablature, and ſometimes an Attic; and, when detached, become the principal ſupports of arches, groins, and vaulted roofs; temples, porticos, pediments, &c. and, when ſo applied, certain rules for their diſtance govern their application. Arches or arched receſſes, in fronts of houſes, ſometimes have a good effect, but are ſeldom pleaſing above the baſements; arched or groined entrances, to reduce the height of narrow paſſages, anſwer extremely well; and if made of ſolid materials between the ground and principal floor, ſerve a double purpoſe, as they keep out noiſe and ſmell; and wherever they can be applied, they are a good defence againſt fire.

It very frequently happens that the architect is conſulted in the furniture of houſes; and, if a man of taſte, he is certainly moſt proper to give deſigns to furniſh the principal ſuite of apartments, as he will take care to harmonize all the parts, making together one general uniſon in the ſtyle with the whole. The contrary is ſometimes ſeen; as in a houſe in Portman-ſquare, where you are conveyed through a ſuite of rooms, in the Grecian, French, Etruſcan, and Indian taſte; which mixture of ſcenes have an odd effect on the viſitor, not unlike enchantment.

Within the laſt thirty years architecture has been making rapid advances to excellence; and, with a degree of triumph, is poſſeſſing herſelf of Great Britain for her throne, and there to erect her ſtandard; and, if induſtry and perſeverance have a claim, the capital is certainly deſerving of ſo noble and honourable a gueſt. The ſeminaries therein for the improvement of deſign, are truly worthy of applauſe, and to them moſt of our living artiſts owe much of their ſkill; particularly the Society of Arts, Manufactures and Commerce, whoſe firſt exhibition was in 1760; the Incorporated Society of Artiſts of Great Britain, by royal charter inſtituted 26th Jan. 1765; the Royal Academy, at Somerſet Place, under the immediate patronage of the King, where honorary premiums for deſigns in architecture are given; candidates ſent to Rome to compleat their ſtudies, free of expence; a courſe of lectures, elucidated by drawings of that ingenious artiſt Thomas Sandby, Eſq. the profeſſor; and an annual public exhibition of the works of various artiſts, (by which means, it is preſumed, the expences are ſupported, as there is no known fund for the purpoſe;) together with the valuable publications of Palladio, Inigo Jones, the Ruins of Palmyra and Balbec, by Wood; the Ruins of Athens, by Stewart; Spalatro, the Dioclefian palace, by Robert Adams; the Ionian Antiquities, collected by Parrs, for the Deletanti Society; the Ruins of Pæſtum; and many foreign publications imported; all which, artiſts of the preſent day ſeize with avidity for their improvement, which certainly is a means of eſtabliſhing in them true principles and correct taſte. Theſe advantages, together with the means of obtaining experimental knowledge in the art, from public buildings, new ſquares, ſtreets, bridges, &c. carrying on in and about the metropolis, with ſo much judgment and alacrity, cannot fail to render England the firſt ſchool of architectural ſtudy in the known world.

We have only to lament, that the materials of this country are inferior to thoſe where the art has been formerly carried to ſo great a degree of excellence; or, we doubt not, but the artiſts and workmen of this capital, are equal in taſte and abilities to the ancients. The tide and folly of raiſed faſhion are ſometimes rather too apt to warp them from their better judgments, which may be eaſily accounted for, as their employers whims frequently require to be gratified; but, when abſurd, caprice ſhould be got the better of, if poſſible, as all impropriecies are placed to the account of the artiſt, whoſe reputation muſt ſuffer in the judgment of the public.

The Syſtem of Architecture, in the firſt edition of this work, was the production of Mr. Plaw, architect, Paddington; but in this new edition it has undergone many alterations and received conſiderable additions.

ARCHITRAVE, in architecture, that part of a column, or order of a column, which lies immediately upon the capital. The architrave is the loweſt member of the entablature. It is ſuppoſed to repreſent the principal beam in timber buildings; whence the name, which is formed of *αρχος*, *chief*, and *trabs*, *beam*. See Plate VI. The architrave is different in the different orders. In the Tuſcan it only conſiſts of a plain face, crowned with a fillet; and is half a module in height. In the Doric and Compoſite, it has two faces or faſciæ; ſee Plates II. and V. In the Ionic and Corinthian, three; ſee Plate IV. in which laſt order it is $\frac{1}{12}$ths of a module high, though but half a module in the reſt. Architects, however, allow themſelves a great latitude in this part; ſome uſing more members than others; and many of them having two or three forms of architraves. Architrave is ſometimes alſo called the reaſon-piece, or maſter-beam, in timber buildings, as porticos, cloiſters, &c. In chimneys it is called the mantle-piece, and over the jaumbs of doors, or lintels of windows, the hyperthyron.

ARCHITRAVE *windows*, of timber, are commonly an ogee raiſed out of the ſolid timber, with a liſt over it; though ſometimes the mouldings are ſtruck, and laid on; and ſometimes they are cut in brick. The upper faſcia is called the *header*, or *heading architrave*; and the lower the *jack*.

ARCHIVAULT, in architecture, the inner contour of an arch; or a band or frame adorned with mouldings, running over the faces of the arch-ſtones, and bearing upon the impoſts. The word is French, *archivolter*; where it ſignifies the ſame thing; formed of *arcus volutus*. It is different in the different orders. In the Tuſcan, it has only a ſingle face; it has two faces crowned, in the Doric and Ionic; and the ſame mouldings with the architrave in the Corinthian and Compoſite.

ARCHIVE, or ARCHIVES, a chamber or apartment wherein the records, charters, and other papers and evidences, of a ſtate, houſe, or community, are preſerved, to be conſulted occaſionally. We ſay the archives of a college, of a monaſtery, &c. The archives of ancient Rome were in the temple of Saturn; the archives of the court of chancery are in the roll's office.

ARCH-MARSHAL, the grand marſhal of the empire. The elector of Saxony is arch-marſhal of the empire; and in that quality he goes immediately before the emperor, bearing a naked ſword.

ARCH-TREASURER, *archithefaurarius*, the great treaſurer of the German empire: This office was created with the eighth electorate, in favour of the elector of Palatine, who had loſt his former electorate, which was given to the duke of Bavaria, by the emperor Ferdinand II. who took it away from Frederic V. elector Palatine, after the battle of Prague, where he was defeated in maintaining his election to the crown of Bohemia. The dignity of arch-treaſurer was conteſted between the elector of Brunſwic, now king of Great-Britain, who claimed it in virtue of his deſcent from the elector Frederic, and the elector Palatine.

ARCTIC, in aſtronomy, an epithet given to the north pole, or the pole raiſed above our horizon. It is called the arctic pole, on occaſion of the conſtellation of the little bear, in Greek called *αρκτος*, the laſt ſtar of the tail whereof nearly points out the north pole.

ARCTIC *circle* is a leſſer circle of the ſphere, parallel to the equator, and 23° 30′ minutes diſtant from the north pole, from whence its name. This, and its oppoſite, the *antarctic*, are called the two polar circles; and may be conceived to be deſcribed by the motion of the poles of the ecliptic, round the poles of the equator, or of the world. See the Treatiſe on the GLOBES, and the Plate annexed.

ARCTURUS, in aſtronomy, a fixed ſtar of the firſt magnitude, in the conſtellation of *Arctophylax* or *Bootes*. The word is formed of *αρκτος*, and *ουρα*, *tail*, q. d. bear's tail; as being very near it.

This ſtar was known to the ancients, as in the following verſe of Virgil:

Arcturum, pluviaſque Hyades, geminoſque Triones.

See alſo Job ix. 9. xxxviii. 32.

ARDEA, in ornithology, a genus of the order of grallæ. The general characters of this order are theſe: The bill is ſtraight, ſharp, long, and ſomewhat compreſſed, with a furrow that runs from the noſtrils towards the point; the noſtrils are linear; and the feet have four toes. Under this genus Linnæus comprehends the grus or crane, the ciconia or ſtork, and the ardea or heron of other authors. The moſt remarkable ſpecies are the following.

The ciconia, or white ſtork of Ray, has naked eye-balls, and black prime wing-feathers. The ſkin below the feathers as alſo the beak, feet, and claws, are of a blood colour. It is a native of Europe, Aſia, and Africa; but is ſeldom or never to be met with in Italy. The ciconia feeds upon amphibious animals. It is ſuch an enemy to ſerpents, that it is reckoned almoſt a crime to kill a ſtork. From this favourable treatment, they are ſeen in Holland and the Low Countries walking unconcerned in ſtreets little frequented. Storks are birds of paſſage; they ſpend the ſummer in Europe, and diſappear all at once, and go off to Egypt, Ethiopia, &c. before winter, and do not return till about the middle of March.

The major, or common heron, has a black creſt depending from the back part of the head, an aſh-coloured body, and a black line and belt on the neck and breaſt. It is a native of Europe. This bird is remarkably light in proportion to its bulk, ſcarce weighing three pounds and an half: the length is three feet two inches; the breadth five feet four inches. The body is very ſmall, and always lean; and the ſkin ſcarce thicker than what is called gold-beater's ſkin. It muſt be capable of bearing a long abſtinence, as its food, which is fiſh and frogs, cannot be readily got at all times. It commits great deva ſtation in our ponds; but being unprovided with webs to ſwim, nature has furniſhed it with very long legs to wade after its prey. It perches and builds in trees, and ſometimes in high cliffs over the ſea, commonly in company with others, like rooks. It makes its neſts of ſticks, lines it with wool, and lays five or ſix large eggs of a pale green colour. During incubation, the male paſſes much of his time perched by the female. They deſert their neſts during the winter, excepting in February, when they reſort to repair them. It was formerly in this iſland a bird of game, heron-hawking being ſo favourite a diverſion of our anceſtors, that laws were enacted for the preſervation of the ſpecies, and the perſon who deſtroyed their eggs was liable to a penalty of twenty ſhillings for each offence. Not to know the hawk from the heron-ſhaw, was an old proverb taken originally from this diverſion; but in courſe of time it ſerved to expreſs great ignorance in any ſcience. In after-times this proverb was abſurdly corrupted to, "he does not know a *hawk* from a *hand-ſaw*." This bird was formerly much eſteemed as a food; made a favourite diſh at great tables, and was valued at the ſame rate as a pheaſant. It is ſaid to be very long-lived: by Mr. Keyſler's account it may exceed 60 years: and by a recent inſtance of one that was taken in Holland by a hawk belonging to the Stadtholder, its longevity is again confirmed, the bird having a ſilver plate faſtened to one leg, with an inſcription, importing it had been before ſtruck by the elector of Cologne's hawks in 1735.—The cinerea of Linnæus is the female of this ſpecies. See Plate IV. Genus 65.

The garzetta, or egret is creſted behind; the body is white, the beak black, and the feet greeniſh. It is a moſt elegant bird. It weighs about one pound; and the length is twenty-four inches, to the end of the legs thirty-two. It is a native of the eaſt. But that formerly it was very frequent in Britain, appears by ſome of the bills of fare: in the famous feaſt of Archbiſhop Neville, we find no leſs than a thouſand aſterides, egrets or egrittis, as it is differently ſpelt. Perhaps the eſteem they were in as a delicacy during thoſe days occaſioned their extirpation in our iſlands; abroad they are ſtill common, eſpecially in the ſouthern parts of Europe, where they appear in flocks. The ſcapulars and the creſt were formerly much eſteemed as ornaments for caps and head-pieces: ſo that aigrette and egret came to ſignify any ornament to a cap though originally the word was derived from *aigre, a cauſe de l'aigreur de ſa voix*.

The ſtellaris, or bittern, has a ſmooth head; it is variegated through the whole body with dark-coloured ſpots of different figures and ſizes. It is a native of Europe, and inhabits chiefly the fen-countries. It is met with ſkulking among the reeds and ſedges; and its uſual poſture is with the head and neck erect, and the beak pointed directly upwards. It will ſuffer perſons to come very near it without riſing; and has been known to ſtrike at boys and at ſportſmen, when wounded and unable to make its eſcape. It flies principally about the duſk of the evening, and then riſes in a very ſingular manner, by a ſpiral aſcent, till it is quite out of ſight. It makes a very ſtrange noiſe when it is among the reeds, and a different and very ſingular one as it riſes on the wing in the night. It builds its neſts with the leaves of water-plants on ſome dry clump among the reeds, and lays five or ſix eggs of a cinereous green colour. This bird and the heron are very apt to ſtrike at the fowler's eyes when only maimed. The food of the bittern is chiefly frogs; not that it rejects fiſh, for ſmall trouts have been met with in their ſtomachs. In the reign of Henry VIII. it was held in much eſteem at our tables, and valued at one ſhilling. Its fleſh has much the flavour of a hare, and nothing of the fiſhineſs of that of the heron.

ARDENT, ARDENS, from *ardere*, *to burn*, ſomething hot, and as it were burning.

ARDENT *ſpirits* are thoſe diſtilled from fermented vegetables; thus called, becauſe they will take fire, and burn. Such are brandy, ſpirit of wine, rum, arrack, &c.

AREA, in geometry, denotes the ſuperficial content of any figure. Thus, if a figure, e. gr. a field, be in form of a ſquare, and its ſide 40 feet long, its area is ſaid to be 1600 ſquare feet: or it contains 1600 little ſquares, each a foot every way. Hence to find the area of a triangle, ſquare, parallelogram, rectangle, trapezium, rhombus, polygon, circle, or other figure, is to find the magnitude or capacity thereof in ſquare meaſure.

To find the area of fields, and other incloſures, they firſt

ſurvey or take the angles thereof, then plot them on paper, and thus caſt up their contents in acres, roods, &c. after the uſual manner of other plain figures. For copious Rules reſpecting the practice of Surveying, and the ſeveral terms reſpecting the art, ſee the Syſtem of SURVEYING throughout.

The law by which the planets move round the ſun, is this; that a line, or radius, drawn from the centre of the ſun to the centre of the planet, always ſweeps or deſcribes elliptic areas proportional to the times. Sir I. Newton demonſtrates, that whatever bodies do obſerve ſuch law in their motions about any other body, do gravitate towards ſuch body.

ARECA, the *fanſel-nut*, in botany, a genus of the order of palmæ pennatifoliæ. The male has no calyx, but three petals, and nine ſtaminæ; the female has no calyx; the corolla has three petals, and the calyx is imbricated. There are two ſpecies, viz. the catheeu and the oleracea.

The catheeu is a native of India. It has no branches, but its leaves are very beautiful: they form a round tuft at the top of the trunk, which is as ſtraight as an arrow. It grows to the height of 25 or 35 feet, and is a great ornament in gardens. The ſhell which contains the fruit is ſmooth without, but rough and hairy within; in which it pretty much reſembles the ſhell of the cocoa nut. Its ſize is equal to that of a pretty large walnut. Its kernel is as big as a nutmeg, to which it bears a great reſemblance without, and has alſo the ſame whitiſh veins within when cut in two. In the centre of the fruit, when it is ſoft, is contained a greyiſh and almoſt liquid ſubſtance, which grows hard in proportion as it ripens. The extract of this nut has been ſuppoſed to be the terra japonica of the ſhops, at leaſt that it is a very ſimilar ſubſtance both in colour and taſte: but according to later obſervations, the genuine drug ſeems to be obtained from the *Mimoſa Catechu*. The fruit when ripe is aſtringent, but not unpalatable, and the ſhell is yellowiſh. Of this fruit there is a prodigious conſumption in the Eaſt Indies, there being ſcarce any perſon, from the richeſt to the pooreſt, who does not make uſe of it; and the trade they drive in it is incredible. The chief uſe that is made of areca is to chew it with the leaves of betel, mixing with it lime made of ſea-ſhells. Cornelius le Brun aſſerts, that they rub the leaves of betel with a red drug of Siam, or with white chalk. In order to chew it, they cut the areca into four quarters and take one quarter of it, which they wrap up in a leaf of betel, over which they lay a little of the lime; afterwards they tie it, by twiſting it round. This bit prepared for maſtication is called *pinang*; which is a Malayan word uſed all over the Eaſt Indies. The pinang provokes ſpitting very much, whether it be made with dried or freſh areca; the ſpittle is red, which colour the areca gives it. This maſtication cools the mouth, and faſtens the teeth and gums. When they have done chewing the pinang, they ſpit out the groſs ſubſtance that remains in the mouth.

The beſt areca of the Indies comes from the iſland of Ceylon. The Dutch Eaſt-India company ſend a great deal of it in their ſhips into the kingdom of Bengal. There grows in Malabar a ſort of red areca, which is very proper for dyeing in that colour. The ſame company ſend ſome of it from time to time to Surat and Amadabat, for the uſe of the dyers in the dominions of the Grand Mogul.

The oleracea, or true cabbage-palm, is the moſt beautiful, and perhaps the talleſt, of all trees. The trunk is perfectly ſtraight, and marked with rings at the veſtigiæ of the footſtalks of the leaves. Near the ground it is about ſeven feet in circumference; but tapers as it aſcends, and attains the height of 170 or 200 feet. The bark is of an aſh colour till within 25 or 30 feet of the extremity of the tree: when it alters at once to a deep ſea-green, which continues to the top. About 5 feet from the beginning of the green part upwards, the trunk is ſurrounded with its numerous branches in a circular manner, all the lowermoſt ſpreading horizontally with great regularity; and the extremities of many of the higher branches bend wavingly downwards, like ſo many plumes of feathers. Theſe branches, when full grown, are 20 feet long, more or leſs. As there are many thouſand leaves upon one tree: every branch bearing many ſcores upon it, and every leaf being ſet at a ſmall and equal diſtance from one another, the beauty of ſuch a lofty group of waving foliage, ſuſceptible of motion by the moſt gentle gale of wind, is not to be deſcribed. The middle rib, in each leaf, is ſtrong and prominent, ſupporting it on the under ſide, the upper appearing ſmooth and ſhining. The pithy part of the leaf being ſcraped off, the inſide texture appears to be ſo many longitudinal thread-like filaments. Theſe, being ſpun in the ſame manner as they do hemp, or flax, are uſed in making cordage of every kind, as well as fiſhing-nets, which are eſteemed ſtronger than thoſe uſually made from any other material of the like nature.

Upon removing the large leaves, or branches, which ſurround the top of the trunk a little way above the beginning of the green bark juſt mentioned, what is called the *cabbage* is diſcovered lying in many thin, ſnow-white, brittle flakes, in taſte reſembling an almond, but ſweeter. This ſubſtance, which cannot be procured without deſtroying the tree, is boiled, and eaten with mutton by the inhabitants of the Weſt Indies, in the ſame manner as turnips and cabbage are with us; though it muſt appear the height of extravagancy and luxury to fell ſo ſtately a tree, which would be an ornament to the moſt magnificent palace in Europe, to gratify the taſte of any epicure, eſpecially as there is but a very ſmall part of it eatable. What is called the *cabbage-flower*, grows from that part of the tree where the aſh-coloured trunk joins the green part already deſcribed. Its firſt appearance is a green huſky ſpatha, growing to above 20 inches long and about four broad; the inſide being full of ſmall white ſtringy filaments, full of alternate protuberant knobs, the ſmalleſt of theſe reſembling a fringe of coarſe white thread knotted: theſe are very numerous, and take their riſe from larger footſtalks; and theſe footſtalks likewiſe are all united to different parts of the large parent-ſtalk of all. As this huſky ſpatha is opened while thus young, the farinaceous yellow ſeed in embryo, reſembling fine ſaw-duſt, is very plentifully diſperſed among theſe ſtringy filaments, which anſwer the uſe of apices in other more regular flowers: theſe filaments being cleared of this duſt, are pickled, and eſteemed among the beſt pickles either in the Weſt Indies or in Europe. But if this ſpatha is not cut down and opened while thus young; if it be ſuffered to continue on the tree till it grows ripe and burſts, then the incloſed part, which while young and tender is fit for pickling, will by that time have acquired an additional hardneſs, become ſoon after ligneous, grow buſhy, conſiſting of very many ſmall leaves, and in time produce a great number of ſmall oval thin-ſhelled nuts, about the bigneſs of unhuſked coffee-berries: Theſe, being planted, produce young cabbage-trees.

The ſockets or grooves, formed by the broad part of the footſtalks of the branches, are uſed by the negroes as cradles for their children. On the inner ſide of the very young footſtalks are tender pellicles, which when dried, it is ſaid, make a writing paper. The trunks ſerve as gutterings; the pith makes a ſort of ſago; and the nuts yield oil by decoction. In the pith alſo, after the trees are felled, there breeds a kind of worms, or grubs, which are eaten and eſteemed a great delicacy by the French of Martinico, St. Domingo, and the adjacent iſlands. Theſe worms, ſays father Labat, are about two inches long, and of the thickneſs of one's finger; the head is black, and attached to the body without any diſtinction of neck. Their preparation for the table is as follows: They are ſtrung on wooden ſkewers before a fire; and as ſoon as heated, are rubbed over with raſpings of cruſt, ſalt, pepper, and nutmeg: this powder abſorbs all the fat, which during the cookery would otherwiſe eſcape: when properly roaſted, they are ſerved up with orange or citron ſauce. Theſe worms being expoſed for ſome time to the ſun, are ſaid to yield an oil which is of great efficacy in the piles. The oil in queſtion, ſays Labat, is never to be heated before its application to the part affected: as repeated experiments have evinced that its ſpirit is totally diſſipated by the fire.

AREOPAGUS, a ſovereign tribunal at Athens, famous for the juſtice and impartiality of its decrees, to which the gods themſelves are ſaid to have ſubmitted their differences. It was in the town, on a rock or hill oppoſite to the citadel. The word ſignifies ſtrictly, *rock of Mars*.

Plutarch attributes the eſtabliſhment of the Areopagus to Solon. Other authors think differently: and with good reaſon; for it appears undeniable that this tribunal was inſtituted before Solon, but the beſt authorities allow him the honour of its reſtoration. The city of Athens, governed till this time by tribunals of a circumſcribed juriſdiction, which were multiplied by the moſt trifling accidents and circumſtances, took no fixed political or civil form, however cloſely united the members of thoſe tribunals were by their general views towards the public good, and by the common love of their country. As each of thoſe tribunals could only act in proportion to the power delegated to it, it was impoſſible that ſo many different and unequal impreſſions ſhould give to the great machine of the ſtate that uniform and regular movement which, by an impulſe always the ſame, would keep each part in the ſituation it ſhould maintain with relation to the whole.

To effect this univerſal and harmonious power, it was neceſſary to unite the different channels of public authority, which, by being too much diſtributed, loſt its force. This authority Solon collected, and placed it all in the court of Areopagus which conſequently became the main ſpring of the government. The judges of this court, who, under Draco, decided only in caſes of murder, now took cognizance of crimes of every kind; and the ſame tribunal which inflicted capital puniſhment on murder, poiſoning, burning of houſes, theft, &c. ſtruck at the roots of thoſe crimes, by arraigning idleneſs, luxury, and debauchery. Equally attentive to ſtimulate the indolence of the young, and the languor of the old, theſe ſage judges roufed in the one the laudable ambition to ſerve the ſtate, and reſtored to the others their former activity. Satisfied that extremes produce the ſame effects, they thought the republic had as much to fear from the exceſs of wealth as from the gripe of poverty. Hence they exacted a minute account of the effects of every individual. Hence their great ſeverity to thoſe idle citizens, who, inſtead of being uſeful members

members in a ſtate, are its bane and its diſhonour. Iſocrates draws a moſt beautiful and ſtriking picture of thoſe venerable and aſtoniſhing men, and of the order and harmony which flouriſhed in Athens by their wiſe adminiſtration.

The judges of the Areopagus, ſays that author, were more induſtrious to prevent crimes, by repreſenting them in an odious light, than to eſtabliſh modes of puniſhment. It was their opinion that the enemies of the ſtate were the inſtruments deſtined by the gods to puniſh the wicked; but that it was their province to correct and reform public and private manners. They were vigilantly attentive to the conduct of all the citizens, but particularly to that of the youth. They well knew that the impetuoſity of juvenile paſſion gave the moſt violent ſhocks to health and growing virtue; that it was the duty of inſpectors of education to ſoften the auſterity of moral diſcipline with innocent pleaſure; and that no recreations were more eligible than bodily exerciſes, which enable a young man to give a good education its full play, which improve health, give a pleaſurable and agreeable vivacity, and even fortify the mind. The fortunes of the Athenians were too unequal to admit the ſame mode of education; and therefore the youth were trained in a manner ſuitable to the rank and circumſtances of their reſpective families. Thoſe of the inferior claſſes were taught agriculture and commerce; from this principle, that idleneſs is followed by indigence, and that indigence excites to the moſt daring and atrocious crimes. Having thus endeavoured, by wiſe precautions, to preclude the entrance of moral evil, they thought they had little to fear.

Exerciſes of the body, ſuch as horſemanſhip and hunting, were objects of education to the youth of liberal fortune. In this ſage diſtribution, their great aim was to prevent the poor from committing crimes, and to facilitate to the rich the acquiſition of virtue. Not ſatisfied with having eſtabliſhed good laws, they were extremely careful to ſee that they were obſerved. With this view, they had divided the city into quarters, and the country into cantons. Thus every thing paſſed under their eyes; nothing eſcaped them; they were acquainted with the private conduct of every citizen. Thoſe who had been guilty of any irregularity were cited before the magiſtrates, and reprehended, or puniſhed in proportion to their miſdemeanour.

The ſame Areopagites obliged the rich to relieve the poor. They repreſſed the intemperance of the youth by a ſevere diſcipline. Corruption in magiſtrates was ſuppreſſed by the puniſhments denounced againſt it; and the old men, at the ſight of the employments of the young, felt themſelves animated with a degree of juvenile vigour and activity.

Religion came likewiſe under the cognizance of the Areopagites. Plato durſt never, as we are told by Juſtin Martyr, divulge his private opinion concerning the Deity. He had learned from the Egyptians the doctrine of Moſes. It appeared to him the beſt, and he embraced it with ardour. But his dread of the Areopagites, who were attached to the prevailing ſyſtem, would not permit him even to name the author of ſentiments which oppoſed the common tradition.

The public edifices, the cleanneſs of the ſtreets, the pay of the ſoldiers, the diſtribution of the public money; in a word, whatever intereſted the republic, was under the direction of the Areopagus. The people themſelves, jealous as they were of their power, did nothing without conſulting this aſſembly, and ſuffered it, without a murmur, to amend their precipitate decrees. Yet this authority, however great it may ſeem, was ſubject to the laws; by them rewards and puniſhments were determined; and thoſe reſpectable judges gave an account of the exerciſe of their truſt to public cenſors, who were placed betwixt them and the people, to prevent the ariſtocracy from growing too powerful.

The moſt important qualifications were required in thoſe who entered into the Areopagus. Solon made a law, by which they who had not been archons for a year ſhould not be admitted members of the Areopagus. To give more force to his law, he ſubjected himſelf to it, and was only admitted on that title. This was but the firſt ſtep: thoſe annual magiſtrates, after having given law to the republic, were interrogated on their adminiſtration. If their conduct was found irreproachable, they were admitted Areopagites with eulogium; but the ſmalleſt miſconduct excluded them from that honour for ever. What adminiſtration was not to be expected from a tribunal ſo well compoſed? what veneration was not due to men of ſuch rare talents and virtue? Such reſpect was paid them, that people preſumed not to laugh in their preſence; and ſo well eſtabliſhed was their reputation for equity, that thoſe whom they condemned, or diſmiſſed without granting their petition, never complained that they had been unjuſtly treated.

The edifice of the Areopagus was extremely ſimple; and its roof, which was at firſt of the moſt common materials, remained in that ſtate till the time of Auguſtus. This we learn from Vitruvius. Oreſtes was the firſt who thought of embelliſhing it. He raiſed in it an altar to Minerva. He likewiſe adorned it with two ſeats of ſolid ſilver: in one of which the *accuſer* ſat, and the *accuſed* on the other. The one ſeat was conſecrated to *Injury*, and the other to *Impudence*. This religious ſketch was brought to perfection by Epimenides, who erected altars to thoſe allegorical deities, and ſoon after a temple, which Cicero mentions in his ſecond book of laws. This temple correſponded with that which Oreſtes had built to the Furies, who brought him to Athens, and procured him the protection of Minerva. Epimenides dedicated it a ſecond time to the Furies or *ſevere Goddeſſes*, as they were termed by the Athenians. A man was thought loſt without reſource, and a victim to every human ill, if he enforced a perjury by invoking the ſacred name of thoſe tremendous divinities.

In early times, the parties themſelves ſtated their cauſe in a ſimple manner. The eloquence of advocates was thought a dangerous talent, fit only to varniſh crimes. But afterwards Areopagus, on this point, relaxed from their ſeverity;—at firſt the accuſed, and ſoon after the accuſers, were permitted to engage thoſe to make the attack and the defence, whoſe profeſſion it was to exert the art of ſpeaking, for others, with accuracy and elegance.

Sextus Empericus ſeems not to have ſufficiently diſtinguiſhed times, where he ſays, that the court of Areopagus did not ſuffer thoſe who were to be tried at their bar to avail themſelves of the abilities of others. What undoubtedly led him into that miſtake, was an inviolable cuſtom of that tribunal, which prohibited, in pleadings, all that warm and picturеſque oratory which ſeduces the judgment and inflames the paſſions.

We muſt not, however, ſuppoſe that the Areopagus always preſerved its old reputation; for ſuch is the conſtitution of human affairs, that perfection with regard to them, is a violent, and conſequently a tranſitory, ſtate. Pericles, who lived about 100 years after Solon, to flatter the people and win them to his party, uſed his utmoſt efforts to weaken the authority of the Areopagus, which was then diſliked by the multitude. He took from it the cognizance of many affairs which had before come under its juriſdiction; and, to forward his deſign of humbling it, employed the eloquence of Ephialtes, whoſe talents were formidable, and who was an avowed enemy to the great men of Athens.

The Areopagus itſelf ſeemed to ſecond the endeavours of a man who projected its ruin, and by its miſconduct haſtened its fall. The old rules of the court, by which none were admitted its members but thoſe whoſe unexceptionable conduct would ſupport its majeſty, ſeemed too ſevere. They grew leſs delicate in their choice; and preſuming that the faults with which they diſpenſed, would ſoon be reformed in the ſociety of ſo many good examples, vice imperceptibly crept among them: corruption, at firſt ſecret and timid, grew inſenſibly open and daring, and made ſuch progreſs, that the moſt ſhameful crimes were ſoon exhibited on the ſtage; and they were not copied from the low and abandoned multitude, but from thoſe ſenators, once the venerable and auſtere cenſors of idleneſs and of vice. Demetrius, the comic poet, wrote a piece which he intitled *The Areopagite*, where he ſtrips the maſk off thoſe hypocritical legiſlators, who were now equally apt to be ſeduced by wealth and by beauty. So much had the Athenian ſenate degenerated in the days of Iſocrates, cir. 340 years before the Chriſtian æra.

Before this tribunal St. Paul was called to give an account of his doctrine, and converted Dionyſius one of their number.

The end of this court of judicature is as obſcure as its origin, which was derived from very remote antiquity. It exiſted, with the other magiſtracies, in the time of Pauſanias, i. e. in the 2d century. The term of its ſubſequent duration is not aſcertained; but a writer, who lived under the emperors Theodoſius the Elder and Younger, in the 5th century, mentions it as extinct.

ARGENT, in heraldry, ſignifies the white colour, uſed in the coats of gentlemen, knights, and baronets. *Argent* is expreſſed, in engraving, by the parts being left plain, without any ſtrokes from the graver. The word is French, derived from the Latin *argentum*, *ſilver*, this colour being ſuppoſed the repreſentation of that metal: whence the Spaniards call this field *campo de plata*, *ſilver field*. Argent of itſelf is uſed in heraldry to ſignify purity, innocence, beauty, and gentleneſs; and, according to G. Leigh, if it is compounded with

Gul.	it ſignifies	boldneſs;
Azu.		courteſy;
Ver.		virtue;
Pur.		favour;
Sab.		religion.

See the SYSTEM, Sect. II. and Plate II.

ARGILLACEOUS *earths*, ſuch as form with water a tenacious paſte, or ſoft ſtones; they burn hard, are corroded by ſtrong coction in the concentrated mineral acids but not acted upon by moderate digeſtion. They are the baſis of earthen wares. They vitrify with ſalts, with arſenic, with gypſum, and difficulty with lead. See Neumann's Works, and Dr. Lewis's Additions, p. 21, & ſeq.

ARGO *navis*, or the *Ship*, in aſtronomy, is a conſtellation of fixed ſtars, in the ſouthern hemiſphere, whoſe ſtars, in Ptolemy's catalogue, are 45; in Tycho's, 11; in the Britannic catalogue, and Sharp's Appendix, 64. See the SYSTEM, Sect. VIII. Plate VI.

ARGUMENT, in logic, is ſome reaſon, or ſeries of reaſoning, by which we eſtabliſh the proof, or ſhew the probability

lity, of ſome given propoſition. Logicians ſomewhat more ſcientifically, define argument, a medium, from whoſe connection with two extremes, the connection of the two extremes themſelves is inferred.

Arguments are termed *grammatical*, *logical*, *phyſical*, *metaphyſical*, *moral*, *mechanical*, *theological*, &c. according to the art, ſcience, or ſubject, from whence the middle term is borrowed.

Thus, if we prove that no man ſhould ſteal from his neighbour, becauſe the ſcripture forbids it, this is a *theological argument*; if we prove it from the law of the land, it is *political*; but if we prove it from the principles of reaſon and equity, the argument is *moral*. Logicians divide their arguments with regard to their form, into ſyllogiſms, enthymemes, inductions, &c. For the definitions and applications of theſe terms of the art, ſee the Syſtem of LOGIC throughout.

ARIANS, followers of Arius, a preſbyter of the church of Alexandria about the year 315; who maintained, that the Son of God was totally and eſſentially diſtinct from the Father; that he was the firſt and nobleſt of thoſe beings whom God had created, the inſtrument by whoſe ſubordinate operation he formed the univerſe; and therefore inferior to the Father both in nature and dignity: alſo, that the Holy Ghoſt was not God, but created by the power of the Son.

The Arians owned that the Son was the Word, but denied that word to have been eternal. They held, that Chriſt had nothing of man in him but the fleſh, to which the λογος or Word was joined, which was the ſame as the ſoul in us. See *Lardner's Credibility*, &c. Vol. IX. b. i. c. 69.

The Arians were firſt condemned and anathematized by a council at Alexandria, in 320, under Alexander, biſhop of that city; who acuſed Arius of impiety, and cauſed him to be expelled from the communion of the church: and afterwards by 380 fathers in the general council of Nice, aſſembled by Conſtantine in the year 325. But, notwithſtanding that, it was not extinguiſhed; on the contrary, it became the reigning religion, eſpecially in the Eaſt, where it obtained much more than in the Weſt. Arius was recalled from baniſhment by the emperor Conſtantine in two or three years after the council of Nice, and the laws that had been enacted againſt him were repealed. In the year 335, Athanaſius, his zealous opponent, was depoſed and baniſhed into Gaul, and Arius and his followers were reinſtated in their privileges, and received into the communion of the church. In little more than a year after this, he fell a victim to the reſentment of his enemies, and died a tragical death, occaſioned probably by poiſon, or ſome other violence. The Arian party found a protector in Conſtantius, who ſucceeded his father in the empire of the Eaſt; and the zeal with which he abetted them produced many animoſities and tumults to the time of his death in the year 362. They underwent various revolutions, perſecuting and oppreſſed, under ſucceeding emperors, according to the degree of intereſt they had in the civil power, till at length Theodoſius the Great exerted every poſſible effort to ſuppreſs and diſperſe them.

The Arians were divided into various ſects, of which ancient writers give an account under the names of *Semi-Arians*, *Euſebians*, *Aetians*, *Eunomians*, *Acacians*, *Plathyrians*, and others. But they have been commonly diſtributed into three claſſes, viz. the *Genuine Arians*, *Semi-Arians*, and *Eunomians*.

Arianiſm was carried in the fifth century into Africa under the Vandals; and into Aſia under the Goths: Italy, the Gauls, and Spain, were alſo deeply infected with it; and towards the commencement of the ſixth century, it was triumphant in many parts of Aſia, Africa, and Europe. But it ſunk almoſt all at once, when the Vandals were driven out of Africa, and the Goths out of Italy, by the arms of Juſtinian. However, it revived again in Italy under the protection of the Lombards in the ſeventh century.

Eraſmus ſeems to have aimed in ſome meaſure to reſtore Arianiſm at the beginning of the ſixteenth century, in his Commentaries on the New Teſtament. Accordingly, he was reproached by his adverſaries with Arian interpetrations and gloſſes, Arian tenets, &c. To which he made little anſwer, ſave that there was no hereſy more throughly extinct than that of the Arians: *Nulla hereſis magis extincta quam Arianorum.* But the face of things was ſoon changed. Servetus, a Spaniard by nation, publiſhed in 1531 a little treatiſe againſt the Trinity, which once more revived the opinions of the Arians in the Weſt. Indeed he rather ſhowed himſelf a Photinian than an Arian; only that he made uſe of the ſame paſſages of Scripture, and the ſame arguments againſt the divinity of our Saviour, with the proper Arians.

It is true, Servetus had not, properly ſpeaking, any diſciples: but he gave occaſion after his death to the forming of a new ſyſtem of Arianiſm in Geneva, much more ſubtle and artful than his own, and which did not a little perplex Calvin. From Geneva the new Arians removed to Poland, where they gained conſiderable ground; but at length became Socinians.

The appellation *Arian* has been indiſcriminately applied, in more modern times, to all thoſe who conſider Jeſus Chriſt as inferior and ſubordinate to the Father; and whoſe ſentiments cannot be ſuppoſed to coincide exactly with thoſe of the ancient Arians. Mr. Whiſton was one of the firſt divines who revived this controverſy, in the beginning of the 18th century. He was followed by Dr. Clarke, who publiſhed his famous book intitled *The Scripture Doctrine of the Trinity*, &c. In conſequence of which, he was reproached with the title of *Semi-Arian*. He was alſo threatened by the convocation, and combated by argument. Dr. Waterland, who has been charged with verging towards Tritheiſm, was one of his principal adverſaries. The hiſtory of this controverſy during the preſent century may be found in a pamphlet, intitled *An account of all the conſiderable Books and Pamphlets that have been wrote on either ſide, in the Controverſy concerning the Trinity, from the Year 1712; in which is alſo contained an Account of the Pamphlets written this laſt Year, on each ſide, by the Diſſenters, to the end of the Year 1719.* Publiſhed at London 1720.

ARIES, or the *Ram*, in aſtronomy, the firſt of the twelve ſigns of the zodiac; from which alſo a twelfth part of the ecliptic takes its denomination. The ſtars in the conſtellation aries, in Ptolemy's catalogue, are 18; in Tycho's 21; in Hevelius's, 27; in the Britannic catalogue, 66. See the SYSTEM, Sect. IX. and the Treatiſe on the GLOBES, and Plate annexed, Fig. 3 and 4.

ARISTOCRACY, in politics, a form of government, where the ſupreme power is lodged in the hands of the optimates, i. e. of a council, or ſenate, compoſed of the principal perſons of a ſtate, either in reſpect of nobility, capacity, or probity. The word is derived from αριστος, *optimus*, and κρατεω, *imperio*, *I govern*. The ancient writers on politics prefer the ariſtocratical form of government to all others.—The republic of Venice is an ariſtocracy. Ariſtocracy ſeems to coincide with oligarchy; which, however, is more ordinarily uſed to ſignify a corruption of an ariſtocratical ſtate, where the adminiſtration is in the hands of too few; or where ſome one or two uſurp the whole power.

ARISTOTELIAN, ſomething that relates to the Philoſopher Ariſtotle.—Thus we ſay, an *Ariſtotelian* dogma, the *Ariſtotelian* ſchool, &c. The Philoſopher from whom the denomination ariſes, was the ſon of Nicomachus, phyſician of Amyntas, king of Macedonia, born in the year of the world 3566, before Chriſt 348, at Stagira, a town of Macedonia, or, as others ſay, of Thrace; whence he is alſo called the Stagirite. At ſeventeen years of age he entered himſelf a diſciple of Plato, and attended in the Academy till the death of that philoſopher. Repairing afterwards to the court of king Philip, at his return he found that Xenocrates, during his abſence, had put himſelf at the head of the Academic ſect; upon which he choſe the Lyceum for the future ſcene of his diſputation. It being his practice to philoſophize walking, he got the appellation *Peripateticus*; whence his followers were alſo called *Peripatetics*. In the ſchools, Ariſtotle is called the philoſopher; and the prince of philoſophers. Such was the veneration paid to him, that his opinion was allowed to ſtand on a level with reaſon itſelf; nor was there any appeal from it admitted, the parties, in every diſpute being obliged to ſhew, that their concluſions were no leſs conformable to Ariſtotle's doctrine than to truth.

Laertius, in his life of Ariſtotle, enumerates his books, to the number of 4000; of which ſcarce above 20 have ſurvived to our age; they may be reduced to five heads; the firſt, relating to poetry and rhetoric; the ſecond, to phyſics; the third, to ethics and politics; the fourth, to phyſics; and the fifth, to metaphyſics. In all which, as there are many things excellent, particularly what relate to poetry, rhetoric, and the paſſions; ſo there are others which the improvements of later ages have taught us to explode and deſpiſe.

ARISTOTELIANS, a ſect of philoſophers, otherwiſe called *Peripatetics*. The Ariſtotelians, and their dogmata prevailed for a long while, in the ſchools and univerſities; even in ſpite of all the efforts of the Carteſians, Newtonians, and other corpuſcularians. But the ſyſtems of the latter have at length gained the pre-eminence; and the Newtonian philoſophy, is now univerſally received. The principals of Ariſtotle's philoſophy, are chiefly laid down in the four books *de Cœlo*: the eight books of phyſical auſcultation, φυσικης ακροασεως, belonging rather to logics, or metaphyſics, than to phyſics. Inſtead of the more ancient ſyſtems, he introduced *matter*, *form*, and *privation*, as the principles of all things: but he does not ſeem to have derived much benefit from them in natural philoſophy. His doctrines are, for the moſt part, ſo obſcurely expreſſed, that it has not yet been ſatisfactorily aſcertained what were his ſentiments on ſome of the moſt important ſubjects. He attempted to refute the Pythagorean doctrine concerning the twofold motion of the earth; and pretended to demonſtrate, that the matter of the heavens is ungenerated, incorruptible, and ſubject to no alteration: and he ſuppoſed that the ſtars are carried round the earth in ſolid orbs. The reader will find a diſtinct and candid account of the logical part of his philoſophy, by Dr. Reid, profeſſor of Moral Philoſophy in the Univerſity of Glaſgow, in the ſecond volume of Lord Kaimes's Sketches of the Hiſtory of Man. Edinb. 4to. 1774. p. 165. J. Harris, eſq. has publiſhed a ſenſible commentary on his Categories, under the title of Philoſophical Arrangements.

A NEW

A NEW SYSTEM OF ARITHMETIC.

ARITHMETIC, from the Greek Ἀριθμητικὴ, is the art of numbering, or the art of computing by numbers.

When a number is made up, or compoſed of intire units, or individuals, it is called a *whole* number. That which is not ſo compoſed, but contains part of an unit, is named a *fractional* number. When an unit contains ten, an hundred, a thouſand, ten thouſand, &c. of ſuch parts, they are termed *decimal* parts; and the arithmetic of numbers in which they occur, is called *decimal arithmetic*. When twelve of the parts make an unit, they are ſtiled *duodecimal* parts; and the arithmetic thereof is named *duodecimal arithmetic*.

If ſixty of the parts go to an unit, they are called *ſexageſimal* parts, and the proper management thereof in computations is termed *ſexageſimal arithmetic*.

In general, every other kind of arithmetic is named *common* or *vulgar arithmetic*, except ſpecious or univerſal arithmetic, for which ſee ALGEBRA.

That arithmetic was practiſed very early in the world, is beyond a doubt, for the idea of number is conveyed from every thing about us; but when, where, or by whom it was firſt taught, there are no certain records. The Moſaic account of the antediluvian world affords a ſtrong preſumption that the art of numbering had arrived to a tolerable degree of perfection before the flood. For their dividing the year into months and days, ſo little differing from the preſent diviſion of time, together with their ſtrict chronology of events, ſuch as the beginning, progreſs, and end of the flood; the births and ages of the patriarchs, &c. all argue their knowledge of numbers: wherefore I cannot ſuppoſe, as ſome do, that the art had its riſe among the Phœnicians, who are reputed to have been the firſt merchants after the flood; though I doubt not but they cultivated and improved it: and, it is probable, that by them it was carried into Egypt, and that it paſſed from thence into Greece.

In order to render arithmetical computations uſeful to ſociety, the firſt thing would be to eſtabliſh ſome common method of notation, on which computations might be founded. It would then be natural to enquire into the relations and properties of numbers, and to invent methods of operation.

The Greeks, Hebrews, and other eaſtern nations, in their notation, uſed the letters of the alphabet; but their methods were confined and very incommodious, which rendered their computations exceedingly difficult and laborious; as is obſervable from the ſpecimens in ſome of the fragments of Pappus, and the Commentaries of Utocius on Archimedes' Treatiſe of the Circle.

The method of notation now in uſe with us, is ſaid to have been received from the Arabians, who learnt it of the Indians. The time of its invention is unknown; but that neither the ancient Greeks nor Romans were acquainted with it, is almoſt certain. Maximus Planudes, who wrote about the beginning of the 14th century, is the firſt Greek writer who has treated of arithmetic according to the preſent mode of numbering, which was at leaſt three hundred years after it was known in Europe; for Doctor Wallis has clearly evinced that a monk named Gerberus, (afterwards Pope Sylveſter II.) who died A. D. 1003, was well acquainted with our notation; having learned it in Spain, from whence he carried it into France many years before his death.

It is reported that it came into Spain by means of the Moors; and it is almoſt certain that it was in uſe in England as early as the middle of the 12th century. There is a book extant of Joannes de Sacra Boſco, which was written in England about the middle of the 13th century, according to the preſent notation; and conſiderable improvements had been made here in this kind of computations before then.

The oldeſt treatiſe on the theory of arithmetic is comprized in the 7th, 8th, and 9th books of Euclid's Elements. It relates chiefly to the doctrine of Proportion, and Prime and Compoſite Numbers. The next is that of Nichomacus, the Pythagorean: his treatiſe conſiſts chiefly of the diviſion of numbers into certain kinds and claſſes, as Plain, Solid, Triangular, Quadrangular, and other ſpecies of figurate numbers: alſo numbers odd and even, &c. Some are of opinion that Nichomacus lived before Euclid.

Boethus, who wrote a Latin treatiſe on arithmetic in the time of Theodorick the Goth, is the next remarkable author on this ſubject: he, however, it is ſuppoſed, took moſt of his works from Nichomacus. Afterwards Pſellus, and Jodochus Willichius, wrote in Greek, but none of theſe were acquainted with the Arabian notation. The firſt author of any conſequence who uſed the modern way of computing, was Jordanus of Namur. He flouriſhed about A. D. 1200: and his arithmetic was afterwards publiſhed and demonſtrated by Joannes Faber Stapulenſis in the 15th century, who alſo himſelf publiſhed a treatiſe containing moſt of the propoſitions of Euclid and Boethus, with many other curious and uſeful theorems. The ſame author alſo wrote a book under the title of Algoriſmus Demonſtratus, illuſtrating the new art of computation by Arabic figures, the manuſcript of which, as Doctor Wallis informs us, is in the Savillian Library at Oxford.

Lucas de Burgo, an Italian, publiſhed, A. D. 1499, a valuable treatiſe on arithmetic, both as to theory and practice. Alſo in the courſe of the following century, Nicholas Tartaglia, an Italian; Clavius and Ramus, both Frenchmen; Stifelius and Heniſchius, Germans; Buckley, Diggs, and Record, Engliſhmen; employed themſelves in improving the art. Theſe have been followed by Wingate, Tacquet, Moor, Parſon, Baker, Kerſey, Wells, Knocker, Filher, Emerſon, Hutton, Bonnycaſtle, and a variety of other authors too tedious to mention; indeed authors on this ſubject are become almoſt innumerable.

Having given a ſhort hiſtorical account of arithmetic, I ſhall proceed to ſhew its operations.

CHAPTER I.

NOTATION.

I. Notation is the art of expreſſing properly and methodically any propoſed number in figures or characters.

II. Number is the name of that idea or notion, under which, things, being conſidered, are ſaid to be *one* or *many*.

III. Every number is expreſſible by the due ordering of the following figures; viz. 1, which, of itſelf, ſignifies one, or an unit; 2, which denotes two; 3, three; 4, four; 5, five; 6, ſix; 7, ſeven; 8, eight; 9, nine; 0, nothing.

IV. A whole number is compoſed of entire units.

V. A fractional number is either only ſome part or parts of an unit, or is compoſed both of entire units, and of ſome part or parts of an unit. In the former caſe, it is named a proper fraction; in the latter, it is called a mixed number.

VI. A whole number is alſo of two ſorts, ſimple and compound. A ſimple whole number conſiſts either of entire units, tens, hundreds, thouſands, &c. not exceeding nine: a compound whole number conſiſts not of either units, tens, hundreds, thouſands, &c. alone, but of ſome two or more of theſe combined: For inſtance, ten, twenty, (or two tens) fifty, (or five tens) one hundred, three hundred, five thouſand, &c. are ſimple whole numbers; and twelve, (or ten and two), twenty-four, (or twenty and four) an hundred and forty-five, three thouſand two hundred and ſixty, &c. are compound whole numbers.

VII. As all units (under ten) are expreſſed by the nine digits, 1, 2, 3, 4, 5, 6, 7, 8, 9; ſo all ſimple whole numbers of tens, hundreds, thouſands, &c. are expreſſed by the ſame figures with cyphers annexed; tens having one cypher annexed; hundreds, two; thouſands, three, &c. Thus 10 ſignifies ten; 20, twenty; 30, thirty; 40, forty; 300, three hundred; 5000, five thouſand, &c.

COR. Hence, a cypher, though of itſelf, or when alone, ſignifies nothing, yet, when placed to the right of any figure, it increaſes its value tenfold.

VIII. As compound whole numbers conſiſt of different ſimple whole numbers combined together, ſo ſuch numbers are expreſſed by the combining or joining together the ſeveral figures denoting them. Thus twenty-five conſiſts of 20 and 5; the cypher in the former denoting that there are no units, and ſignifies 20 without any addition; but, putting the five in the cypher's place, we have 25, which is the true expreſſion for twenty-five. Again, three hundred and ſixty-four, conſiſts of 300, 60, and 4; but joining theſe together, 60 and 4 make 64, and joining this to 300, the whole is 364. Furthermore, eight thouſand, four hundred and ſeventy-five, conſiſts of 8000, 400, 70, and 5; and 70 and 5 make 75; alſo 75 and 400 make 475; and 475 and 8000 make 8475, the propoſed number; and ſo for others.

COR. I. Hence, the firſt place towards the right hand of any whole number, conſiſts of units; the ſecond, of tens; the third, of hundreds; the fourth, of thouſands, &c. the value of any figure being increaſed or decreaſed, according as its ſtation is removed one place more to the left or right hand.

COR. II. Hence, by this management, any number, however great, is eaſily and readily expreſſed.

The following table denotes the value of any number, to the hundred thouſand of millions.

Hundreds of Thouſands of Millions.	Tens of Thouſands of Millions.	Thouſands of Millions.	Hundreds of Millions.	Tens of Millions.	Millions.	Hundreds of Thouſands.	Tens of Thouſands.	Thouſands.	Hundreds.	Tens.	Units.
4	5	6,	9	8	7,	5	6	2,	3	4	1

In this table, the firſt figure to the right, taken ſingly, denotes 1; if two are taken, they make 41; three, make three hundred and forty-one; four, two thouſand, three hundred and forty-

forty-one; five, fixty-two thoufand, three hundred and forty-one; fix, five hundred and fixty-two thoufand, three hundred and forty-one; feven, feven millions, five hundred and fixty-two thoufand, three hundred and forty-one; eight, eighty-feven millions, five hundred, &c. &c. as before; nine, nine hundred and eighty-feven millions, five hundred, &c. &c. ten, fix thoufand, nine hundred and eighty-feven millions, &c. &c. eleven, fifty-fix thoufand, nine hundred and eighty-feven millions, &c. &c. twelve, four hundred and fifty-fix thoufand, nine hundred and eighty-feven millions, &c. &c. And after this manner any other numbers, let the figures be what they may, are to be read.

Thus, 678075902, fignifies fix hundred and feventy-eight millions, feventy-five thoufand, three hundred and two; alfo, 20367540213, fignifies twenty thoufand, three hundred and fixty-feven millions, five hundred and forty thoufand, two hundred and thirteen.

N. B. It will be ufeful, in reading large numbers, to point them off at every three figures, as every three are run off together in the reading. Thus, in the laft example, the firft three are taken together, the next three are read in like manner, only the word thoufands is added; the next three are diftinguifhed by the word millions following in the reading. If there were three more, they would ſtill be read the ſame way, only the word thoufands would again follow; after the next three, millions of millions, (by ſome termed billions;) after the next three, thoufands again; after the next, millions of millions of millions, (or trillions), and ſo on; the word thouſand, and the repetition of millions of millions of millions of millions, &c. or quadrillions, quintillions, &c. according to the value, following each other alternately in the reading.

The following is a Synopſis of the Roman Notation, by Letters of the Alphabet.

1 is denoted by	I		50=L
2	by	II	100=C
3		III	500=D or IↃ
4	IIII or	IV	1000=M or CIↃ
5		V	2000=MM
6		VI	5000=IↃↃ or V̄
7		VII	6000=V̄I
8		VIII	10000=X̄ or CCIↃↃ
9		IX	50000=IↃↃↃ
10		X	60000=L̄X
11		XI	100000=C̄ or CCCIↃↃↃ
12		XII	500000=IↃↃↃↃ
13		XIII	1000000=M̄ or CCCCIↃↃↃↃ
14		XIV	2000000=M̄M̄
15		XV	5000000=IↃↃↃↃↃ or I̅ↃↃ
16		XVI	10000000=C̄CIↃↃ
17		XVII	
18		XVIII	50000000=IↃↃↃ
19		XIX	&c. &c.
20		XX	

Remarks on this Notation.

1ſt. As often as any character is repeated, ſo many times its value is repeated.

2d. A character of inferior value, with reſpect to another character, does, when placed before the ſame, diminiſh its value by the value of ſuch inferior character; but, if placed after it, the value thereof is ſo much increaſed.

3d. Every Ↄ affixed to this character IC (500) increaſes its value ten-fold.

4th. Every time a C and Ↄ are placed at each end of this character, CIↃ (1000) its value is increaſed ten-fold.

5th. A line over any character increaſes its value a thouſand fold.

By a ſlight compare of the two notations, it is obvious how much ſuperior the preſent mode of numbering is to the old Roman method; both as being more ſimple and eaſy, and infinitely better accommodated to arithmetical operations.

The Characters or Signs made uſe of in this Syſtem.

1ſt. This character (+) ſignifies plus, or more, and, placed between two numbers, it denotes that they are to be added together.

2d. This ſign (−) ſignifies minus, or leſs, and, put between two numbers, ſhews that the latter is to be ſubtracted from the former.

3d. When this mark (×) is put between two numbers, it ſignifies that they are to be multiplied together.

4th. This character (÷) being between two numbers, denotes that the former muſt be divided by the latter.

Note alſo, if two numbers be placed one above another, with a line between them, it ſignifies that the upper number is to be divided by the under one.

5th. This character (=) placed between two numbers, denotes them to be equal. Thus 4+5=9, ſignifies that the ſum of 4 and 5 is equal to 9.

6th. A figure of 2 put over any number, denotes the ſquare thereof; a figure of 3, the cube thereof; a figure of 4, the biquadrate thereof, &c. Thus 4^2, 4^3, 4^4, denote the ſquare, cube, and biquadrate of 4 reſpectively.

7th. This ſign (√) prefixed to any number, ſignifies that the ſquare root thereof is to be extracted; and if a 3, 4, 5, &c. be put over this character, it ſhews that the cube, biquadrate, ſurſolid, &c. root, is to be extracted. Thus $\sqrt{64}$, $\sqrt[3]{64}$, $\sqrt[4]{64}$, denote the ſquare root, the cube root, and the biquadrate root of 64.

8th. When two points (:) are placed between two numbers, and four points (::) between the next two, it indicates that theſe numbers are proportional. Thus 2 : 4 :: 6 : 12, muſt be read thus: As 2 is to 4 ſo is 6 to 12.

9th. A line or vinculum (———) drawn over the top of numbers, ſhews that they are to be taken as one compound quantity.

CHAPTER II.

RUDIMENTS OF SIMPLE ARITHMETIC, OR THE ARITHMETIC OF WHOLE NUMBERS.

SECT. I. ADDITION OF WHOLE NUMBERS.

ADDITION is the method of collecting certain given numbers into one, which ſhall be equivalent to the whole.

AXIOM. The whole, is equal to all its parts taken together. Hence this

RULE. Place all the numbers one under another, in ſuch order that the units place of each may exhibit one diſtinct row; the tens place of each, another diſtinct row; the hundreds place, another; the thouſands, another; &c. drawing a line underneath the whole. Then begin at the unit's place, and reckon up all the figures in that row, writing down the overplus, above entire tens, under the line, and bearing in mind ſo many to be carried and added to the next row, as there are tens in the firſt. Then the row of tens being accordingly added up, together with what was carried, the overplus which remains above entire tens, muſt be put down below the line, under the ten's place; and one for each ten muſt be carried to the next row, and the proceſs continued in this manner through each column, obſerving to write, under the laſt row, the whole ſum.

N. B. When there is no exceſs above the tens, write a cypher under the column.

EXAMPLES.

3278	78426	40325
4152	54315	1072
678	67820	128
4028	47853	54320
7068	69542	7809
3264	57869	3456
782	34578	876
4630	78456	327
2048	47807	48728
Sum 29908	Sum 536666	Sum 157041

Here, in the firſt example, having placed the ſeveral ſums, one below another, and drawn a line under them, as directed above; I begin with the unit's column, ſaying 8 and 8 are 16, and 4 make 20, and 8, 28; and 7, 35; and 2, 37; and 8, 45; and 3, 48; and 2, 50; and 8, 58. I ſet down the overplus 8, and carry 5 for the three tens to the next column, which, on caſting up, I find amounts to 50; wherefore, as there is no overplus above the tens, I ſet down 0, and carry 5 to the next row, which I add up in like manner, and find it amounts to 29; I therefore ſet down 9, and carry 2 to the laſt row, the amount of which I find to be 29; I place down 29 accordingly, and ſo the whole ſum is 29908. Obſerve the ſame method in the other examples.

N. B. Addition is proved by beginning at the top and caſting each row downwards.

SECT. II. SUBTRACTION OF WHOLE NUMBERS.

SUBTRACTION is the taking of one number from another, in order to find their difference.

RULE. Place the greater number uppermoſt, ſo that units may be under units, tens under tens, &c. and draw a line under them. Then begin at the unit's place, and take the lower figure from the upper figure, placing down the difference underneath them; and do ſo with the reſt of the figures. But if the lower figure in any inſtance be greater than the upper figure, then 10 muſt be added to the upper figure, and, ſubtraction being made, 1 muſt be carried to the next lower figure, and the ſum muſt be ſubtracted from the figure which is above the ſame, placing down the remainder, and proceeding agreeably to theſe directions with each row.

EXAMPLES.

From	4286	From	478093	From	678093
Take	3242	Take	67843	Take	289764
Remainder	1044	Remaind.	410181	Remaind.	388329

Here, in the firſt example, the numbers being properly placed, and a line drawn as directed, I proceed thus: I take 2 from 6 and there reſts 4, which I put down; then I ſay, take 4 from 8, and there remains 4; take 2 from 2 and there reſts 0: and take 3 from 4 and there remains 1; each of which remainders I write down under its proper figure, and the whole is 1044.

In the ſecond example, I ſay 2 from 3 and there reſts 1; 4 from 2 I cannot take, but borrowing 10 to put to it, it becomes 12, from which taking 4, the remainder is 8; then I carry 1 to 8, and ſo it becomes 9; and as 9 cannot be ſubtracted from 0, I again borrow 10, and the remainder is 1; then I carry 1 to 7, and ſo ſubtracting, the remainder is 0. Alſo, 6 from 7, and there reſts 1, and nothing from 4 leaves 4; therefore the whole remainder is 410181; and ſo for any other.

N. B. Subtraction is proved by adding the remainder and the under line, or number ſubtracted, together; for, if their ſum be equal to the upper line, the work is right; otherwiſe not.

SECT. III. MULTIPLICATION OF WHOLE NUMBERS.

Multiplication is a compendious method of performing a manifold addition of the ſame number. But before any thing can be done, the following table muſt be perfectly got by heart.

MULTIPLICATION TABLE.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

Explanation of the Table.

To find the product of two figures, look for one of the figures in the top row, and for the other in the ſide row; then in the angle of meeting is their product.

Thus, the product of 5 and 8 is 40, and of 6 and 9 is 54.

General Rule for Multiplication.

Place the multiplier (or number given to multiply by) under the multiplicand, (or the number to be multiplied) ſo that units may be under units, tens under tens, &c. and draw a line under them. Then begin with the unit's figure of the multiplier, (if it conſiſts of more than one) and by it multiply the units figure of the multiplicand. Set down the overplus above the tens, below the line, in the unit's place, and for each ten bear in mind 1 to be added to the next product. Then, by the ſame figure, multiply the next figure of the multiplicand, adding ſo many units as there were tens in the laſt product, and placing down the overplus as before. Proceed thus till each figure in the multiplicand has been multiplied by the firſt figure in the multiplier, writing down the product of the laſt entire. Then take the ſecond figure of the multiplier, and multiply thereby as with the firſt, placing the firſt figure of the product under the figure which you multiply with. Do ſo with each figure in the multiplier, ſo will the ſum of thoſe products be the product required.

EXAMPLE I.

Multiply 468332
By 6
Product 2810112

EXAMPLE II.

Multiply 6084358
By 11
Product 66927938

EXAMPLE III.

Multiply 84308765
By 243
25292695
337235060
16861730
20487029895

Here, in the firſt example, I multiply the firſt figure of the multiplicand by 6, ſaying 6 times 2 are 12; I ſet down the 2 and carry 1; then I proceed to the next figure, and ſay 6 times 3 are 30, and 1 that I carry, make 31; I ſet down 1, and carry 3, ſaying 6 times 3 are 18, and 3 make 21. I put down 1, and carry 2; proceeding to the next figure, whoſe product by 6 is 48, and 2 which are carried make 50; ſo I write down 0, and carry 5: then the product of the next figure is 36, and 5 which are carried, make 41; therefore, I place down 1 and carry 4; the laſt product is 24, and 4 which are carried make it 28, which I write down, and ſo the whole product is 2810112.

In like manner the ſecond example is performed.

In the third example, I firſt multiply by 3, the unit's figure of the multiplier, ſetting down the whole product 25292695, as above; then I multiply by 4, placing the firſt figure of the product directly under it, in the ten's place, and the reſt of the figures in the proper order as they follow each other. Laſtly, I multiply by 2, and place the firſt figure of the product under it in the third place, and the reſt in regular order as they come. Then the ſum of the products, caſt up in the order they ſtand, is 20487029895, which is the product required.

Note. The ſecond example might have been done according to the manner of the third, by making two products, 1 being the multiplier each time.

EXAMPLE. IV.

Multiply 42786307
By 218403
128358921
17114523280
342290456
42786307
8557261
Product 9344657807721

EXAMPLE V.

Multiply 68901478
By 4567318
551211824
68901478
206704434
48231046
4134088
314507390
27560591
Product 314694960896004

COR. I. When either the multiplicand, multiplier, or both, have cyphers on the right hand, then multiply the ſignificant figures according to the former rule; and annex to the product as many cyphers as there are in the multiplicand and multiplier.

EXAMPLE. Let 84308765000 be multiplied by 243000.

Here, 84308765 multiplied by 243, the product is 20487029895; to which annexing five cyphers (the number in both the multiplicand and multiplier) it becomes 2048702989500000, which is the product required.

COR. II. Hence, if the multiplier be 10, 100, 1000, 10000, &c. the product is had by annexing as many cyphers to the multiplicand as there are in the multiplier. Thus the product of 246875 by 10 is 2468750; by 100, it is 24687500; by 1000, it is 246875000, &c.

COR. III. When the multiplier is a compoſite number, that is a number which conſiſts of complete factors, or in other words, is the product of ſome two or more numbers, then the multiplicand being multiplied by one of the factors, and that product by the other, and ſo on for each factor, the laſt product will be the product anſwering the whole; and by this method the trouble of adding two or more lines may frequently be ſaved.

EXAMPLE. Let 785364 be multiplied by 48.

Here the number 48 conſiſts of the factors 6 and 8. Wherefore I multiply 785364 by 8, and the product is 6282912, which multiplied by 6, gives 37697472, the anſwer ſought, and ſo the addition of two lines is ſaved.

N. B. It would have been the ſame if the firſt product had been made by 6, and the next by 8; for it is an indifferent thing in whatever order the factors are taken.

Alſo, in any numbers the multiplicand may be made the multiplier, and the multiplier the multiplicand, at pleaſure, according as it ſhall appear to be the moſt advantageous in the operation.

COR. IV. When the multiplier is any number above 10 and under 20, ſet the product made by the unit figure a place further to the right hand, and add thereto the multiplicand, or the multiplicand may be added by taking a figure at a time, as you proceed on in the operation after you have multiplied the firſt figure in the multiplicand.

EXAMP. Let 46302 be multiplied by 17. The operation is as below.

First Method.	Second Method.
46302	46302
324114 product by 7.	17
787134 product.	787134 product.

Explanation of the Second Method.

Firſt I multiply the unit's figure of the multiplicand by 7, and ſet down the overplus which is 4; and carry 1; then I multiply the next figure, or cypher, and take in the unit's figure of the multiplicand together with what was carried, and the whole is 3. Then I multiply the next figure which is 3, taking in the figure in the ten's place of the multiplicand; which in this inſtance, being only a cypher, does not augment the product. In like manner, I proceed to the next figure; the product thereby is 42, which, with 3 which was to be carried, and the figure in the hundreds place of the multiplicand, namely 3, makes 47. I ſet down 7 and carry 4, and thus proceed to the end, taking in a figure of the multiplicand each

each time. This, when it becomes familiar, is exceedingly eaſy, and will ſave the writing of many needleſs figures.

N. B. In the ſame way when the multiplier is above 110, and leſs than 120, the product will be had by taking in the firſt figure of the multiplicand when you come to the ten's place, and the firſt and ſecond when you come to the hundred's place; afterwards the 2d and 3d, the 3d and 4th, and ſo on; till the multiplication is compleated.

COR. V. When the multiplier conſiſts of two figures and the unit's place is 1, multiply by the figure in the ten's place, and at each multiplication take in a figure of the multiplicand. The firſt figure ſo taken in muſt be that in the ten's place, the next that in the hundred's, &c. leaving out the unit's figure, but annexing the ſame to the product on the right, ſo that it may therein obtain the place of units.

EXAMPLE. Multiply 634 by 21.

Here, in multiplying by 2, I take in 3 the firſt time, which makes the product 11, I ſet down 1 and carry 1, and the next time I take in the 6, which makes the product 13; I ſet down 3, and carry 1, and ſo the next product is 13, which I ſet down; and, by annexing the units figure to the number it becomes 13314, the product ſought.

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  634
   21
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13314
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COR. VI. When the multiplier is 100, 1000, 10000, &c. wanting any number conſiſting of two figures, of which either the firſt or ſecond figure is an unit, then multiply the multiplicand by the number ſo wanting; having previouſly annexed thereto, 2, 3, 4, &c. cyphers, as the caſe ſhall be, and the remainder will be the anſwer.

Thus, let 54327 be multiplied by 988. Here, the multiplier is 1000, wanting 12; therefore I multiply 54327, by 12, and the product is 651924; which, ſubtracted from 54327000, leaves 53675076, the anſwer required.

COR. VII. When in the multiplier, ſome two or more adjacent figures are equal to ſome multiple of another figure therein, the operation may be abbreviated by multiplying firſt by that other figure, and then by multiplying that product by the figure which denotes the multiple, and adding the two products together, having placed them ſo that the firſt figure of each row, or product, may ſtand under that figure of the multiplier, whoſe product by the multiplicand, ſuch row denotes.

EXAMPLE I.

```
Multiply   408765
By           3612
          -------
           4905180
         14715540
Product  1476459180
```

EXAMPLE II.

```
Multiply   4675231
By          324981
          ---------
         42077079
        3738593711
     1514774844
1519361245611
```

EXPLANATION.

In the firſt example, I begin with multiplying by 12, and then I multiply that product by 3; becauſe, three times 12 are equal to the next two figures 36. I place the products down as above, and their ſum is the whole product required.

In the ſecond example, the firſt row of figures obtained, is the product by 9; the ſecond is taken equal to 9 times the firſt row; becauſe, 9 times 9, are equal to the firſt two figures (81), and the third row is taken equal to 4 times the ſecond row; becauſe 4 times 81, are equal to the three laſt figures (324).

Their ſum, according to the due order in which they are placed, is 1519361245611, the product required.

In both theſe examples the operations are performed with half the trouble and half the figures, which are required by the common method.

SCHOL. It will frequently happen that great advantages may be derived from the joint application of theſe ſeveral methods.

Thus. If the multiplier is 12816; the product for the firſt two figures, viz. 16, may be had in one line by COR. IV. and the product for the laſt 3 will be had by multiplying that product by 8; becauſe 8 times 16, are equal to 128. And the product, by the whole, will be equal to the ſum of theſe two when placed in due order. This mode of contraction is not treated of by any author that I have read; nor, indeed, do I know of any perſon that ever hit upon it before.

Its uſe is very great, for it will ſeldom happen in the courſe of buſineſs but ſome advantage from it will accrue, either by rendering the operations ſhorter or more eaſy, or both; wherefore, I am happy in having the opportunity of communicating, in the New Royal Encyclopædia, ſo uſeful an improvement in Arithmetical Calculations. A variety of forms of proceeding in different caſes might have been enumerated, but our limits confine me to paſs on to other matters; I am, however, perſuaded that what has been ſhewn, will prove a ſufficient leſſon to an ingenious mind.

SECT. IV. DIVISION OF WHOLE NUMBERS.

As multiplication teacheth how to find the amount of any number when repeated a given number of times, ſo diviſion, by having both the number and amount given, teacheth to diſcover how often ſuch number had been repeated in order to give that amount: or, by having, inſtead of the number, the number of times it was repeated, given; the number itſelf, (though before unknown) is by this art found out.

Briefly, it is the art of finding ſuch a part of the dividend as the diviſor expreſſes; or, of diſcovering how often one number is contained in another.

GENERAL RULE. Set down the number to be divided (called the dividend) and the number by which the diviſion is to be made (named the diviſor) on the left hand thereof, but ſeparated from it by a crooked line. Alſo make another crooked line on the right hand, beyond which the figures ariſing by the diviſion (named the quotient) are to be placed.

Then take a part of the dividend, including as many figures to the left hand, as there are figures in the diviſor; or, one more, if the number expreſſed by them, when ſo taken, is leſs than the diviſor; and find how often the diviſor is contained in, or can be taken out of ſuch part of the dividend, (which generally may be diſcovered on a compare of the firſt, or two firſt figures of each) and place the figure which denotes the number of times in the quotient; obſerving to multiply the diviſor thereby, to ſubtract the product from the part of the dividend aforeſaid, and to note down the remainder.

Then annex to the remainder the next following figure in the dividend, and find how often the diviſor is contained in this number, (uſually called the dividual) placing the figure, which expreſſes the number of times in the quotient, and multiplying and ſubtracting as before.

Bring down the next figure of the dividend to the remainder, and proceed again as above, continuing to do ſo, till all the figures of the dividend are in this manner brought into the operation.

N. B. When after a figure of the dividend has been annexed to a remainder, it happens that the number is leſs than the diviſor, a cypher muſt be placed in the quotient, and another figure of the dividend muſt be annexed; and the ſame muſt be repeated again, if the dividual ſhould continue ſtill leſs than the diviſor.

Note alſo, That if after ſubtraction is made, the remainder is greater than the diviſor, it ſhews that the quotient figure has been taken too little; and it muſt be ſo increaſed as to cauſe the remainder to be leſs than the diviſor.

EXAMPLE I.
Divide 42674 by 26.

```
Divr. Divid. Quot.
26) 4264 (164
    26
    ---
    166
    156
    ---
    104
    104
    ---
    ...
```

EXAMPLE II.
Divide 378965 by 481.

```
Divr.  Divid.  Quot.
481) 378965 (787
     3367
     ----
     4226
     3848
     ----
     3785
     3367
     ----
      418 Remains.
```

Here in the firſt example, having placed the dividend and diviſor, as directed, I take the firſt two figures of the dividend, namely, 42, and enquire how often 26 is contained therein, and find it to be but once: I therefore place 1 in the quotient, and ſubtract 26 from 42, and the remainder is 16; to which I annex the next figure of the dividend, namely, 6; and ſo the dividual is 166. I now enquire how often 26 is contained in 166, and find it is contained ſix times; I place 6 in the quotient and multiply the diviſor by 6, ſubtracting the product from 166; the remainder is 10, to which I annex the other figure of the dividend, namely, 4, and the the dividual is conſequently 104. Again, I enquire how often the diviſor is contained in 104, and I find it is contained four times therein. I place 4 in the quotient, and multiply the diviſor thereby; the product is 104, therefore there is no remainder, and the whole quotient is 164.

The ſecond example is wrought in like manner, only in it there is a remainder after the diviſion is finiſhed of 418, which ſhews that the quotient is 787, and 418 parts out of 481 of another unit, viz. if 1 be divided into 481 parts, then the exact quotient is 787, and 418 of ſuch parts. Such parts are called fractions, and are expreſſed by placing the remainder over the diviſor, with a line between them, thus $\frac{418}{481}$. The upper number is named the numerator of the fraction, becauſe it expreſſes the number of the parts; and the lower number is called the denominator, becauſe, by it is underſtood of what denomination ſuch parts are. The whole quotient, therefore, will ſtand thus $787\frac{418}{481}$. But of fractions, and their operations, I ſhall treat hereafter.

SCHOL.

SCHOL. When the divisor is very large, and it appears that the quotient will consist of a great many figures, it is adviseable to multiply the divisor by all the nine digits severally, and place the products in a table, before one begins the operation, for by that means the quotient figure, as well as the product of it and the divisor, will always be had by inspection, and so the business will consist merely in subtracting.

EXAMPLE. Divide 487654327861 by 246874.

Divisor. Dividend. Quotient.

246874)487654327861(1165186

TABLE.

246874	1
493748	2
740622	3
987496	4
1234370	5
1481244	6
1728118	7
1974992	8
2221866	9

246874
407803
246874
1609292
1481244
1280487
1234370
461178
246874
2143046
1974992
1680541
1481244
199297 Remainder.

COR. I. When the divisor does not exceed 12, it is unnecessary to set down all the several products and subtract as has been taught, because the process at each figure may very well be comprehended in the mind without that trouble, and so as nothing in such case is requisite but to put down the quotient figures, it will make the work appear more concise and methodical to write them down under the dividend as they arise, a line of separation having first been drawn.

EXAMPLE I.
Divide 478654 by 6.
Divisor. Dividend.
6)478654
Quotient 79775$\frac{4}{6}$

EXAMPLE II.
Divide 68743254 by 11.
Divisor. Dividend.
11)68743254
Quotient 6249386$\frac{8}{11}$

Here, in the first example, I ask how often 6 is contained in 47, the answer is 7 times, for 7 times 6 is 42, and consequently there remains 5, which is expressive of so many tens, and which carried to the next figure (8) of the dividend, they make 58; then I say, how often 6 in 58? the answer is 9 times, and 4 remains, which carried to the next figure, they make 46; the sixes in 46 are 7, and 4 remains; then the sixes in 45 are 7, and 3 remains; and the sixes in 34 are 5, and 4 remains, which I place over the 6 in manner of a fraction, and so the quotient is 79775$\frac{4}{6}$.

The other example is done after the same manner.

COR. II. If the divisor have cyphers towards the right hand, cut off so many of the right hand places of the dividend as there are such cyphers in the divisor; then, rejecting the cyphers in the divisor, proceed to work as before; and, when the operation is finished, annex the figures cut off to the remainder.

Thus, let the dividend be 46784, and the divisor 300. I cut off two figures, viz. 84, from the dividend, and divide the rest 467 by 3; the quotient is 155, and 2 remains; to which remainder I annex 85, the figures cut off, and it becomes 285, and so the quotient is 155$\frac{285}{300}$. The same must be observed for any other such divisor.

COR. III. When the divisor is 10, 100, 1000, 10000, &c. cut off so many figures to the right hand as the divisor contains cyphers; then those to the left will be the quotient, and the right hand figures will be the remainder.

Thus, let the dividend be 687543287, and the divisor 1000; then three figures being cut off, the quotient is 687543, and the remainder 287; or the full quotient is 687543 $\frac{287}{1000}$.

COR. IV. When the divisor is a compositе number, that is, a number which is the product of two or more small numbers, then divide by one of such small numbers, and that quotient by another, and so on till a division has been made by each of them, and the last quotient will be the answer.

N. B. If there are remainders in the operation, multiply the last remainder by the last divisor but one, taking in the remainder belonging to such divisor (if any), then multiply that sum by the last divisor but two, and take in the remainder belonging to it, proceeding thus till you have multiplied by the first divisor, and taken in the first remainder (if any), and the result will be the remainder, answerable to the whole divisor.

EXAMPLE. Divide 47876 by 48.

Here first divide by 8, and the quotient is 5984, with a remainder of 4; then I divide this quotient by 6, and the next quotient is 997, with a remainder of 2. I multiply this last remainder by 8, taking in the first remainder, and the result is 20. So the true answer is 997 $\frac{20}{48}$.

SCHOL. The best way of proving division is to multiply the quotient by the divisor, taking in the remainder; and if the result be the same with the dividend, the work is right, otherwise not.

Thus in the example on the former column of this page, where the number is 487654327861, is given to be divided by 246874; if the quotient 1165186 be multiplied by the divisor 246874, and the remainder 199297 be added to the product, the result will be the same as the dividend, namely 487654327861, which shews that the division was rightly performed.

Also, the best way of proving multiplication is by division; for if the product, when divided by the multiplier, give the multiplicand, the operation is true, otherwise it is not so.

The old method of proving multiplication and division, by casting out the nines, is not worth attending to, for it will often happen that the operation according to it will appear to be right, when notwithstanding the same is wrong.

SECT. V.

REDUCTION OF MONEY, WEIGHTS, MEASURES, &c.

Reduction, properly speaking, is not a RULE in Arithmetic, but rather the application of multiplication and division, in reducing money, weights, measures, &c. of any denomination to another. It includes three cases.

CASE I. If numbers of a greater denomination are to be reduced to their equivalents of a less, multiply continually by the number of the next inferior denomination which is equivalent to one of the greater, till you arrive at the required denomination, adding to each product, by the way, those of the same denomination with itself, if such there be, and the last product will be the answer. This is called Reduction Descending.

CASE II. If numbers of a less denomination are to be reduced to their equivalents of a greater, divide continually by such number as makes one of the next greater denomination, till you arrive at the required denomination, and the last quotient, with the several remainders (if any) will be the answer. This is named Reduction Ascending.

CASE III. When a number of any proposed denomination cannot be reduced to that required by multiplication or division alone, both rules are to be used promiscuously; so that by one it may be reduced to such a denomination as may by the other be reduced to the required denomination.

Note. When in Reduction Ascending you have remainders, each will be of the same denomination with its respective dividend.

N. B. In this business, as well as in many of the following articles, it will be requisite to have recourse to tables of coins, weights, measures, &c. Such tables will be given under their proper heads, namely, coin, weights, measures, &c. and therefore it will be superfluous to enumerate them here.

EXAMPLE I.
OF MONEY. DESCENDING.
In 3gl. 14s. 6$\frac{1}{4}$d how many farthings?

OPERATION.
3 14 6$\frac{1}{4}$
20
654 (adding 14)
12
7854 (adding 6)
4
Answ. 31419 (adding 3)

EXAMPLE II.
OF MONEY. ASCENDING.
In 31419 farthings, how many pounds?

OPERATION.
4)31419
12) 7854+3
20) 654+6d.
32+14s.
3gl. 14s. 6$\frac{1}{4}$d.

EXAMPLE III.
In 4674 crowns, how many guineas?

OPERATION.
4674 crowns
5 shillings in a crown
3)23370 shillings in all.
7)7790
1112 remainder 6.
Ans. 1112 guineas and 18 shill.

EXAMPLE IV.
In 1112 guineas and 18 shillings, how many crowns?

OPERATION.
Guineas. s.
1112 18
21
1120 (taking in 8)
2225 (taking in 1)
5)23370 number of shillings.
Ans. 4674 crowns.

EXAMPLE V.
In 3cwt. 2 qrs. 14 lb. 10 oz. avoirdupoise, how many ounces?

OPERATION.
cwt. qrs. lb. oz.
3 2 14 10
4
14
28
116
29
406
16
2436
4
6506 Answer.

EXAMPLE VI.
In 24 weeks how many minutes?

OPERATION.
24 weeks.
7
168 days.
24
672
336
4032 hours.
60
Answ. 241920 minutes.

EXAMPLE VII.

In 420 gallons of beer, how many pints?

Gallons.
420
4
1680 quarts.
2
Anſwer 3360 pints.

EXAMPLE VIII.

In 420 ells Engliſh, how many ells Flemiſh?

420 ells Engliſh.
5
3) 2100 quarters.
Anſw. 700 ells Flemiſh.

EXAMPLE IX.

If 3 barley-corns make an inch, how many barley-corns will reach round the globe of the earth, ſuppoſing the circumference to be 360 degrees, and each degree to contain 70 Engliſh miles?

360 degrees.
70
25200 miles.
1760
15120000
428400
44352000 yards.
3
133056000 feet.
12
1596672000 inches.
3
Anſw. 4790016000 barley-corns.

CHAPTER III.

RUDIMENTS OF COMPOUND ARITHMETIC, OR THE ARITHMETIC OF NUMBERS OF DIFFERENT DENOMINATIONS.

SECT. I. ADDITION OF NUMBERS OF DIFFERENT DENOMINATIONS.

RULE. Place all numbers of the ſame denomination directly under each other, obſerving to place the columns in ſuch order, that the higheſt denomination may ſtand firſt towards the left hand, and the next inferior denomination next towards the right hand; and ſo on, that the loweſt denomination may obtain the farthermoſt place to the right hand, and draw a line under them. Then begin at the leaſt denomination; and add up all the figures in that row as in addition of whole numbers, and find by reduction how many of the next ſuperior denomination the ſum contains; carry the ſame to the next row, but write down the overplus (if any) under the leaſt denomination, or the row which has been added.

Then add up the next row together with what was carried; finding, as before, how many of the next ſuperior denomination are contained in the ſum, in order to be carried to the next row, and writing down the overplus. Proceed in this manner till you come at the higheſt denomination, which muſt be added up and wrote down in all reſpects as in addition of whole numbers.

EXAMPLE I.

l.	s.	d.
241	14	6
123	10	4½
47	13	10¼
63	18	11
114	9	7½
57	16	0¼
649	3	3¾

EXAMPLE II.

Troy Weight.

lb.	oz.	dwt.	grs.
47	11	15	14
14	9	13	15
71	10	10	10
67	10	15	17
81	9	10	18
12	10	4	0
227	2	10	2

EXAMPLE III.

Land Meaſure.

Acr.	Roods	Perch.
3	3	37
72	1	4
21	2	16
76	1	0
9	0	3
183	0	20

EXAMPLE IV.

Dry Meaſure.

Buſh.	Pecks	Gal.	Pts.
8	3	1	7
19	1	0	6
8	2	1	2
6	1	1	4
2	3	0	5
46	1	0	0

EXAMPLE V.

Cloth Meaſure.

Eng. Ells	Qr.	Nails
70	4	3
61	3	2
16	2	1
10	1	0
3	0	2
162	2	0

Here, in the firſt example, I begin and caſt up the column of farthings, and the ſum is 7, or 1 penny, and 3 farthings; I ſet down ¾, and carry 1 to the row of pence; the amount of which I find to be 39, or 3 ſhillings and 3 pence. I ſet down the 3 pence, and carry 3 to the row of ſhillings, which I add up and find it amounts to 83, or 4 pounds 3 ſhillings. I put down 3 ſhillings, and carry 4 to the pounds, which I add up as in common addition. The whole ſum is 649l. 3s. 3¾d.

The reſt of the examples are equally eaſy, due regard being had to the different denominations, and how many of an inferior kind make one of the next ſuperior.

N. B. In order to facilitate the addition of money, ſome writers give what they call a Pence Table, in manner following.

PENCE TABLE.

d.		s.	d.	d.		s.	d.
20	is	1	8	130	is	10	10
30	—	2	6	140	—	11	8
40	—	3	4	150	—	12	6
50	—	4	2	160	—	13	4
60	—	5	0	170	—	14	2
70	—	5	10	180	—	15	0
80	—	6	8	190	—	15	10
90	—	7	6	200	—	16	8
100	—	8	4	210	—	17	6
110	—	9	2	220	—	18	4
120	—	10	0	230	—	19	2
				240		£1	0

SECT. II. SUBTRACTION OF MIXT NUMBERS, OR NUMBERS OF DIFFERENT DENOMINATIONS.

RULE. Place the leſs number under the greater, and in ſuch order as directed in addition; drawing a line under them. Then, beginning at the leaſt denomination, take the under numbers from the upper, and ſet down their reſpective remainders under them. But in caſe the under number of any denomination is greater than the upper, borrow one of the next ſuperior denomination, viz. add as many to the upper number as make 1, in the next higher denomination, and ſubtract as before, carrying 1 to the under line of the next ſuperior denomination, for that which was borrowed.

Note, the higheſt denomination muſt be ſubtracted as integers.

EXAMPLE I.

Money.

	l.	s.	d.
From	27	10	6¼
Take	18	12	7½
Rem.	8	17	11¾

EXAMPLE II.

Avoirdupoiſe Weight.

	Tons	cwt.	qr.	lb.	oz.	dr.
From	27	12	1	15	13	14
Take	18	16	2	13	15	15
Rem.	8	15	3	1	13	15

As our intention is to be brief, where much explanation is not required, I ſhall not enumerate further examples. Thoſe who underſtand one properly, will do any other with the ſame eaſe; and a due attention to the rule, together with what has been taught before, is amply ſufficient for the underſtanding of theſe examples.

SECT. III. TO MULTIPLY MIXT NUMBERS, OR NUMBERS OF DIFFERENT DENOMINATIONS.

RULE. Place the multiplier under the number of the leaſt denomination, and having multiplied it, reduce the product to the next ſuperior denomination, ſetting down the overplus, and carrying the quotient to be added in the multiplying of the next row; proceed thus through each denomination.

N. B. When the multiplier is a compoſite number, multiply by the factors, as in multiplication of whole numbers.

Note alſo, if the number is above 12, and not compoſite, find the product for the neareſt compoſite number; then find the product for the exceſs, or defect, of the given number, and ſubtract it from, or add it to, the former product, (according as the caſe ſhall require) and the difference or ſum will be the anſwer ſought.

EXAMPLE I.

What is the value of 9 cwt. of ſugar, at

l. s. d.
4 17 11¼ per cwt.
9
£.44 1 9¾ Anſwer.

EXAMPLE II.

What is the value of 12lb. of tea, at

s. d.
7 8¾ per lb.
12
£.4 12 6 Anſwer.

EXAMPLE III.

What comes 100lb. of raiſins to, at 7½ per lb.

10
6 8
10
£. 3 2 6 Anſwer.

EXAMPLE IV.

What is the value of 37 dozen of knives, at

l. s. d.
2 5 7½ per doz.
6
£.13 13 10½ Anſwer.

Val. of 36 doz. 82 3 3
Val. of 1 doz. 2 5 7½
Anſwer £.84 8 10½

SCHOL. There are methods of obtaining the product in theſe caſes, let the multiplier be what it may, or however great; but, in general, the trouble will be conſiderable, and the anſwer will be far more readily had by the RULE OF PRACTICE.

SECT.

SECT. IV. TO DIVIDE NUMBERS OF DIFFERENT DENOMINATIONS.

RULE. Divide each denomination beginning with the higheſt, as in diviſion of whole numbers; only obſerving, that when there is a remainder in any denomination, ſuch remainder muſt be reduced to the next inferior denomination, and added to the num er of that denomination before the diviſion thereof takes place.

N. B. When the diviſor is a compoſite number, divide by the factors one after another, and the laſt quotient will be the anſwer.

EXAMPLE I.

If 7lb. of ſugar coſt 5s. $1\frac{1}{4}$d. what is that per lb?

s.	d.
7) 5	$1\frac{1}{4}$
0	$8\frac{1}{4}$ Anſwer

EXAMPLE II.

Divide 44l. 1s. $9\frac{3}{4}$d into 9 equal parts.

l.	s.	d.
9) 44	1	$9\frac{3}{4}$
£. 4	17	$11\frac{1}{4}$ = the value of each part.

EXAMPLE III.

If 6l. 16s. 8d. be divided equally among 80 perſons, what is each man's ſhare?

l.	s.	d.
10) 6	16	8
8) 0	13	8
£. 0	1	$8\frac{1}{4}$ Anſwer,

EXAMPLE IV.

Divide 27l. 3s $4\frac{1}{2}$d. by 81.

l.	s.	d.
9) 27	3	$4\frac{1}{2}$
9) 3	0	$4\frac{1}{2}$
£. 0	6	$8\frac{1}{4}$ Anſwer.

Alike eaſy is the diviſion of Weights, Meaſures, &c.

CHAPTER IV.

VULGAR FRACTIONS.

1ſt. Fractions are expreſſions for any aſſignable parts of an integer or unit, and are repreſented by two terms, or numbers, placed one above another with a line between them; the upper term is called the numerator, and the lower the denominator. Likewiſe, the denominator ſhews into how many parts the integer is divided, and the numerator declares how many of ſuch parts are intended by the fraction.

2d. A Proper Fraction is that where the numerator is *leſs* than the denominator, as $\frac{3}{4}$.

3d. An Improper Fraction is that wherein the denominator is *leſs* than, or *equal* to, the numerator; as $\frac{4}{3}$, or $\frac{4}{4}$.

4th. A Single Fraction is that which conſiſts but of *one* numerator, and *one* denominator.

5th. A Compound Fraction, or fraction of a fraction, is that whoſe parts are vulgar fractions connected with the word *of*, as $\frac{1}{2}$ of $\frac{2}{3}$ of $\frac{3}{4}$.

6th. A Mixt Number is a whole number, with a fraction annexed, as $15\frac{3}{4}$.

7th. The Reciprocal of a Fraction is when the numerator is changed into the denominator, and the denominator is made the numerator. Thus $\frac{4}{3}$ is the reciprocal of $\frac{3}{4}$.

Hence, the Reciprocal of a Proper Fraction is an improper Fraction, *et vice verſa*.

LEMMA I. If the numerator and denominator of any fraction be each multiplied, or divided by the ſame given number, the fraction, thus multiplied, or divided, retains its former value; thus, if the numerator and denominator of the fraction $\frac{4}{6}$ be multiplied by 2, it becomes $\frac{8}{12}$, which is equivalent to the former.

For, if any thing be divided into 2 parts, and one of them be taken, it is the ſame thing as if it were divided into 4 parts and two of them were taken; the value in each caſe being one half; and the ſame in diviſion, for if the numerator and denominator of the fraction $\frac{8}{12}$ be divided by 2, the fraction becomes $\frac{4}{6}$, which is equal to the former.

LEMMA II. In any fraction, if the numerator be augmented, or the denominator diminiſhed, its value in either caſe is encreaſed; but if the numerator be made leſs, or the denominator more, then its value is diminiſhed. Thus, ſuppoſe the fraction to be $\frac{3}{4}$, if the numerator be augmented to 4, it is evident its value is augmented alſo; for, it is clear, that 4 parts out of 5 muſt be greater than 3 parts out of 5; or if the denominator be made 4, it is evident that the value is thereby increaſed; for 3 parts out of 4 are more than 3 parts out of 5; ſeeing, that when any number or quantity is divided only into 4 parts, each part muſt contain more than if the ſame were divided into 5 parts. By a ſimilarity of reaſoning, if the numerator is taken at 2, or the denominator at 6, its value is diminiſhed.

Hence, alſo, if the numerator of a fraction be multiplied by any given whole number, or the denominator thereof divided thereby, the value of the fraction will be multiplied ſo many times as the given number expreſſes. Thus if the numerator of the fraction $\frac{3}{7}$, be multiplied by 3, it becomes $\frac{9}{7}$; or 3, which is equal to three times the former; or, if the denominator of the fraction $\frac{3}{7}$, which, by the preceeding Lemma, is equivalent to $\frac{1}{7}$, be divided by 3, it becomes $\frac{1}{7}$, as before; and ſo, in either caſe, its value is multiplied.

Alſo by the like reaſoning, if the numerator of any fraction be divided, or its denominator multiplied by any given number, the value thereof will be diminiſhed ſo many times; or, which is the ſame thing, the value of the fraction will be thereby divided by ſuch number.

Note alſo, the numerator of any fraction is expreſſive of a dividend, whereof the denominator is the diviſor.

SECT. I. REDUCTION OF VULGAR FRACTIONS.

PROB. I. To reduce a whole number to the form of a fraction.

RULE. Place an unit (or 1) under it for a denominator.

EXAMP. Reduce 6 to the form of a fraction.

Here I place 1 under it, and it becomes $\frac{6}{1}$, the form required.

SCHOL. If it is required, that it ſhould have any aſſigned number for its denominator, then multiply the numerator, and denominator, of the form found as above, by ſuch number, and it will be the fraction required; for, by the preceding Lemma, it retains its ſame value. Thus in the preceding Example, if it were required that its denominator ſhould be 5, the fraction would be $\frac{30}{5}$.

PROBLEM II. To reduce a fraction to its leaſt terms.

RULE. Divide the terms of the given fraction by any number, which will divide them without a remainder, and the quotients (by the Lemma) will be the terms of a new fraction, equivalent to the former; alſo thoſe terms, if they will divide by any number, muſt be divided, and ſo on, till a fraction is had: the terms of which cannot be divided by any given number, except unity, or 1, and then the fraction will be in its loweſt terms.

EXAMP. Let $\frac{12}{18}$ be propoſed. Here by dividing both the terms by 2, we have $\frac{6}{9}$, which cannot be reduced lower, and ſo the fraction is in its leaſt terms.

Again, let $\frac{42}{56}$ be propoſed; then, by dividing by 2, we have $\frac{21}{28}$, and this being divided by 3, gives $\frac{7}{8}$, which is the fraction in its loweſt terms.

COR. I. If the terms of any fraction conſiſt of numbers multiplied into one another, and are expreſſed by the ſign of multiplication (×) between them; then, if one number only in each term be divided by any given number, its value will remain the ſame, and it will be reduced into lower terms.

In like manner, if one number only in each term be multiplied, its value will be the ſame. And univerſally, if the ſame quantity of numbers in each term, thus connected, be multiplied, or divided, by any given number, the products, or quotients, will exhibit a fraction equivalent to the former.

Thus: let the fraction $\frac{3\times5\times4}{5\times10\times3}$ be propoſed. It is equivalent to $\frac{1\times5\times4}{5\times10\times3}=\frac{1\times1\times4}{5\times2\times3}=\frac{1\times1\times2}{1\times2\times3}=\frac{1\times1\times1}{1\times1\times3}=\frac{1}{3}$ in its leaſt terms.

COR. II. If the terms of a fraction conſiſt of numbers connected by the ſigns of addition, (+) or of ſubtraction, (—) or both, then the numbers muſt either be reduced into one by means of addition and ſubtraction, in order to be reduced lower, or elſe every number in each term muſt be alike divided.

EXAMPLE.

Let $\frac{4+6=8}{10+8=4}$ be propoſed. This is equal to $\frac{8}{14}=\frac{4}{7}$, the fraction in its leaſt terms; or the ſame is $=\frac{5+3-1}{5+4-2}=\frac{4}{7}$, as before.

SCHOL. In reducing fractions to their leaſt terms by the foregoing method, there will ſometimes be a great difficulty in finding ſuch a number as will divide both its terms; and then the method in the following Problem, of finding the greateſt common meaſure, is to be practiſed.

PROBLEM III. To find the greateſt common meaſure of two or more numbers.

RULE. If there be two numbers only, divide the greater by the leſs, and the diviſor by the remainder, continuing to repeat the ſame till nothing remains; then will the laſt diviſor be the greateſt common meaſure required.

If there are three or more numbers, find the greateſt common meaſure for two of them; and then find the common meaſure of that common meaſure, and one of the other numbers; and ſo on through all the numbers; ſo will the greateſt common meaſure, laſt found, be the anſwer.

N. B. If 1 proves to be the common meaſure, the given numbers are prime to each other.

EXAMPLE.

What is the greateſt common meaſure of $\frac{412}{516}$, or of 412 and 516?

OPERATION.

412) 516 (1
412
104) 412 (3
312
100) 104 (1
100
4) 100 (25
100
...

Here the diviſor, 4, is the greateſt common meaſure, and the fraction brought into its leaſt terms is $\frac{103}{129}$.

PROBLEM IV. To find the leaſt number which can be divided by two or more given numbers without a remainder.

RULE. If the required number is only to be divided by two numbers, divide either number by the greateſt common meaſure, and multiply the quotient by the other number, and the product will be the anſwer.

If it is to be divided by three or more numbers, find the leaſt number which can be divided by two of them, and then find the leaſt number which will divide by that and another of the numbers, and ſo on through all the numbers; ſo will the number laſt found be the required anſwer.

EXAMPLE.

What is the leaſt number which can be divided by 15 and 25?

Here the greateſt common meaſure is 5, and $25 \div 5 = 5$, and $15 \times 5 = 75$, the number ſought; or $15 \div 5 = 3$; and $25 \times 3 = 75$, as before.

PROB. V. To reduce a mixed number to an improper fraction.

RULE. Multiply the whole number by the denominator of the fraction, and to the product add the numerator; ſo will the ſum be the numerator of the required fraction; the denominator is the denominator of the given fraction.

EXAMPLE. Reduce $5\frac{3}{4}$ to an improper fraction.

Here $5 \times 4 = 20$; and $\frac{20+3}{4} = \frac{23}{4}$, the fraction required.

N. B. This caſe properly belongs to addition of fractions, for it is the ſame thing as reducing the whole number to a fraction, whoſe denominator is 4 (as by SCHOL. of PROB. I.) and then adding the two fractions together, as directed in

PROBLEM VI. To reduce an improper fraction to its equivalent whole or mixed number.

RULE. Divide the numerator by the denominator, and the quotient will be the whole or mixed number required.

EXAMPLE. Reduce $\frac{23}{4}$ to its equivalent whole or mixed number.

Here $23 \div 4 = 5\frac{3}{4}$, the anſwer.

SCHOL. As the numerator of any fraction is expreſſive of a dividend, and its denominator is the diviſor of ſuch dividend, the reaſon of the above proceſs is ſelf-evident.

PROBLEM VII. To reduce a compound fraction to a ſingle fraction equivalent thereto.

RULE. Multiply together all the numerators of the given fractions: do the ſame with the denominators; then will the product of the former be the numerator, and of the latter the denominator of the fraction required.

EXAMPLE. Let $\frac{2}{3}$ of $\frac{3}{4}$ be reduced to a ſingle fraction.

Here $\frac{2 \times 3}{3 \times 4} =$ (in its leaſt terms) $\frac{1}{2}$, the fraction required.

Note. If any part of the compound fraction be a whole or mixed number, it muſt be reduced to a fraction by one of the former Problems, before this Rule is applied.

SCHOL. The reaſon of this rule is manifeſt; thus, in the above inſtance, the fraction $\frac{1}{2}$ is $3 \div 4$; and $\frac{1}{2}$ of $\frac{3}{4} = \frac{1}{2}$ of $3 \div 4$; but $\frac{1}{2}$ of 3 is 3 times greater than $\frac{1}{2}$ of 1 (or $\frac{1}{2}$) and, therefore, by the ſecond of the preceding Lemmas, $\frac{2 \times 3}{3} = \frac{2}{3}$ of 3; alſo $\frac{2 \times 3}{3} \div 4 = \frac{2}{3}$ of $\frac{1}{4}$, = by the ſaid Lemma $\frac{2 \times 3}{3 \times 4} = \frac{1}{2}$, as before.

The rule may be proved in like manner for three or more fractions thus compounded, by taking the firſt two, and then the third, and ſo on.

PROBLEM VIII. To reduce any fraction to another equivalent one, which ſhall have any aſſigned number for its denominator.

RULE. Multiply the numerator of the fraction by the aſſigned number; divide the product by the denominator, and the quotient will be the numerator of the fraction required, under which write the aſſigned number.

EXAMPLE. Reduce $\frac{2}{3}$ to an equivocal fraction, which ſhall have 12 for its denominator.

Here $\frac{2 \times 12}{3} = 8$, the required numerator, and therefore the fraction is $\frac{8}{12}$.

SCHOL. The truth of this rule is manifeſt; for it is evident, that the numerator and denominator, by ſuch proceſs, will become equally multiplied or divided; and therefore the fraction ſo produced is (by Lemma I.) equivalent to the given fraction. Thus, in the above inſtance, if both terms of the fraction be multiplied by 4, it will give the required fraction.

N. B. When the numerator of the required fraction does not come out in whole numbers, the caſe is impoſſible.

PROBLEM IX. To reduce fractions of different denominators to equivalent fractions having a common denominator.

RULE. Multiply all the denominators together, and it will be a common denominator for each fraction; to which denominator find the numerator of each fraction by the preceding Problem.

EXAMPLE. Reduce $\frac{3}{4}$ and $\frac{5}{6}$ to a common denominator.

Here $4 \times 6 = 24$, the common denominator, then $\frac{3 \times 24}{4} = 3 \times 6 = 18$, the numerator for the firſt fraction; and $\frac{5 \times 24}{6} = 5 \times 4 = 20$, the numerator for the ſecond fraction; and therefore the required fractions are $\frac{18}{24}$ and $\frac{20}{24}$.

SCHOL. It is to be obſerved, that the above method, though it finds a common denominator, yet it does not find the leaſt common denominator, except when the denominators of the given fractions are prime to each other.

The leaſt common denominator is always the leaſt number, which will divide by each of the given denominators without a remainder, and is found by Problem IV; and the numerators anſwerable thereto will be found, as above, by Problem VIII.

In the laſt example, the leaſt number which can be divided by 4 and 6 is 12, and the numerators from thence for each fraction, are 9 and 10 reſpectively; and therefore the fractions, with the leaſt common denominator, are $\frac{9}{12}$ and $\frac{10}{12}$.

PROBLEM X. To find the value of a fraction in the known parts of the integer.

RULE. Multiply the numerator by ſuch a number of units of the next leſs denomination as is equal to an unit (or 1) of that name or denomination which the fraction is of, dividing the product by the denominator, and the quotient ſhews the value ſought in ſuch inferior denomination.

If there be a remainder after the diviſion, multiply it by the number, which in the next inferior denomination conſtitutes an unit in the laſt or preceding denomination, and divide by the denominator as before, and the quotient will be the value of the remainder in ſuch inferior denomination. Proceed in this manner (if there are remainders after the diviſion) to the loweſt denomination, and the ſeveral quotients connected in due order will be the value of the whole given fraction.

EXAMPLE I. What is the value of $\frac{3}{8}$ of a pound ſterling?

Here $\frac{3 \times 20s.}{8} = 7s.$ with a remainder of 4; and $\frac{4 \times 12d}{8} = 6d.$

Wherefore the required value is 7s. 6d.

EXAMPLE II. What is the value of $\frac{5}{6}$ of a cwt. avoirdupoiſe?

Here $\frac{5 \times 4qrs.}{6} = 3qrs.$ with a remainder of 2; and $\frac{2 \times 28\ lb.}{6} = 9lb.$ with a remainder of 2: and $\frac{2 \times 16oz.}{6} = 5\ oz.$ and a remainder of 2. and $\frac{2 \times 16drs.}{6} = 5\ drs.$ with a remainder of 2, (or $\frac{2}{6}$, or $\frac{1}{3}$.) And therefore the whole value is $3qrs.\ 9lb.\ 5oz.\ 5\frac{1}{3}drs.$

EXAMPLE III. What is the value of $\frac{5}{8}$ of an acre?

Here $\frac{5 \times 4r.}{8} = \frac{5}{2} = 2r.$ with a remainder of 1. and $\frac{1 \times 40p.}{2} = 20p.$ And therefore the anſwer is 2 roods and 20 perches.

PROBLEM XI. To reduce a fraction of one denomination to that of another.

RULE. If it be from a leſs denomination to a greater, multiply the denominator by all the numbers in each denomination, (from that given to that required) which make an unit in the next ſuperior denomination; but, if it be from a greater denomination to a leſs, multiply the numerator by all ſuch numbers of each denomination; and the product, in either caſe, will be the anſwer.

EXAMPLE I. Let there be given $\frac{3}{5}$ of a penny, to find what fraction of a pound it is equivalent to.

Here $\frac{3}{5 \times 12 \times 20} = \frac{1}{5 \times 4 \times 20} = \frac{1}{400}$, the fraction ſought, in its leaſt terms

EXAMPLE II. Let there be given $\frac{3}{5}$ of a pound, to find what fraction of a penny is equivalent thereto.

Here $\frac{3 \times 20 \times 12}{5} = \frac{720}{5}$ of a penny, the anſwer = 144 pence.

EXAMPLE III. Reduce 12s. 6d. to the fraction of a farthing.

Here 12s. 6d. = 150 pence $= \frac{150}{1}$ and $\frac{150 \times 4}{1} = \frac{600}{1}$, the fraction required.

EXAMPLE IV. Reduce 7s. 6d. to the fraction of a pound.

Here 7s. 6d. = 90 pence $= \frac{90}{1}$; and $\frac{90}{1 \times 12 \times 20} = \frac{9}{1 \times 12 \times 2}$ $= \frac{3}{1 \times 4 \times 2} = \frac{3}{8}$, the fraction required.

SCHOL. Where broken numbers are given to be reduced to the fraction of any aſſigned integer, as in the two laſt examples, they muſt always be reduced to the loweſt denomination mentioned, and then turned into a fraction of that denomination (by writing 1 for its denominator, as taught in Problem I.) before the above Rule can be applied.

SECT.

SECT. II. ADDITION AND SUBTRACTION OF VULGAR FRACTIONS.

RULE. Reduce compound fractions to ſingle ones, mixed numbers to improper fractions, fractions of different integers to thoſe of the ſame, and all of them to a common denominator.

This preparation being made, add together or ſubtract their numerators, as if they were whole numbers, and the ſum or difference will be the numerator of the fraction ſought; under which write the common denominator; then reduce the fraction to its leaſt terms, if it will admit of being brought lower.

EXAMPLE I. Add together $\frac{1}{5}$ of a pound, $\frac{1}{4}$ of a ſhilling, and $\frac{1}{3}$ of a penny.

Here $\frac{1}{4}$ of a penny $= \frac{3}{4\times12\times20}$ of a pound $= \frac{1}{4\times4\times20} = \frac{1}{320}$, and $\frac{1}{3}$ of a ſhilling $= \frac{1}{3\times20} = \frac{1}{60}$ of a pound. So the given fractions are $\frac{1}{5}$, $\frac{1}{320}$, and $\frac{1}{60}$ of a pound. Which reduced to the leaſt common denominator become $\frac{64}{320}$, $\frac{1}{320}$, and $\frac{5}{320}$, reſpectively. Then $320+24+3=347$, the numerator ſought; and therefore the ſum of the given fractions is $\frac{347}{320}$ of a pound ſterling; which fraction is in its leaſt terms.

EXAMPLE II. Subtract $\frac{3}{8}$ of a ſhilling from $\frac{1}{5}$ of $\frac{2}{3}$ of a pound.

Here $\frac{3}{8}$ of a ſhilling $= \frac{3}{8\times20} = \frac{3}{160}$ of a pound; and $\frac{1}{5}$ of $\frac{2}{3} = \frac{1\times2}{3\times5} = \frac{2}{15}$ of a pound. Alſo $\frac{2}{15}$ and $\frac{3}{160}$ reduced to the leaſt common denominator, are $\frac{64}{960}$ and $\frac{18}{960}$ reſpectively. Their difference is $\frac{46}{960} = \frac{23}{480}$ of a pound, the anſwer.

SECT. III. MULTIPLICATION AND DIVISION OF FRACTIONS.

RULE. Reduce compound fractions to ſimple ones, and mixed numbers to improper fractions. Then, in multiplication, multiply the numerators together for a new numerator, and the denominators together for a new denominator. And, in diviſion, having, inſtead of the diviſor, ſubſtituted its reciprocal, proceed as in multiplication.

EXAMPLE I. What is the product of $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{2}{5}$, multiplied together?

Anſwer. $\frac{1\times2\times2}{2\times3\times5} = \frac{2}{3\times5} = \frac{2}{15}$.

EXAMPLE II. What is the product of $\frac{2}{3}$ of $\frac{3}{4}$ of 7, multiplied by $\frac{1}{2}$ of 6?

Here $\frac{2}{3}$ of $\frac{3}{4}$ of $7 = \frac{2\times3\times7}{3\times4\times1}$; and $\frac{1}{2}$ of $6 = \frac{1\times6}{2\times1}$. This multiplied into the former, we have the anſwer $= \frac{2\times3\times7\times1\times6}{3\times4\times2} = \frac{2\times6\times3\times7}{3\times5\times2} = \frac{3\times3\times3\times7}{5\times5} = \frac{189}{25} = 7\frac{14}{25}$.

EXAMPLE III. Let $\frac{3}{4}$ be divided by $\frac{1}{2}$.

Here the reciprocal of $\frac{1}{2}$ is $\frac{2}{1}$; and $\frac{3}{4}\times\frac{2}{1} = \frac{3\times2}{4\times1} = \frac{3\times1}{2} = \frac{6}{2}$, the anſwer.

EXAMPLE IV. Divide $9\frac{1}{6}$ by $\frac{1}{2}$ of 7.

Here $9\frac{1}{6} = \frac{55}{6}$, and $\frac{1}{2}$ of $7 = \frac{7}{2}$; its reciprocal is $\frac{2}{7}$; and $\frac{55}{6}\times\frac{2}{7} = \frac{55\times2}{6\times7} = \frac{55}{3\times7} = \frac{11}{21} = 2\frac{11}{21}$, the anſwer.

SCHOL. The reaſon of the foregoing Rule will be underſtood from what follows.

Thus: let the firſt example be reſumed; then, to multiply the two firſt numbers together, $\frac{1}{2}$ and $\frac{2}{3}$, it is evident that $\frac{2}{3}$ is $= 2\div3$, or the third part of 2; and therefore the product by 2 will be three times as great as that by $\frac{2}{3}$. Now, by Lemma II. the product by 2 is $\frac{1\times2}{2}$; but this, being three times as much as it ought, muſt be divided by 3; and, by the ſaid Lemma, a fraction is divided by any whole number, by multiplying the denominator; and therefore, $\frac{1\times2}{2\times3}$ is the product of $\frac{1}{2}$ by $\frac{2}{3}$; alſo, this product multiplied by $\frac{3}{4}$ is, for the ſame reaſon, $= \frac{1\times3}{2\times3}\times2$, and $\div5$; $= \frac{1\times3\times2}{2\times3\times5}$, which is agreeable to the Rule. Again, in diviſion, EXAMPLE III. the diviſor, $\frac{1}{2}$, is $=$ the third part of 2; and therefore, if $\frac{3}{4}$ be divided by 2, the diviſor, being $=$ three times the proper diviſor, the quotient, of courſe, will be proportionably too little.

But $\frac{3}{4}\div2 = \frac{4}{7\times2}$; and this being multiplied by 3, gives $\frac{3\times4}{7\times2}$, as before, which proves the rules true.

I have been the more copious on fractions, becauſe a due comprehenſion thereof is one main pillar in Arithmetic.

CHAPTER V.

SECT. I. DECIMAL FRACTIONS.

1ſt. A decimal fraction is one which has an unit (or 1) for its denominator with cyphers annexed. Thus $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. are decimal fractions.

2d. A decimal fraction is expreſſed without the denominator, by writing only the numerator, and prefixing a point on the left hand of it; and the number of places in the numerator is always equal to the number of cyphers in the denominator. Thus .3 ſignifies $\frac{3}{10}$, .03 ſignifies $\frac{3}{100}$; $.37 = \frac{37}{100}$; $.004 = \frac{4}{1000}$, &c. conſequently, if the numerator has not ſo many places as the denominator has cyphers, the void places muſt be filled up with the cyphers towards the left hand.

3d. Cyphers on the right hand of a decimal do neither increaſe nor diminiſh its value. Thus, .3, .30, and .300, are equal to each other, becauſe $\frac{3}{10}$, $\frac{30}{100}$, $\frac{300}{1000}$, (which are their proper repreſentatives) are, as it is plain from vulgar fractions, equal to one another. But cyphers placed to the left hand, decreaſe the value of the fraction in a ten-fold ratio. Thus of the following; .3, .03, and .003, &c. each one is in value but $\frac{1}{10}$ of the preceding one, as is evident from their repreſentatives in vulgar fractions; viz. $\frac{3}{10}$, $\frac{3}{100}$, $\frac{3}{1000}$, &c.

SCHOL. The reaſon of writing decimals thus, is evident, for ſince they are equal to fractions, of like numerators with denominators, that are conſtantly 1 and cyphers annexed, and ſince the denominator of a fraction is a diviſor to the numerator, and to divide by 1, with cyphers annexed, is only to cut off ſo many figures as there are cyphers, the value of the fraction is fitly expreſſed by placing a point before the numerator. Thus: ſuppoſe the fraction $\frac{25}{100}$; now, ſince to divide by 100 is no more than to cut off two figures, therefore, when a point is put before .25, they will ſtand as figures cut off, or parts of 100.

Again: ſuppoſe the improper fraction $\frac{785}{100}$; it is plain they are $= 7\frac{85}{100}$. But, according to the decimal notation, they muſt be expreſſed 7.85. And this notation, in many caſes, gives decimals a great advantage over vulgar fractions: for as the ſeveral decimal parts are, as has been obſerved, in a ten-fold ratio, and the whole numbers alſo increaſe or decreaſe, in the ſame ratio, it follows that they may be promiſcuouſly brought into operation with each other, provided due care be uſed, and, at the concluſion, a proper number of figures be pointed off, anſwerable to the decimals that have been in uſe.

In what follows, I ſhall only lay down the rules, with an example or two to each, leaving my reader to prove the truth of them by vulgar fractions.

SECT. II. REDUCTION OF DECIMALS.

PROBLEM. I. To reduce a vulgar fraction to a decimal.

RULE. Annex as many cyphers to the numerator, as you would have decimal places, and divide by the denominator.

N. B. This is the ſame as finding the numerator of a fraction whoſe denominator is 1, with a given number of cyphers annexed.

See Reduction of Vulgar Fractions. PROB. VIII.

EXAMP. I. Reduce $\frac{3}{8}$ to a decimal.

Here, if to 3 I annex 6 cyphers, as being deſirous for the ſake of accuracy, of having ſo many decimals, then the quotient by 8 is .375000. But, as I find it comes without a remainder in three places of figures, I reject the three cyphers, as uſeleſs, for by definition 2, they are of no value.

EXAMP. II. Reduce $\frac{37}{517}$ to a decimal Anſwer .071577.

SCHOL. When it is requiſite that there ſhould be a great many places of decimals, and after a few figures are got, it is obſerved, that the remainder is either ſome multiple or aliquot part of the numerator of the given fraction; then multiply, or divide the figures already found (according as the caſe ſhall be) by the number, denoting ſuch multiple, &c. and the reſult will be the next following figures of the quotient.

EXAMPLE. Let the fraction be $\frac{4}{17}$. Then by proceeding as before, it will be found $= .2352941\frac{2}{17}$, and the remainder 2, being $= \frac{1}{2}$ the numerator (4), I divide the ſaid quotient by 2, and the reſult is $11764\frac{7}{17}$; wherefore, I annex this to the former, and it becomes $.235294117647\frac{7}{17}$ true to 12 places of decimals. Again, I ſee that the remainder 1 is equal to $\frac{1}{4}$ of the numerator, and therefore by dividing the laſt quotient by 4, there will be 12 more places true, viz. $.058823529411\frac{3}{4}$, and this annexed to the former, gives $.235294117647058823529411\frac{3}{4}$. Alſo, I obſerve, that after the ſixteenth figure the decimal repeats the ſame figures again, and ſo it may be continued further at pleaſure, *ad infinitum*.

PROBLEM II. To reduce the decimal of one denomination to the decimal of another.

RULE. This is performed in all reſpects as in common reduction, where one denomination is given to be reduced to another; obſerving that there muſt be juſt as many places of decimals in the anſwer, as there are in the given decimal; and therefore, when there are more places of figures in the anſwer than there are decimals in the given number, the exceſs to the left hand will be whole numbers; but if there are fewer places therein, the defect muſt be ſupplied by prefixing cyphers.

N. B. It will ſometimes be requiſite to annex cyphers to the given decimal, and then the number of decimal places muſt be taken accordingly.

EXAMP. I Reduce .0235 of a pound ſterling, to the decimal of a penny. Here, $.0235\times20\times12 = 56400$; and as the given number conſiſts of 4 places of decimals only, therefore, the anſwer is 5.6400, where 5 is a whole number, denoting ſo many pence, and the reſt .64 are decimal parts of a penny.

EXAMP. II Reduce .2795 of a ſhilling to the decimal of a pound. Here .2795÷20, (or which, by definition 3, is the ſame as 27950÷20)=1.3975; but the decimal places in the given number, with the cyphers annexed, are ſix, and therefore one cypher muſt be prefixed to this number; and ſo the anſwer is .013975 of a pound.

COROL. I. Hence the value of any decimal, in the ſeveral known parts of the integer, will be had by the ſame method; only obſerving, at each multiplication, to ſet off the whole numbers in each denomination, and continue the operation with the decimal parts only. Thus, if it is required to find the value of .3785 of a pound ſterling, in ſhillings, pence, &c.

Here .3785 × 20 = 7.5700 (the 7. being ſhillings); then .57 × 12=6.84, (the 6. being pence) and .84×4=3.36, (the 3. being farthings) and ſo the value is 7s. 6d. and .36 decimal parts of a farthing.

Again, In 342.5 pence, how many pounds?

Here 342. pence=1l. 8s. 6d. and .5 of a penny=½, and therefore the required value is 1l. 8s. 6½d.

COROL. II. Any integer number of an inferior denomination is brought to the decimal of a ſuperior denomination, by reducing it firſt to the vulgar fraction of ſuch ſuperior denomination, and then finding its equivalent decimal by PROBLEM I. or, a ſufficient number of cyphers being annexed thereto for decimal places: it may often be more conveniently reduced to the decimal of ſuch ſuperior denomination, by dividing as directed in this problem; obſerving to make as many decimal places in the anſwer, as there were cyphers annexed in the operation, by prefixing as many cyphers as are neceſſary.

EXAMPLE. Reduce 9d. to the decimal of a pound. Here 9÷12, or, which is the ſame, 9.00÷12=.75; and .75÷20; or, .7500÷20.=.0375, the decimal required.

COROL. III. Hence, if the given number conſiſts of integers in divers denominations, to be reduced to the decimal of ſome ſuperior denomination; reduce the loweſt denomination to the next ſuperior, and prefix thereto the given integers of that denomination. Alſo reduce that number to the decimal of the next ſuperior denomination, prefixing the integers, if any, as before, and ſo on to the end. The laſt reſult is the anſwer.

EXAMPLE. Reduce 3f. 3¼d. to the decimal of a pound. Here 1 farthing, reduced to the decimal of a penny, is .25, to which I prefix 3, and it becomes 3.25; and this reduced to the decimal of a ſhilling is .2708333, &c. and prefixing 3, it is 3.2708333, which reduced to the decimal of a pound is .2635416666, &c. the anſwer.

N. B. The ſeveral denominations of weights, meaſures, &c. are managed in like manner; due regard being had to the number of integers, which in one denomination is equivalent to an unit in the next ſuperior denomination, as was ſhewn both in reduction of whole numbers and vulgar fractions.

SCHOL. The value of any decimal of a pound ſterling, may be had by inſpection, thus: Double the firſt figure (or that in the place of tenths) for ſhillings, and if the ſecond figure be 5, or more, reckon another ſhilling; then call the figures in the ſecond and third places, after the 5 is deducted, ſo many farthings, abating 1 when they are above 12, and 2, when above 37; and the reſult will be the anſwer.

EXAMPLE. What is the value of .375 of a pound?

Here the double of 3 is 6, but the next figure being above 5, I make it 7, which are ſhillings. Then the reſidue (when 5 is taken from 7) is 25; which, being above 12, I reckon only 24, for farthings which make 6d. and ſo the value required is 7s. 6d.

SECT. III. ADDITION AND SUBTRACTION OF DECIMALS.

RULE. Reduce the decimals to one and the ſame denomination, if they are not ſo already. Then place the numbers ſo, that the units (if any) may ſtand under units; and the tenth's place of the decimals, under the tenths, &c. and add or ſubtract them as in whole numbers, placing each figure directly under its proper column, ſo that it may obtain the ſame place in the rank of decimals, &c. as the figures in ſuch column obtain.

ADDITION.

EXAMPLES.	
23.27515	
.15614	
5.436278	
.0023456	
Total 28.8663036	

EXAMPLES.	
4.7652	
26.	
.374	
35.406	
7.00352	
Total 73.54872	

SUBTRACTION.

From	7.8543
Take	4.02765
Rem.	3.82665

From	76.543
Take	.37856
Rem.	76.16444

SECT. IV. MULTIPLICATION AND DIVISION OF DECIMALS.

RULE. Multiply and divide them as in whole numbers; obſerving in multiplication, that the product muſt contain as many places of decimals, as there are in both the multiplicand and multiplier; and in diviſion that the number of ſuch places, in the quotient, together with thoſe in the diviſor, muſt be equal to the number of decimal places in the dividend.

Hence, if the dividend be a whole number, or contain but few places of decimals, cyphers muſt be annexed thereto, till the number of decimal places therein exceed the number of ſuch places in the diviſor, by as many as there are decimal places required in the quotient.

EXAMPLE I.

Mult.	4.276
By	3.5
	21380
	12828
Product	14.9660

EXAMPLE II.

Mult.	.37324
By	.0936
	513916
	2063664
Prod.	.03536552064

EXAMPLE III.

Div.	4.732604
By	.4
	.4) 4.732604
Quot.	11.83151

EXAMPLE IV.

Div.	4278.48.
By	.06
	.06)4278.48.00
Quot.	71308.

EXAMPLE V. Divide .2274203 by 5.326.

OPERATION.

5.326).2274203(.04270 Quotient.
21304
14380
10652
37283
37282
3 Remainder.

Here, in the ſecond example, the product contains only 8 figures, though, according to the rule, there ſhould be 9 decimal places; wherefore I prefix a cypher to make up a deficiency, placing a point before it, to ſhew that the figures are decimals.

In the fourth example, the dividend being a whole number, and the diviſor having two decimal places, I annex two cyphers (as decimals) to the dividend; and then, according to the Rule, all the figures in the quotient are whole numbers; but if there had been a remainder after the diviſion, and it had been required to have a certain number of decimals in the quotient, then as many cyphers more muſt have been annexed as would have been equal to the required number of decimals.

In the laſt example it appears, that, without annexing cyphers there ſhould be five places of decimals in the quotient; and therefore I find it requiſite to prefix a cypher. There being a remainder of 3, more places of decimals may be had by annexing cyphers.

Thus, by annexing 6 cyphers, the quotient will be .042700000018. But, if the quotient is continued no farther than .04270, the cypher on the right hand may be rejected; for in that caſe, by Definition III. it does not augment the value.

COR. I. If any decimal number is to be multiplied by 10, 100, 1000, &c. the product will be had by only removing the decimal point ſo many places towards the right hand, as there are cyphers annexed to the unit; and, on the contrary, if the diviſor of any decimal number is 10, 100, 1000, &c. the quotient will be had by removing the decimal point the like number of places towards the left hand. Thus; .2754×100=27.54 and 27.54÷100=.2754.

COR. II. When, in multiplication, there are many decimal parts in the multiplicand and multiplier, and but a few decimals are required in the product, the operation may be ſhortened, as follows: Write the unit's place of the multiplier under that figure, in the multiplicand, whoſe place you would retain in the product, diſpoſing the reſt of the figures in the contrary order to that which they are properly placed in; then begin always at that figure in the multiplicand which ſtands over the figure which you multiply with, and ſet down the products, ſo that their right hand figures may ſtand in a line under one another.

Note. The firſt figure in every line muſt be increaſed with what would ariſe (by carrying 1, from 5 to 15; 2 from 15 to 25; 3 from 25 to 35, &c.) from the product of the preceding figures which are left out of the operation.

EXAMPLE I.

Multiply 79.80625 by 7.854, and let four places of decimals be retained in the product.

OPERATION.

79.80625	
458.7	
5586438	
638450	
39903	
3198	
Product	626.7983

EXAMPLE II.

Multiply 535.5625 by .6375, and let three decimals be retained.

OPERATION.

535.5625	
5736.0	
3213375	
16067	
3749	
268	
Product	341.428

N. B. In the ſecond example, there being no unit's figure in the multiplier, therefore, to render the operation the more plain and

and eaſy to be comprehended, according to the Rule, I have put a cypher in the place of units.

Cor. III. By a ſimilar procedure, the operations in diviſion may be ſhortened. The method is thus: conſider, according to the foregoing Rule, how many decimal places there ought to be in the dividend, in order to give the deſired number of decimals in the quotient; alſo, conſider how many figures the quotient (with ſuch number of decimals) will contain, which is done by obſerving how many figures of the dividend will be uſed (according to the common method) to give the firſt quotient figure; then each of the remaining figures of the dividend will give a figure more. Take as many of the left hand figures of the diviſor into the operation, as there are to be figures in the quotient, and as many figures of the dividend as will give the firſt quotient figure; and at each diviſion leave out another figure on the right hand of the diviſor, always making the laſt remainder the dividend.

Example. Let 63092.878 be divided by 76.84375, and let there be three places of decimals in the quotient.

Operation.

Diviſor. Dividend.

76,84375)63092.878(821.034

614750

161787

143588

18099

15369

2730

2563

167

154

13

Here, in this example, there being five places of decimals in the diviſor, there ought (according to the common method) to be eight places of decimals in the dividend, in order to give three decimal figures in the quotient; and therefore, to the dividend there ſhould be five cyphers annexed. Alſo, it is evident, that to give the firſt quotient figure (by the whole diviſor) will take all the given figures of the dividend; and as the five cyphers will give five more figures, it is plain that there will be ſix figures in the quotient. Therefore I take only ſix figures of the diviſor, with as many of the dividend as will give the firſt quotient figure.

In each diviſion I leave out another figure of the diviſor, but augment its product by each quotient figure, as was taught in multiplication.

CHAPTER VI.

RULE OF PRACTICE.

Practice is a compendious way of caſting up the value of any articles, whether by weight or meaſure, the price of the integer being given.

It is generally formed by taking ſuch aliquot parts of the given quantity, as the price is of a pound, ſhilling, &c.

The following are the moſt uſual methods:

1ſt. When the price is leſs than a penny, divide by the aliquot parts of a penny, and then by 12 and by 20, and you will have the value required.

2d. When the price is an aliquot part of a ſhilling, divide by ſuch aliquot part, and the quotient will be the anſwer in ſhillings; which, if above 20, muſt be reduced into pounds.

3d. When the price is pence and farthings, and not an aliquot part of a ſhilling, divide the given number by ſome aliquot part of a ſhilling; and then conſider what part of the ſaid aliquot part the reſt is, and divide the quotient thereby; and the laſt quotient, together with the former, will be the anſwer in ſhillings, which muſt be reduced into pounds as before; or the price may be frequently ſo divided, that each part will be ſome aliquot part of a ſhilling, and then a proper aliquot part of the given number muſt be taken for each, and their ſum collected as above.

4th. When the price is an even number of ſhillings, without pence and farthings, multiply the given number by the half thereof; doubling the firſt right hand figure of the product for ſhillings, and thoſe to the left are pounds.

5th. When the price is any odd number of ſhillings, except 5; either multiply thereby and divide by 20, or find the value of the greateſt even number, as above; to which add $\frac{1}{20}$ of the given number, for the odd ſhilling.

6th. When the price is an aliquot part of a pound, as 10s. 6s. 8d. 5s. 4s. &c. divide the given quantity by ſuch aliquot part, and the quotient will be the anſwer in pounds.

7th. When the price is ſhillings, pence, &c. it muſt be ſo divided, that one or more of the foregoing rules may be applied, as ſhall appear moſt convenient; and when it can be done, aliquot parts of parts may be taken.

8th. When the given number is a whole number, with parts annexed, find the value of the whole number by the preceding methods; to which add a part of the price anſwerable to the given parts.

9th. When the given quantity, whoſe value is ſought, is of ſeveral denominations, and the price is of an integer of the higheſt denomination, multiply the price by the number of the higheſt denomination, or find the value thereof by ſome of the foregoing methods; then take the ſame parts of the price for thoſe of the lower denominations, as they are of an unit of the higheſt denomination, and the ſum of all will be the anſwer.

10th. When the given quantity is of ſeveral denominations, and the price is that of an unit of ſome lower denomination, the higher denomination muſt be reduced to ſuch lower denomination; and then the laſt, or ſome preceding method, muſt be uſed.

TABLE OF ALIQUOT PARTS.

Parts of a Pound.

s.	d.		
10	0	is	$\frac{1}{2}$
6	8	—	$\frac{1}{3}$
5	0	—	$\frac{1}{4}$
4	0	—	$\frac{1}{5}$
3	4	—	$\frac{1}{6}$
2	6	—	$\frac{1}{8}$
2	0	—	$\frac{1}{10}$
1	8	—	$\frac{1}{12}$
1	4	—	$\frac{1}{15}$
1	0	—	$\frac{1}{20}$
0	8	—	$\frac{1}{30}$
0	6	—	$\frac{1}{40}$
0	4	—	$\frac{1}{60}$
0	3	—	$\frac{1}{80}$
0	1	—	$\frac{1}{240}$

Parts of a Shilling.

6d.	is	$\frac{1}{2}$
4	—	$\frac{1}{3}$
3	—	$\frac{1}{4}$
2	—	$\frac{1}{6}$
1½	—	$\frac{1}{8}$
1	—	$\frac{1}{12}$

Parts of a Cwt.

lb.		
56	is	$\frac{1}{2}$
28	—	$\frac{1}{4}$
14	—	$\frac{1}{8}$
16	—	$\frac{1}{7}$
8	—	$\frac{1}{14}$
7	—	$\frac{1}{16}$

I. What is the value of 8274lb. at 4d. per lb?

d. | d. 8274

$\frac{1}{2}$ is | $\frac{1}{2}$ 4137

$\frac{1}{4}$ is | $\frac{1}{4}$ 2068

$\frac{1}{12}$ | 689 $\frac{1}{3}$

$\frac{1}{24}$ | 344 $\frac{1}{2}$

Anſw. £. 34 17 1½

Or thus:

4d is the $\frac{1}{12}$ of a £. 8 | 0 | 8274

4d is the $\frac{1}{3}$ of 8d | $\frac{1}{12}$ | 689 8 6

Anſw. £. 34 17 1½

Here in dividing by 20, there is a remainder of 14, which are ſo many three pences, and make 8s. 6d.

II. What is the value of 7284lb. at 3d. each?

3d is $\frac{1}{4}$ | 7284

20 | 1821

Anſw. £. 91 1

Or thus 8 | 0 | 7284

Anſw. £. 91 1

Here 4 remains in the diviſion by 20, which are 4 three pences.

III. What is the value of 4443 at 7½d. each?

4d is = | $\frac{1}{3}$ | 1111

2d is = | $\frac{1}{6}$ | 481

$\frac{1}{2}$ is $\frac{1}{4}$ of 2d | $\frac{1}{8}$ | 111 1 6

| 27 15 4½

| 4 12 6

£. 143 9 5½ An.

Or thus:

6d is $\frac{1}{10}$ of a £. 4 | 0 | 1111 3

1½d is $\frac{1}{4}$ of 6d | $\frac{1}{4}$ | 111 1 6

$\frac{1}{2}$ is $\frac{1}{3}$ of 1½d | $\frac{1}{8}$ | 27 15 4½

| 4 12 6

Anſw. £. 143 9 5½

IV. Given 4395 at 6s. each?

4395

3

£. 1297 10 Anſw.

See method the 4th.

V. Given 2736 pieces at 7s. each.

2736 — 3

8 20 16 — 7

137 16 — 2 | 0 | 1929 | 2

£. 964 12s. An. £. 964 12s. An.

Or thus

VI. $\frac{1}{4}$ | 3576 pieces at 9s. 4d. each

96£. Anſwer.

VII. What comes 9876 to at 7s. 1½d. each?

7

1½d is — $\frac{1}{8}$ | 69132

| 1234 6

2 | 0 | 7036 6 6

Anſw. £. 3518 6 6

VIII. What is the value of 5678½ lb. at 4d per lb.

4d is $\frac{1}{60}$ of a £. 6 | 0 | 5678

£. 94 18 8

The value of ½lb. is 4

¼lb. is 1

Anſwer £. 94 19 11

IX. What is the value of 3 cwt. 22lb. at 13s. and 3½d. per cwt.

s. d.

13 3½

3

£. 2 0 3½

14lb. is = | 1 8½ nearly

2 is ⅛ of 14lb. | 1 8 ditto

1 is ½ of 2 | 1 4 ditto

½ is ½ of 1 | 1 2 ditto

¼ is ½ of ½ | 1 ditto

£. 2 3 3 Anſw.

X. What is the value of 3 tons, 4 cwt. 1 qr. at 2l. 5s. per cwt?

Tons cwt. q.

3 4 1

20

Given wt. 64 cwt. and 1 qr.

2

£. 128 val. of 64 cwt at 2l

5s. is ¼ | 16 val. of do. at 5s

1 qr. is ¼ | 11 3 val. 1 qr. of cwt

£. 144 11 3 Anſwer.

CHAPTER VII.

TARE AND TRETT, &c.

1ſt. Tare is allowance to the buyer of any commodity for the weight of the box, caſk, &c. containing the ſame.

2d. Trett is an allowance of 4lb. in every 104lb. on account of waſte, duſt, &c.

3d. Cloff is an allowance of 2lb. in every 3 cwt. to make the weight hold out when retailed.

4th. Gross Weight, the whole weight both of package and goods before any of the aforeſaid allowances are deducted.

5th. Suttle Weight is when part of the allowances are deducted from the groſs.

6th. Neat Weight is that which remains after all the allowances are deducted.

The

The Rules for making theſe allowances are reſolved into the five following caſes:

I. When Tare only is allowed, and the ſame is ſo much in the whole, ſubtract it from the groſs, and the remainder will be the Neat Weight.

II. When the caſe is as before, but the Tare is at ſo much per box, cask, &c. multiply the number of boxes, casks, &c. by the Tare of one of them, ſubtract the product from the groſs, and the remainder will be the Neat Weight.

III. When the caſe is as before, but the Tare is at ſo much per cent. divide the groſs weight by the aliquot parts of a cwt. as in the Rule of Practice; ſubtract the quotient (or the ſum or difference of the quotients, as the caſe ſhall be) from the groſs, and the remainder will be the Neat Weight.

IV. When both Tare and Trett are allowed, divide the Suttle Weight (or that weight which remains after the Tare is deducted) by 26; ſubtract the quotient from the ſubtle, and the remainder is the Neat.

V. When Tare, Trett, and Cloff are allowed, deduct the Tare and Trett as above directed, and divide the Suttle by 168; then ſubtract the quotient from the Suttle, and the remainder will be the Neat Weight.

EXAMPLES.

I. Let the Groſs be 28 cwt. 2 qrs. 18 lb. and the Tare 1 cwt. 1 qr. 21 lb. 8 oz. required the Neat Weight?

Here, 1 cwt. 1 qr. 21 lb. 8 oz. ſubtracted from the Groſs, leaves 27 cwt. 0 qr. 24 lb. 8 oz. the Neat Weight required.

II. What is the Neat Weight of 7 hogſheads of tobacco, each weighing 5 cwt. 2 qrs. 21 lb. Groſs, and the Tare 98 lb. per hogſhead?

Here, 5 cwt. 2 qrs. 21 lb. multiplied by 7, gives 39 cwt. 3qrs. 7 lb. the whole Groſs; and 98 lb. or 3 qrs. 14 lb. multiplied by 7, gives 6 cwt. 0 qr. 14 lb. the whole Tare, which ſubtracted from the Groſs, leaves 33 cwt. 2qrs. 21 lb. the Neat Weight required.

III. Let the Groſs be 16 cwt. 2 qrs. 14 lb. and the Tare 16 lb. per cwt. what is the Neat Weight?

Here, 16 lb. is $\frac{1}{7}$ of a cwt. Wherefore, divide the Groſs by 7, and the quotient, 2 cwt. 1 qr. 14 lb. is the Tare, which ſubtracted from the Groſs, leaves 14 cwt. 1 qr. the Neat Weight.

IV. Suppoſe the Groſs Weight to be 154 cwt. 2 qrs. 8lb. and the Tare 12 lb. per cwt. what is the Neat Weight, allowing alſo for Trett?

OPERATION.

Cwt.		2 qrs. is $\frac{1}{2}$	12 lb.
16 lb. is $\frac{1}{7}$	154	8 lb. is $\frac{1}{7}$ of 2 qrs. $\frac{1}{7}$	6 oz.
4 is $\frac{1}{4}$ of 16 $\frac{1}{4}$	22 qrs.		13$\frac{1}{4}$ nearly.
Subtract	5 2	Tare of 2 qrs. 8lb.	6 13$\frac{1}{4}$
	16 2 lb.		

6 13$\frac{1}{4}$ oz. Tare of 2 qrs. 8 lb.

16 2 6 13$\frac{1}{4}$ whole Tare.

	Cwt.	qrs.	lb.	oz.	
Groſs	154	2	8	0	
Tare	16	2	6	13$\frac{1}{4}$	Subtract
26)	138	0	1	2$\frac{1}{4}$	Suttle
	5	1	6	7$\frac{1}{2}$	nearly=Trett
Anſw.	132	2	22	10$\frac{1}{4}$	Neat Weight.

V. What is the Neat Weight of two hogſheads of tobacco, each weighing 5 cwt. 3 qrs. 20 lb. Groſs, the Tare being 7 lb. per cwt. and the Trett and Cloff as uſual?

OPERATION.

	Cwt.	qrs.	lb.	
	15	3	20	
			2	
	31	3	12	groſs.
7lb is $\frac{1}{16}$	1	3	27	tare.
26)	29	3	13	
	1	0	16$\frac{1}{2}$	nearly, trett
168)	28	2	24$\frac{1}{2}$	ſuttle.
	0	0	19	cloff.
Anſw.	28	2	5$\frac{1}{2}$	Neat Weight.

N. B. In ſome commodities 2 lb. in 100 lb. is allowed for cloff, in which caſe, inſtead of dividing the Suttle by 168, it muſt be divided by 50 only, and the quotient will be the Cloff to be ſubtracted as before.

Note alſo, that in calculating oil, if the Neat Weight be reduced into half pounds, and divided by 15, the quotient will be the neat gallons, becauſe 7$\frac{1}{2}$ lb. are allowed to the gallon.

CHAPTER VIII.

SINGLE RULE OF THREE.

1ſt. This Rule takes its name from having always, in the queſtions to which it relates, three terms given to find a fourth, which ſhall have the ſame proportion to one of the given terms as ſubſiſts between the other two; it is therefore ſometimes called the Rule of Proportion; and, becauſe of its excellence and uſe, it is alſo named the Golden Rule.

2d. Before the operation is begun, the given terms muſt be arranged in one line, with two points between the 1ſt and 2d, and four points between the 3d and 4th. Thus, 2 : 4 : : 6; and the reading of them is after this manner; viz. as 2 is to 4, ſo is 6 to the fourth number or anſwer. When the fourth term is found (or given) it is frequently ſet after the third term, with two points between them.

3d. To arrange terms properly, is called ſtating the queſtion; to perform which, obſerve that the term, wherein the demand of the queſtion reſts, is to be made the ſecond term; it is generally preceded by the interrogative of the queſtion; viz. the words, I demand? How much? How many? How long? What will? &c.

The firſt term is always of the ſame kind, or nature, as the ſecond; and the third is of the ſame kind, or nature, as the fourth term or anſwer.

4th. When the 4th term or anſwer bears ſuch proportion to the 3d as the 2d does to the 1ſt, the queſtion is called Direct; which is the caſe when there is the ſame affection between the 3d and 4th, as there is between the 1ſt and 2d; viz. when the 2d term is either greater or leſs than the firſt; and it is neceſſary that the 4th be in like manner either greater or leſs than the 3d.

5th. When the 4th term bears ſuch proportion to the 3d as the 1ſt does to the 2d, the queſtion is ſaid to be Inverſe; the affection between the 3d and 4th being, under ſuch circumſtance, of a contrary nature to the affection between the 1ſt and 2d. This happens when the 2d term is either greater or leſs than the firſt; and it is neceſſary, that the fourth be in the former caſe leſs, and in the latter, greater than the 3d.

Having by theſe inſtructions ſtated the queſtion, and diſcovered from its nature whether the ſame be direct or inverſe, then to perform the operation, obſerve the following rules.

I. Reduce the 1ſt and 2d terms to one and the ſame denomination, if they are not ſo already; and the 3d term to the loweſt denomination, if it be a number of ſeveral denominations.

II. If the queſtion be direct, multiply the 2d and 3d terms together, and divide the product by the firſt, and the quotient will be the anſwer in the ſame denomination with the 3d term, after its deduction, if any was made.

III. If the queſtion be inverſe, multiply the 1ſt and 3d terms together, and divide the product by the 2d, and the quotient will be the anſwer, as before.

N. B. Sometimes when the 3d term is of ſeveral denominations, it will be unneceſſary to reduce it to the loweſt, viz. when the 1ſt and 2d terms are ſuch, that the Multiplication and Diviſion may be eaſily performed without it.

Note alſo, when the given terms are fractions, the reciprocal of the firſt and ſecond term, according as the queſtion is Direct or Inverſe, may be taken in lieu of ſuch term, and then the anſwer will be had by multiplying all the terms together.

EXAMPLE I. If 5 oxen coſt 55l. 10s. what will 21 oxen coſt at that rate?

oxen.	oxen.	l.	s.	
As 5	: 21	: : 55	10	(: the Anſwer)
		20		
		1110		ſhillings.
		21		
		5) 23310		product of 2d and 3d terms.
		20) 4662		anſwer in ſhillings.
		£. 233		2s. anſwer in pounds.

EXPLANATION. The demand of the queſtion in the above example, is the value of 21 oxen? therefore, by Definition 3d, 21 oxen muſt be the ſecond term; then as (by the ſaid Definition) the firſt term muſt be of the ſame kind or nature with the ſecond, it is plain that 5 oxen muſt be the firſt term; and the other number, namely 55l. 10s. which is of the ſame nature with the anſwer, muſt be the third term; wherefore I write them down in order as above, and the proper reading thereof in that order is, as 5 is to 21, ſo is 55l. 10s. (the price of 5) to the anſwer (or the price of 21.) Then, to determine whether the queſtion be Direct or Inverſe, I obſerve, that the ſecond term is greater than the firſt, and the anſwer muſt be greater than the third, in the ſame proportion, and therefore (by Definition 4th) the queſtion is direct.

Then, according to Rule I. I reduce the third term into ſhillings; alſo I multiply the ſame by the ſecond term, and divide the product by the firſt, and the quotient is the anſwer in ſhillings, according to Rule III. which, being divided by 20, gives the anſwer in pounds.

SCHOLIUM I. In order to abbreviate the operations, it will be convenient to connect the two terms, which are to be multiplied together with the ſign of multiplication between them, and to write the diviſor under them in manner of a fraction, which will be a fractional expreſſion for the anſwer, to be reduced into its loweſt terms by Prob. II. of Fractions.

SCHOL. II. Sometimes alſo the operation may be ſhortened thus: obſerve how often that term which is the diviſor is contained in one of the other terms (noting the Remainder) and multiply the remaining term by the quotient, and take parts for the remainder, to be added to the product.

SCHOL. III. When the diviſor is a compoſite number, and one of the other terms is leſs than the diviſor, but no aliquot part thereof,

thereof, obſerve what aliquot part of the diviſor comes neareſt to the ſaid leſs term; divide the remaining term by the number denoting the aliquot part, and it will give the value, anſwering to the number expreſſed by the ſaid aliquot part of the diviſor. Then take aliquot parts of this value for the exceſs or defect, and ſubtract or add the ſame, as the caſe ſhall be, and it will give the anſwer.

Contractions of this kind will often prove extremely uſeful, though they have not, I believe, been noticed by any other author.

Thus the preceding example may, by Scholium I. (after the reduction) be written, $\frac{1119\times21}{8}$ = anſwer in ſhillings, and $\frac{1119\times21}{8\times10}$, or $\frac{1119\times21}{160}$ = anſwer in pounds = 11.19×21 = 233.19, or 233l. 2s.

Or, by following the ſecond Scholium, I obſerve that 5 is contained 4 times in 21, but that there is a remainder of 1. Therefore I multiply 55l. 10s. by 4, and it gives 222l. to which I add the fifth part of 55l. 10s. viz. 11l. 2s. (becauſe 1 is the fifth part of 5,) and the ſum is 233l. 2s. as before.

Note. In following this method, when the remainder is large, it will be better to take the quote 1 more, and ſo deduct inſtead of adding, a proportionable ſhare, anſwerable to the parts in exceſs.

Thus, in the foregoing example, if the ſecond term had been 24, then the neareſt quote, by the firſt term, would have been 5, but producing an exceſs of 1. Therefore, in that caſe, I ſhould have multiplied the 55l. 10s. by 5, and deducted a fifth part from the product, in order to obtain the anſwer.

EXAMPLE II. Suppoſe a ſhip ſails 24 leagues in 12 hours, (or half a natural day,) how many leagues will ſhe ſail in a week, at the ſame rate?

Hours. Week. Leag.

Here the ſtating will be thus: As 12 : 1 : : 24 : (the anſwer.)

But as in 1 week there are 14 half days, therefore, when the firſt and ſecond terms are reduced to the ſame denomination, the proportion will be, As 1 : 14 : : 24 : Anſwer.

And $\frac{14\times24}{1}$ = 336 leagues, the diſtance ſought.

EXAMPLE III. If 9 yards of cambric coſt 5l. 12s. what will 72 yards coſt at that rate?

Yds. yds.

As 9 : 72 : : 5l. 12s. (Anſwer.)

Therefore the anſwer = $\frac{5l.12s.\times72}{9}$ = 5l. 12s. $\times8$ = 44l. 16s.

EXAMPLE IV. If 8 men can finiſh a piece of work in 15 days, what number of men will be required to perform the ſame in 24 days?

Days. Days. Men.

As 15 : 24 : : 8 : Anſwer.

Here the proportion is Inverſe, becauſe the ſecond term is greater than the firſt; and the anſwer muſt be leſs than the third; for it is not neceſſary to have ſo many men to do a piece of work, if 24 days be allowed, as would be employed, provided 15 days only were allowed.

Therefore, $\frac{8\times15}{24}$ = $\frac{15}{3}$ = 5, the number of men required.

EXAMPLE V. If 56 yards of ſhalloon, of 3-quarters wide, are neceſſary for the linings of 10 ſuits of cloaths, how many yards of ſhalloon, of 5-quarters wide, would it take to line them?

Qrs. Qrs. Yards.

As 3 : 5 : : 56 : (Anſwer.)

Here the queſtion is alſo Inverſe; therefore, $\frac{3\times56}{5}$ = $56\times.6$ = 33.6 yards = 33$\frac{3}{5}$ yards = the Anſwer: or $\frac{3\times56}{5}$ = $3\times11\frac{1}{5}$ = 33$\frac{3}{5}$, as before.

EXAMPLE VI. If $\frac{3}{16}$ of a ſhip coſt 274l. 12s. 6d. what will $\frac{1}{16}$ thereof be worth?

As $\frac{3}{16}$: $\frac{1}{16}$: : 274l. 12s. 6d. : Anſwer.

Therefore, $\frac{1}{3}\times\frac{1}{16}\times$ 274l. 12s. 6d. = Anſwer; videlicet, $\frac{16\times5}{3\times32}$ (or $\frac{5}{2\times3}=\frac{1}{6}$) $\times$ 274l. 12s. 6d. = $\frac{274l.\ 12s.\ 6d.\times5}{6}$ = 45l. 15s. 5d. $\times5$ = 228l. 17s. 1d. the Anſwer.

Or, the two fractions reduced to the leaſt common denominator are $\frac{5}{16}$ and $\frac{3}{16}$; and rejecting the denominators, as common to both multiplier and diviſor, the proportion will ſtand thus. As 6 : 5 : : 274l. 12s. 6d. : (Anſwer.) And 274l. 12s. 6d. $\times5$ = 1373l. 2s. 6d. which, divided by 6, gives 228l. 17s. 1d. the ſame as before.

EXAMPLE VII. If 60 gallons of water, in 35 minutes time, be conveyed through a pipe into a ciſtern which holds 200 gallons, and if, by a cock in the ciſtern, there runs out 45 gallons in the ſame time, how long will the ciſtern be in filling, provided the cocks keep running at the above rates?

Here it is evident, that, at the end of 35 minutes, there will be 15 gallons in the ciſtern, and that it will keep filling at the ſame rate.

Gal. Gal. Min.

Hence, As 15 : 200 : : 35 : (Anſwer.)

Therefore, $\frac{200\times35}{15}$ = $\frac{200\times7}{3}$ = $\frac{1400}{3}$ = 466$\frac{2}{3}$ minutes, or 7 hours, 46 minutes, and 40 ſeconds, the Anſwer.

EXAMPLE VIII. If 54 oxen coſt 411l. 1s. 6d. what is the price of 28 oxen at that rate?

Oxen. Oxen.

As 54 : 28 : : 411l. 1s. 6d. : (the Anſwer.)

OPERATION:

3) 411 1 6

9) 137 8 6

15 4 6

£152 5 0 Anſwer.

Here I devide the price by 3, and it gives the price of 18, becauſe 18 is the $\frac{1}{3}$ part of 54. Then, to obtain the price of the remaining 2, I divide this by 9, becauſe 2 is the $\frac{1}{9}$ part of 18. The ſum of theſe is 152l. 5s. the Anſwer ſought.

Other queſtions might be given to illuſtrate this Rule, but a due attention to what has been delivered, will afford ſufficient inſtruction for every caſe, and in a more conciſe and methodical method than has been given by other writers.

CHAPTER IX.

DOUBLE RULE OF THREE.

The Double Rule of Three, by ſome called the Rule of Five, is when five terms are given to find a ſixth.

The beſt method of ſolving queſtions of this kind, is to make two ſtatings in the ſingle rule; but to ſuſpend the operation till it is diſcovered, from the nature of the queſtion, which of the terms will be multipliers, and which of them diviſors.

Then the three terms which are multipliers may be connected by ſigns of multiplication between them, and the two terms which are diviſors may be connected in like manner, and written under the other with a line between them, in form of a fraction, to be reduced to its leaſt terms, as has been ſhewn in the ſingle rule. And in general all the contractions, which have been introduced there, may be occaſionally uſed here.

EXAMPLE I. If the carriage of 100lb. weight for 30 miles coſt 2 ſhillings, what will the carriage of 500lb. coſt for 200 miles?

As 100lb. : 500lb. : : 2s. : (1ſt Anſwer.)

As 30 m. : 200 m. : : 1ſt Anſwer: (Anſwer required.)

Then $\frac{500\times2\times200}{100\times30}$ = $\frac{50\times2\times2}{3}$ = $\frac{200}{3}$ = 66s $\frac{2}{3}$ = 3l. 6s. 8d. = the Anſwer.

EXPLANATION. Here I ſay by the ſingle rule, as 100lb. is to 500lb. ſo is 2s. the value of the carriage of 100lb. for 30 miles, to the value of 500lb. for 30 miles.

Then, as 30 miles is to 200 miles, ſo is the firſt anſwer (or the value of 500lb. for 20 miles) to the value of 500lb. for 200 miles.

The firſt anſwer by the ſingle rule = $\frac{500\times2}{100}$: and the ſecond Anſwer therefore = $\frac{500\times2}{100}\times200\div30$ = $\frac{500\times2\times200}{100\times30}$ as above.

Or, ſince, from the nature of the queſtion, both the ſtatings are direct, therefore the firſt terms of each are diviſors, and the reſt multipliers; and hence the procedure is evident.

This mode is vaſtly ſuperior to that of working out the firſt ſtating by itſelf, not only becauſe there will be frequently a remainder in the firſt operation, which, if neglected in the ſecond, will ſometimes produce a material error in the required anſwer, or, if retained, will make the work very troubleſome and tedious, but, becauſe conſiderable advantages will often occur in this way, which cannot poſſibly happen in the other.

EXAMPLE II. If 68 men can build a wall in 27 days, when the day is 9 hours long, in how many days will 54 men build the ſame when the day is 17 hours long?

Men. Men. Days.

As 68 : 54 : : 27 : (1ſt Anſwer.)

Hours Hours

9 : : 17 : : 1ſt Anſwer (to true Anſwer.)

Then $\frac{68\times27\times9}{54\times17}$ = $\frac{4\times9}{2}$ = 2×9 = 18 days, the Anſwer.

Here both the ſtatings are inverſe; for, in the firſt ſtating it is evident, that 54 men muſt require a longer time for the doing of a piece of work than is neceſſary in caſe 68 men are employed; and therefore the fourth term, or anſwer, muſt be greater than the third, and of courſe will not have the ſame affection to it as the ſecond has to the firſt.

In the ſecond example it is plain, that when the day is 17 hours long, a piece of work will be done in fewer days, than when the day is only 9 hours long; and therefore the fourth term, or the required anſwer, muſt be leſs than the third term; or the time that 54 men can do a piece of work in, when the day is 9 hours long, ſuppoſed to be obtained by the firſt ſtating. Wherefore, this ſtating is alſo inverſe; and therefore 54 and 17 are the diviſors, and the reſt multipliers.

This queſtion is called a queſtion of the Double Rule of Three Inverſe. Sometimes one ſtating will be direct, and the other inverſe, and ſuch queſtions are alſo deemed inverſe; wherefore, ſince there is ſuch a difference in queſtions of this kind, this mode of ſolution, which diſcovers at once what ſtatings are

direct, and which are inverse, must be infinitely preferable to that ambiguous way (used by many authors) of placing all the five terms in one line, after a certain order; and then giving rules for operation, according as the question is conceived to belong to the direct or inverse rule; without considering whether an inverse question involves two indirect statings, or only one.

EXAMPLE III. If 24 students spend 64 pounds in 16 months, what sum of money will serve 9 students 8 months?

Stu. Stu. l.
As 24 : 9 :: 64 : (1st Answer.)
M. M.
As 16 : 8 :: 1st Answer: (required Answer.)

Then $\frac{9\times64\times8}{24\times16} = \frac{9\times4}{3} = 3\times4 = 12$l. the Answer.

SCHOL. Sometimes questions will occur wherein 3 or more statings are necessary, but the same method may be applied to all.

EXAMPLE IV. If the carriage of 150 feet of wood, that weighs three stone per foot, comes to 3l. for 40 miles, how much will the carriage of 54 feet of free stone, that weighs eight stone per foot, come to for 25 miles?

Feet Feet l.
As 150 : 54 :: 3 : (1st Answer.)
Stone Stone
As 3 :: 8 : 1st Answer. : (2d Answer.)
Miles Miles
As 40 : 25 :: 2d Answer. : (required Answer.)

Then $\frac{54\times3\times8\times25}{150\times3\times40} = \frac{54}{6\times5} = \frac{9}{5} = 1\frac{4}{5}$l. = 1l. 16s. the Answer sought.

Here all the statings are direct, as is evident on inspection, and therefore 150, 3, and 40, are the divisors, and the rest multipliers.

SCHOL. Sometimes the given numbers will be such as cannot be reduced at once to an answer, by this method of placing them in a fractional manner; but it will, nevertheless, be convenient to express them so at first, as they will be a guide to the future operation, and in most cases some advantages may be derived from it.

N. B. It is in this, as in the single rule, commonly necessary to reduce the 1st and 2d terms of each stating to one and the same denomination; and the third term (unless the rest of the numbers are such, that the operation may be performed without that trouble) must be reduced to the lowest denomination mentioned in it.

CHAPTER X.

SECT. I. INVOLUTION AND EVOLUTION.

DEFINITION I. If a number be multiplied certain times into itself, the result is called a Power of that number.

When a number is multiplied into itself once, the result is called the 2d Power; when twice, the 3d Power; thrice, the 4th Power; and so on; the number itself being always deemed the 1st Power, though usually named the Root.

The 2d Power is also called the Square; the 3d, the Cube; the 4th, the Biquadrate; the 5th, the Sur-solid; the 6th, the Square Cube, &c. of any number.

COROL. Hence, if it be required to find any Power of a given number, it is done by multiplying the same as often into itself as is denoted by the number of the Power, less 1.

Thus, the 3d Power of $16 = 16\times16\times16 = 4096$; the 4th Power thereof $= 16\times16\times16\times16 = 65,536$; and so for any Power of any other number.

DEFINITION II. The raising of a given number to any required Power, is called Involution; but if a certain Power of any number be given, and it be required to determine the 1st Power thereof, or the number or root from which the same was raised, then the art of performing this business is called Evolution, or the Extraction of Roots; and on this I shall solely insist through the following part of this Article.

Note. The Root of the 2d Power is called the Square Root; of the 3d Power, the Cube Root; of the 4th Power, the Biquadrate Root, &c.

TABLE OF POWERS.

1st Power or Root	2d Pow. or Square	3d. Pow. or Cube	4th Pow. or Biqua.	5th Pow. or Sur-Solid.	6th Pow. or Square Cube.	7th Pow. or 2d Sur-Solid.	8th Pow. or Square Cube.	9th Pow. or Cube Cube
1	1	1	1	1	1	1	1	1
2	4	8	16	32	64	128	256	512
3	9	27	81	243	729	2187	6561	19683
4	16	64	256	1024	4096	16384	65536	262144
5	25	125	625	3125	15625	78125	390625	1953125
6	36	216	1296	7776	46656	279936	1679616	10077696
7	49	343	2401	16807	117649	823543	5764801	40353607
8	64	512	4096	32768	262144	2097152	16777216	134217728
9	81	729	6561	59049	531441	4782969	43046721	387420489

SECT. II. TO EXTRACT THE SQUARE ROOT.

RULE I. Distinguish the given number into periods of two figures each, by putting a point over the place of units, another over the place of hundreds, another over the place of tens of thousands, &c. Also, if there are decimals, by placing a point also over the hundredths place, another over the ten thousandths place, &c. annexing a cypher, if requisite, to make the periods complete. Then there will be as many figures in the Root as there are periods; and the periods of decimals denote the number of decimals in the Root.

II. Find by the Table a square number, either equal to, or the next less, than the first period to the left hand, and put the root of it to the right hand of the given number, in manner of a quotient, and it will be the first figure of the root required.

III. Subtract the square number, found as above, from the first period, and to the remainder bring down the next period for a resolvend or dividend; and, on the left thereof, write the double of the quotient figure for a divisor; and see how oft it is contained in the resolvend (excluding the last figure.)

IV. Annex the answer to the quotient figure, and also to the divisor, multiplying the same, thus augmented by this last quotient figure, and subtracting the product from the whole resolvend.

V. Then to the remainder bring down the next period, for a new resolvend; double the whole quotient for a divisor, annexing thereto the next figure of the root; and thus proceed unto the end; observing, that if at any time the product of the last quotient figure, and the augmented divisor, be greater than the resolvend, a less figure must be taken in lieu thereof, and placed in the quotient.

Note. If, after all the figures in the dividend have been brought into the operation, there should still be a remainder, and it is required that the answer should be had to a greater degree of accuracy, then annex a pair of cyphers to the remainder, and proceed to find another figure, (which will be a decimal;) do the same to the next remainder, and so on, till there are as many decimal figures in the root as is requisite.

Note, also, That when half the desired number of figures are had in the root, the rest may be found by dividing by the double of the root (according to the short method of leaving out a figure in the divisor each time) without being at the trouble of obtaining new divisors, or annexing to the remainders any more periods of figures. And it is further observable, that instead of doubling the root each time for a divisor, the last quotient figure may all along be added to the former divisor.

EXAMPLE I.

What is the square root of 327286.9681?

OPERATION.

Root. 572.09

327286.9681 (572.09
25
107)772
7)749
1142)2386
2)2284
114409)1029681
1029681
.....

EXAMPLE II.

What is the square root of 10?

OPERATION.

10.000000(3.16227
9
61)100
1)61
626)3900
6)3756
632)144000
1264
176
127
49
44
5

Here, in the first example, I point off the given number into pairs, both ways from the unit figure (6.) Then I find that the greatest square number under 32 is 25, which I place under 32, and the root 5 in the quotient, doubling the same for a divisor. Then bring the next period (27) down for a dividend, and perceive that the next quotient figure will be 7, which I therefore annex to the root, and to the divisor, placing the product of the whole divisor by 7 under the dividend, subtracting it therefrom, and bringing down the next period. Then I add the last quotient figure to the former divisor, (or, which is the same, double the whole quotient,) and it becomes 114. I observe that the next figure in the root will be 2, which I annex to the divisor, and to the quotient; and thus I proceed to the end, and find the root to be 572.09.

The second example is wrought in like manner, only there, after three figures are had, I divide by the double of the quote; and, as I do not include the last root figure, I cut off one figure from the last period brought down, and so, with very little trouble, I obtain three more figures. If, in the last divisor, I had included the quotient figure, I should then have got four figures more in the root.

SCHOL. The square root of a vulgar fraction is found by extracting the square root of the numerator for a new numerator, and the square root of the denominator for a new denominator. Thus the square root of $\frac{4}{9} = \frac{2}{3}$. The truth of this is evident, for $\frac{2}{3}$ squared $= \frac{2}{3}\times\frac{2}{3} = \frac{4}{9}$; or, if it is desired that either the numerator or denominator of the root shall be the same as that of the given fraction, then multiply the numerator and denominator together, and extract the square root of the product, which will be the respective denominator or numerator of the required root. Thus,

Thus, in the former example, if it is required that the numerator of the root ſhould be the ſame as that of the given fraction, namely, 4,

Then, $4\times 9=36$, the ſquare root of which is 6; and $\frac{4}{9}$ is the fraction required: or, if it is required to have the ſame denominator, then $\frac{6}{9}$ is the root required. The truth of this proceeding is evident; for $\frac{4}{9}$, and $\frac{6}{9}$, are each $=\frac{2}{3}$, the former root: or, it may be proved thus; $\frac{4\times 4}{9\times 4}=\frac{16}{36}$; and therefore the ſquare root of $\frac{4\times 4}{6\times 4}$ is of courſe $=$ ſquare root of $\frac{16}{36}$.

Alſo, $\frac{4\times 9}{9\times 9}=\frac{36}{81}$; and therefore the ſquare root of $\frac{4\times 9}{9\times 9}=$ ſquare root of $\frac{36}{81}$.

In the former caſe, the ſquare root of the numerator is equal to the given numerator; and in the latter, the ſquare root of the denominator is equal to the given denominator.

This method, therefore, will ſave the extraction of one of the terms of the given fraction. However, in general, it will be better to reduce the given fraction to a decimal, and then extract its root.

SECT. III. TO EXTRACT THE CUBE ROOT OF A GIVEN NUMBER.

Rule I. Point off the given number into periods of 3 figures each, placing a point over the unit's figure, and one upon every 3d figure, both to the right and left thereof, if there are decimal figures in the given number.

II. Find the greateſt cube contained in the firſt period, and ſubtract it therefrom, placing the root in the quotient, and annexing the next period to the remainder for a reſolvend.

III. Divide the ſaid reſolvend (excepting the two laſt figures of the period annexed) by three times the ſquare of the quotient figure, which will generally give the next figure of the root, though ſometimes, in this firſt inſtance, it will prove too big.

IV. Having placed the figure in the quotient, multiply the ſame by thrice the figure of the root, and write the product under the diviſor before uſed; in ſuch order, that the ten's place thereof may ſtand under the unit's place of the other: alſo ſquare the laſt figure, and place this under the product, ſo that the ten's place (if any) may ſtand under the unit's place of the product; ſo will the ſum of the three rows in the order they ſtand, be a more correct diviſor.

V. Divide the whole of the above reſolvend by this diviſor, and to the remainder bring down the next period.

VI. Divide this (leaving out the two laſt figures as before) by 3 times the ſquare of the root, already found, and place the figure in the quotient, adding to ſuch diviſor, the product of thrice the laſt mentioned root, by this figure, together with the ſquare of the ſaid figure; but placed in the ſame order as is deſcribed as above, for finding the laſt correct diviſor; then the ſum will be another correct diviſor.

VII. Divide the laſt reſolvend by this diviſor, and to the remainder bring down the next period, proceeding to find another figure of the root, and a correct diviſor as before, and ſo on to the end; when, if there be ſtill a remainder, and more exactneſs be required, annex to the remainder three cyphers, and repeat it till as many decimal figures are obtained as is requiſite.

Example. What is the cube root of 67507.82424?

Operation.

Root
67507.824240(40.717
64
$3\times 4^2=48$) 3507 Reſolvend
$3\times 40^2=4800$
$7\times 3\times 40=840$
$7^2=49$
Diviſor 488449) 3507824 Reſolvend
3419143
$3\times 407^2=496947$
$1\times 3\times 407=1221$
$1\times 1=1$
Diviſor 497068911) 88081240 Reſolvend
49706911
$3\times 4071^2=49719123$
$7\times 3\times 4071^1=85491$
$7^2=49$
Diviſor 4972767259) 38974329000 Reſolvend
34809370813
4164958187 Remainder.

Here, by annexing more cyphers, and continuing the operation, the anſwer may be had to any degree of accuracy. But when a few figures are got, as many more may be had true in the root without changing the diviſor; and there need not to be more figures taken in the diviſor, than there are figures already in the root; and a figure may be cut off each time, as has been before taught, which renders the work exceeding ſhort.

Thus, in the above example, having the laſt reſolvend 38974329000, the diviſor 4972767259, and 40.71 the root, there may be cut off from the diviſor and dividend, ſix figures each, and four more figures will be had correct in the root, with very little trouble; as follow,

Diviſor Reſolvend
4972|767259)38974|329000)7817
34809|
4165
3978
87
50
37
35
2

The 4 figures obtained as above, being annexed to 40.71, make the root 40.717817, true to 8 figures, and the laſt 4 being obtained with great facility.

N. B. If the firſt 4 figures of thrice the ſquare of the root had been uſed for the diviſor, it would have been ſufficient; at leaſt, it would give three more places correct, and not have differed from the truth above 1 in the fourth figure.

SECT. IV. A GENERAL METHOD OF EXTRACTING THE ROOTS OF ALL POWERS.

Rule I. Prepare the given number for extraction, by pointing it off from the unit's place into periods; each of which muſt contain as many figures as is denoted by the number, expreſſing the name of the power.

II. Find the firſt figure of the root by trial, take the difference between the power thereof, from the given number, and to the remainder bring down the firſt figure belonging to the next period for a dividend.

III. Involve the root to the next inferior power to that which is given, and multiply it by the number, denoting the given power for a diviſor.

IV. Find how many times the diviſor may be had in the dividend, and the quotient will be another figure to be added or ſubtracted to the root, according as the former was leſs or greater than the truth.

V. Involve the whole root to the given power; take the difference between it and the given number, and annex thereto the firſt figure of the next period for a new dividend; finding a diviſor as before, and proceeding thus till the operation is finiſhed.

N. B. When a few figures are had in the root, the next diviſor will give near as many more, without the trouble of renewing the operation.

Example. What is the biquadrate root of 19987173376?

Operation.

19987173376 — 4.. Root too great
$4^4=256$ ..... — -2. leſs, quote
Diff. 5612826624 — 38. Root ſtill too great
Diviſ. $=4\times 4^3=256$) 561 Divid. (2. quo — —3. 93 leſs, quote.
376.07 Root.
19987173376 Given number
$38^4=2085136$ ...
Diff. 864186624
Diviſ. $=4\times 38^3=219|968)864|186$ dividend (3.93 quote.
660
204
198
6
6

Here the aſſumed root being more than juſt, the quotient figure (2) is to be ſubtracted. Alſo I find by involution that 380 is too great, and therefore the next quotient figures are alſo to be ſubtracted.

I venture to take 3 figures the next operation, which being ſubtracted from the former, leaves 376.07 for the root; therefore I doubt not but 376. is either the true root or very near it; and on involving the ſame I find it to be the root required. So by only two ſhort operations, the root of the fourth power is had true to four figures, erring only in the fifth.

N. B. The biquadrate root may be found by firſt extracting the ſquare root, and then the ſquare root of that root; the ſquare cube root may be found by extracting the ſquare, and then the cube root; the root of the 8th power may be reſolved in 3 ſquare roots; that of the 9th power into two cubes, &c.

Note alſo, Any root of a vulgar fraction is had by extracting the root of both numerator and denominator. But it is better to throw it into a decimal, and then extract it.

SECTION V.

A GENERAL METHOD WHEREBY THE ROOTS OF ALL POWERS MAY BE READILY APPROXIMATED.

Rule. Find the neareſt root of the firſt period (whether the ſame be greater than the truth or leſs) and multiply the power thereof by the number denoting the name of the next higher power; alſo multiply the given number by the number denoting the name of the next inferior power, and add theſe two products together. Then as this ſum is to the difference between the given number and the power of the ſaid root (cyphers being annexed to fill up the vacant periods) ſo is twice the root to the

correction, which must be added to the root, if the root was less than just, but subtracted if greater.

N. B. In all odd powers, as the next greater and next less are denoted by even numbers, the given number and the power of the root may be multiplied by only half those numbers, or, which is the same, the power of the root must be multiplied by the greater half of the number denoting the name of the power; and the given number by the less half thereof; and then, instead of twice the root, the root only must be taken for the 3d term.

The first term of the proportion for the cube root will therefore be twice the cube of the assumed root, added to the given number; for the sur-solid root, it will be thrice the 5th power of the assumed root, more twice the given number; for the root of the 7th power, it will be four times the 7th power of the supposed root added to thrice the given number, and so on.

EXAMPLE. Let it be required as before, to extract the cube root of 67507.82424. Here 4 is the nearest root of the first period, which, as the root will consist of 2 figures of whole numbers, must be called 40, and the operation will stand thus:

The given number 67507.82424 Given numb. 67507.82424
Thrice nearest cube 128000 Supposed cube 64000.
(Sum) 195507.82424 Difference 3507.82424

As 195507.82424 : 3507.82424 :: 40 : (Correction)

40

1955|07.82&c.) 140312.96960 (.7177 nearly
13685
346
195
151 1st Root 40.
137 Correction + 7177
14 Answer 40.7177
14

Note, Here the answer at the first operation errs only 1 in the sixth figure, and if the operation be repeated it will give the answer true to 17 or 18 places. Note also, the first operation will in any case give 3 or 4 true figures, and the next operation will treble the number.

THE INVESTIGATION OF THE FOREGOING RULE.

Let the number denoting the power to be extracted be n, and the given number a; or, which is the same, let the $\frac{1}{n}$th root of a be required. Also put $x =$ the true root, and let r be a supposed root taken near to x (the nearer the better;) v, being the excess or defect, so will $r \pm v = x$. Then $\overline{r \pm v}^n = a$; and by the binominal theorem $\overline{r \pm v}^n = r^n \pm nr^{n-1}v + n.\frac{n-1}{2}.r^{n-2}v^2 \pm$ &c. which terms for an approximation are sufficient. Then $\pm nr^{n-1} + n.\frac{n-1}{2}r^{n-2}v \times v = a - r^n$, and $\frac{a - r^n}{\pm nr^{n-1} + n.\frac{n-1}{2}r^{n-2}v} = v$; but $\frac{a-r^n}{\pm nr^{n-1}}$ is also an approximate of v, therefore $v = \frac{a-r^n}{\pm nr^{n-1} + n.\frac{n-1}{2}r^{n-2} \times \frac{a-r^n}{\pm nr^{n-1}}} =$

$$\frac{\pm anr^{n-1} \mp nr^{2n-1}}{+n^2r^{2n-2} + n.\frac{n-1}{2}.r^{n-2} \times a - r^n} = \frac{\pm ar \mp r^{n+1}}{nr^n + \frac{n-1}{2} \times a - r^n} =$$

$$\frac{\pm ar \mp r^{n+1}}{\frac{n+1}{2}r^n + \frac{n-1}{2}.a} = \frac{\pm 2ar \mp 2r^{n+1}}{n+1.r^n + n-1.a} = \frac{\pm a \mp r^n}{n+1.r^n + n-1.a} \times 2r$$

$= \frac{a \mp r^n}{n+1.r^n + n-1.a} \times 2r$; which resolved into a proportion, we have, As $n+1.r^n + n-1.a : a \mp r^n :: 2r : v$, the correction to be added to or subtracted from r, according as r is taken less or greater than x, which proportion in odd powers may be reduced, as has been before shewn.

If a Theorem is wanted, that shall give x at once, then $r \pm \frac{\pm 2ar \mp 2r^{n+1}}{n+1.r^n + n-1.a} = x =$ (in either case)

$$\frac{n-1.r^{n+1} + n+1.ar}{n+1.r^n + n-1.a} = \frac{n+1.a + n-1r^n}{n+1.r^n + n-1.a} \times r$$, and hence as

$n+1r^n + n-1.a : n+1.a + n-1r^n :: r : x$.

In words thus, assume a number, near to the root, whether greater or less than the same; then to the number denoting the power to be extracted, add 1, and multiply the sum by the power of the assumed root; also from the number, denoting the said power, subtract 1; and multiply the difference by the given number; and add the two products together, for the first term of the proportion.

Likewise, multiply the former sum by the given number, and likewise the aforesaid difference by the power of the assumed root, and add these two products together, for the second term in the proportion

Then the 3d term will be the assumed root, and the 4th term or answer will be a nearer value of the root, containing thrice the number of figures that were true in the root before.

In odd powers, the proportion may be reduced by dividing the first and 2d terms by 2; and so, in the cube root, the first term will be twice the cube of the supposed root, added to the given number; and the 2d, twice the given number added to the cube of the supposed root: in extracting the root of the fifth power, the first term will be 3 times the 5th power of the supposed root, added to twice the given number; and the second term, three times the given number, more twice the fifth power of the assumed root.

In the root of the 7th power, the first term will be 4 times the 7th power of the assumed root, more 3 times the given number, and the second term, 4 times the given number added to 3 times the 7th power of the supposed root, and so on.

A rule for the cube root, agreeing with this latter method, has been given by some authors; but I know of none who have investigated one general proportion, for approximating the roots of all powers.

Mr. Burrow, late mathematical master at the Tower, to whom I was formerly assistant, made some attempts; but the method that he took, though a gentleman of excellent abilities, was not well adapted to the purpose; for after all that he did in this business, the matter was still left to be guessed at; and, in many cases, it would require fifty times the trouble to ascertain a fit proportion for extracting the roots of a *particular Power*, that I have been at in investigating and giving two general Proportions for extracting the Roots of *all Powers*.

The first of these methods will be found to have the preference in point of expedition; as by the latter method a longer division (by $\frac{1}{3}$ part) must be used, than is necessary in the former.

SECT. VI. ANOTHER NEW METHOD FOR EXTRACTING THE CUBE ROOT.

RULE. Find the nearest root of the first period, whether greater or less than the truth, and thereto annex cyphers to supply the vacancy of the remaining figures to be had in the root. Divide the difference between four times the number to be extracted, and this root (so ordered) by thrice the said root. Then the square root of the quotient, added to the assumed root, will be equal to twice the required root; or such root may be taken for a new operation, if more accuracy is wanted.

N. B. This method is entirely new, having invented it also myself: it is an easy Rule to be remembered, and will nearly treble the number of true figures in the root, at each operation.

EXAMPLE. What is the cube root of 7892485271?

7892485271 | 2000 = nearest root.
4
31569941084 = 4 times given number
8000000000 = cube of nearest root

Thrice nearest root = 6000) 23569941|084 = difference

. . . . .
3928323.514 | 1982 = square root
1 | 2000 = assumed root
29 | 292 | 2 | 3982 = sum
9 | 261 | 1991 = cube root req.
388 | 3183
3104
79
78
1

CHAPTER XI. BARTER.

DEFINITION. Barter is the exchanging of one commodity for another in trade, so as neither party may sustain loss thereby.

RULE I. Find the value of that commodity, whose quantity is given, and find also what quantity of the other, at its proposed rate, will amount to the same money: then so much of the latter commodity must be given for the former.

RULE II. When one commodity is advanced above the ready money price, find the advanced price of the other in the same proportion; and then proceed as above.

EXAMPLE I. How much sugar at 8d. per lb. must be given for 16 cwt. of tobacco at 5l. per cwt.?

Here 16 cwt. of tobacco at 5l. per cwt. comes to 80l. then say, As 8d. : 80l. (or 19200 pence) :: 1 : (Answer.)

Therefore $\frac{19200}{8} = 2400$lb. of tobacco, or 21 cwt. 1qr. 20lb. the Answer.

EXAMPLE II. A and B barter with each other. A hath 200 yards of cloth at 6s. 8d. per yard, ready money, but in barter he will have 8s. per yard. B has hops at 1l. 14s. per cwt. ready money. How many cwt. of hops must B give A for his cloth, so that his gain in the barter may be equal to A's?

As 6s. 8d. (or 80 pence) : 1l. 14s. (408 pence) :: 8s. : (price of hops in barter.)

Then $\frac{408 \times 8}{80} = 40.80$s. the price which B's hops must be charged at per cwt. in barter. Also A's 200 yards of cloth at 8s. comes to 80l.

And

And as 40.8s. : 80l. (or 1600s.) : : 1 cwt. : (the anſwer).

Therefore $\frac{1600}{40.8}=\frac{200}{5.1}$=39 cwt. 0 qr. 24$\frac{5}{17}$ lb. the anſwer required.

QUEST. III. Two merchants, A and B, barter with each other. A has 460 yards of broad cloth, worth 9s. 2d. per yard, but in barter he will have 11s. per yard. B has coffee at 2s. per lb. for which he charges 2s. 6d. How much coffee muſt A receive for his cloth, and what does he gain or loſe by the bargain?

Here A's cloth, at 11s. per yard, comes to 5060s.

And as 2s. 6d. (or 2.5) : 5060 : : 1lb. : to the quantity of coffee, which A muſt receive.

Therefore $\frac{5060}{2.5}=\frac{1012}{.5}$= 2024lb. = the pounds of coffee, which B muſt give A for his cloth.

Now, to find the gain or loſs of either party in this tranſaction.

As 9s. 2d. (or 110d.) : 2s. (or 24d.) : : 11s. : the value that B's coffee ought to be charged at per lb. ſo as neither to gain nor loſe,=2.4s. And therefore, as 2.4s. : 5060s. : : 1lb. the quantity of coffee which B ought to give A for his cloth,= $\frac{5060}{2.4}=\frac{1265}{.6}$=2108$\frac{1}{3}$lb. But B only gives A 2024lb. and therefore he ſaves 84$\frac{1}{3}$lb. which at 2s. per lb. the prime coſt of the coffee, comes to 8l. 8s. 8d. the gain of B by this bargain. And ſo much alſo A loſt.

CHAPTER XII. FELLOWSHIP.

I. Fellowſhip is a general rule by which merchants, tradeſmen, &c. in company, determine each perſon's particular ſhare of the gain or loſs in proportion to his ſhare in the joint ſtock.

II. Fellowſhip is either double or ſingle.

III. Single Fellowſhip is when each perſon's ſtock is employed during one and the ſame given time.

IV. Double Fellowſhip is when the different ſtocks are employed for unequal portions of time.

SECT. I. OF SINGLE FELLOWSHIP.

RULE. As the whole ſtock is to the whole gain or loſs, ſo is each man's particular ſtock to his particular ſhare of the gain or loſs.

QUEST. I. A and B have gained by trading 160l. A put into ſtock 300l. and B 500l. what is each perſon's ſhare of the gain?

Here the whole ſtock is 800l. And as 800l. : 160l. : : 300l. : to the ſhare of A = $\frac{160\times300}{800}=\frac{2\times300}{10}=\frac{2\times30}{1}$= 60l. Alſo, as 800l. : 160l. : : 500l. : to the ſhare of B= $\frac{160\times500}{800}=\frac{2\times500}{10}=\frac{2\times50}{1}$=100l.

Moreover 60l. the gain of A, added to 100l. the gain of B, makes 160l. the whole gain, which ſhews that the work is right.

SCHOL. I. After the gain or loſs of one perſon is found, the reſt may be found without uſing the whole gain or loſs, and the whole ſtock, by ſaying, as that perſon's ſtock is to his gain, or loſs, ſo is any other's perſon's ſtock to his gain, or loſs, and it will frequently happen that, by this method, the different anſwers will be obtained in a ſhorter way than by adhering ſtrictly to the foregoing rule, eſpecially if care be taken to embrace every contraction that may preſent itſelf in the operations, as deſcribed in the Rule of Three.

SCHOL. II. When it does not appear that the method pointed out in the laſt ſcholium will be attended with any advantage; then when there are many joint ſtocks to ſettle, or caſes of bankruptcy, &c. it will be a good way to find the gain or loſs upon 1l. which is done by dividing the whole gain by the whole ſtock. Then multiply the quotient by each man's particular ſtock, and it will give his particular ſhare of the gain or loſs.

This method will ſave a repetition of diviſions; and the multiplications may alſo be ſhortened by beginning with the ſmalleſt ſhare firſt; for then the next may be wrought by multiplying the ſaid quotient by the difference between that and the former ſtock, and adding the product to the former; and the next, by multiplying by the difference between that ſtock and the preceding, and adding the product in like manner to the preceding ſhare, and ſo on; always going forward to the next greater ſtock.

Thus, in the laſt example, the gain of 1l. ſtock = $\frac{160}{800}$= 1l. And 300×.2=60l.=gain of A. Alſo, 200 (or 500 −300)×.2=40l. and 60+40=100l.=gain of B.

QUESTION II. Four perſons in partnerſhip, A, B, C, and D, put into ſtock 360l. 480l. 700l. and 860l. reſpectively, for a certain time, at the end of which they have gained 396l. what is each perſon's ſhare of the gain?

£.		£.	£.	£.	£. Share.
360 = A's ſtock.	Then, As	2400	: 3960 : : 360 :		594=A's
480 = B's.	As	3	: 4 : : 594 :		792=B's
700 = C's.	As	24	: 33 : : 792 :		1155=C's
860 = D's.	As	35	: 43 : : 1155 :		1419=D's
2400 = Whole ſtock.			Whole gain		3960 Proof

EXAMPLE III. Four men, A, B, C, and D, bought a caſk of ale for 20 ſhillings, and agreed that each man's part of the purchaſe ſhould be as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{1}{6}$, reſpectively; what muſt each pay?

Here the fractions, reduced to the leaſt common denominator, are $\frac{30}{60}$, $\frac{15}{60}$, $\frac{12}{60}$ and $\frac{10}{60}$; and, conſequently, the ſhares will be as 20, 15, 12, and 10, reſpectively.

Then 20+15+12+10=57.

			s. d. f.		s. d. f.
And, As 57	: 20	: :	20 0 0	: to the ſhare of A=	7 0 0$\frac{42}{57}$
As 4	: 3	: :	7 0 0$\frac{42}{57}$	ſhare of B=	5 3 0$\frac{15}{57}$
As 5	: 4	: :	5 3 0$\frac{15}{57}$	ſhare of C=	4 2 1$\frac{14}{57}$
As 2	: 1	: :	7 0 0$\frac{42}{57}$	ſhare of D=	3 6 0$\frac{14}{57}$
					20 Proof

EXAMPLE IV. Five men trade together, and compoſe a ſtock of 823l. 15s. A put in 96l. 10s. B, 108l. 5s. C, 162l. 6s. D, 196l. 6s. and E, 260l. 8s. and their whole gain is 98l. 17s. What is each man's part thereof?

Here the whole gain, 98.75l. being divided by the whole ſtock, gives .12l. for the gain of 1l. which therefore will be a common multiplier. Then,

l.		l.	l.	s.	d.		
96.5		11.58	= 11	11	7	.8	= A's ſhare.
108.25		12.99	= 12	19	9$\frac{1}{2}$	.4	= B's.
162.3	×.12 =	19.476	= 19	9	6	.96	= C's.
196.3		23.556	= 23	11	1$\frac{1}{2}$	.76	= D's.
260.4		31.248	= 31	4	11$\frac{1}{2}$	.08	= E's.
823.75		£	98	17	0 Proof.		

SCHOL. III. If the whole ſtock, and each man's gain or loſs be given to find the particular ſtock of each, then ſay, as the whole gain is to the wole ſtock, ſo is each man's gain to his ſtock.

SECT. II. OF DOUBLE FELLOWSHIP.

RULE. Multiply each man's ſtock by the time of its being in trade, and add the ſeveral products into one ſum; then ſay, as that ſum is to the whole gain or loſs, ſo is the product of each man's ſtock and time, to his part of the gain or loſs.

EXAMPLE I. Three merchants, A, B, and C, enter into partnerſhip: A put in 60l. for 4 months: B, 50l. for three months: C, 30l. for 2 months: and the whole of the gain is 60l. What is each man's part thereof?

l.		l.	l.	
60×4=240	Then, as	450 : 60 : : 240 :	32	= A's ſhare.
50×3= 50		450 : 60 : : 150 :	20	= B's.
30×2= 60		450 : 60 : : 60 :	8	= C's.
£ 450			£ 60	Proof.

SCHOL. I. When there are many in partnerſhip, it will expedite the work to divide the whole gain or loſs by the ſum of the products of each man's ſtock and time, and multiply the reſpective quotients by each of ſuch products, and the reſults will be the ſeveral anſwers required. And this way alſo may be frequently rendered ſhorter, by beginning with the leaſt product, and proceeding according to the differences as ſtated in SCHOL. II. of Single Fellowſhip: or, having calculated one's ſhare, you may ſay, as the product of his ſtock and time is to the product of any other man's ſtock and time, ſo is the gain or loſs of the former partner to the gain or loſs of the latter.

SCHOL. II. When the whole ſtock, the time of each man's continuing in partnerſhip, and the gain or loſs of each is given, to find the proper ſtock of each, it may be done thus:

Divide each man's gain by the time, and add the ſeveral quotients into one ſum. Then ſay, as the ſum of the quotients is to the whole ſtock, ſo is each quotient to the correſponding ſtock; or find by Problem IV. of Fractions, the leaſt number that is diviſible by each man's time, and let the ſame be ſeverally divided by each ſuch time accordingly. Alſo multiply each of the reſpective quotients by the correſponding gain or loſs, and add all the products into one ſum, noting diſtinctly to what perſon each relates; then ſay, as the whole gain or loſs is to the ſaid ſum, ſo is each product to the correſpondent ſtock, or to the ſtock of ſuch partner as the product in operation had a reference to.

N. B. This latter method will be preferable, when there is a remainder in dividing any of the gains by its time.

EXAMPLE II. Three perſons, A, B, and C, hire a piece of land for 6l. 10s. To which ſum A contributed 11l. 5s. B, 20l. and C, 29l. 5s. Now they propoſe to ſtock the ſame with oxen, and that A's oxen ſhall be at paſture for 4$\frac{1}{2}$ months; B's for 5 months; and C's, for 6$\frac{1}{2}$ months. The number of oxen to be fed is 22. How many muſt each man put to graſs?

Here the times are 9 half months, 10 half months, and 13 half months, reſpectively; and the leaſt number which is diviſible by each of them=9×10×13. And therefore the multiplier in the caſe of A, is $\frac{9\times10\times13}{9}$=10×13=130; in that of B is $\frac{9\times10\times13}{10}$=9×13=117; and in that of C, is $\frac{9\times10\times13}{14}$= 90. Then

			Oxen
11.25×130=1462.5	And, as	6435 : 22 : : 1462.5 :	5=A's
20×117=2340.		6435 : 22 : : 2340 :	8=B's
29.25×90=2632.5		6435 : 22 : : 2632.5 :	9=D's
6435			22 Proof

CHAP. XIII. ALLIGATION, &c.

Alligation teacheth how to mix ſimples of different qualities, ſtrengths, values, or rates, ſo that the compoſition may be of ſome intermediate quality, ſtrength, or value.

Alligation is of four kinds, viz. Medial, Alternate, Partial, and Total.

I. Alligation Medial, is the method of finding the rate of the compound, from having the rates and quantities of the ſeveral ſimples given.

II. Alligation Alternate teaches, by knowing the rate of the compound, and the rates of the ſimples of which it is compoſed, to find the proportional quantities of each ſort, to form ſuch a mixture.

III. Alligation Partial is when the rates of the ſimples, the rate of the compound, and the quantity of one (or more) of the ſimples to be mixed, are given to find the ſeveral quantities of the reſt of the ſimples.

IV. Alligation Total is when the rates of the ſimples, the rate of the compound, and the quantity of the compound are given, to find the reſpective quantities of the ſimples uſed in making that quantity of the compound.

SECT. I. OF ALLIGATION MEDIAL.

RULE. Multiply each quantity by its rate; and divide the ſum of the products, by the ſum of the quantities, (or whole compoſition) and the quotient will be the rate of the compound required.

EXAMPLE. A Vintner would mix together 80 gallons of malaga, at 8s. per gallon; 50 gallons of ſherry, at 5s. 6d. per gallon; 32 gallons of canary, at 7s. per gallon; and 29 gallons of white wine, at 4s. 6d. per gallon: how muſt the mixture be ſold?

Here,
8s. × 80 = 640
5·5 × 50 = 275
7· × 32 = 224
4·5 × 29 = 130·5
191 1269·5

191) 1269·5 (6s.
1146
123·5
12
191) 1482. (7
1337
145
4
191) 580 (3
573
7

Anſwer, 6s. 7¾d. and $\frac{7}{191}$ of a farthing.

SCHOL. When in the given quantities there are fractional parts, it will be convenient before you commence the operation, to reduce them all to fractions having the leaſt common denominator.

Then the denominators, being common, may be rejected, and the operation carried on with the numerators, as though they were given whole numbers.

SECT. II. OF ALLIGATION ALTERNATE.

RULE I. Set down the rates of the ſimples in a column under each other; and write down the rate of the compound oppoſite the middle of the column, and on the left thereof.

II. Connect, or link with a crooked or curve line, the rate of each ſimple, which is leſs than that of the compound, with one or any number of thoſe that are greater; and link each greater rate with one, or any number of the leſs.

III. Write down the difference between the rate of the compound, and that of each ſimple, oppoſite the rate to which it is linked.

IV. Then if only one difference is found oppoſite any rate, it will be the quantity belonging to that rate; but, if there be ſeveral, their ſum will be the rate.

N. B. Queſtions of this kind admit of innumerable anſwers, and are of the ſame nature with thoſe under the head of *Indeterminate Problems*, in the Syſtem of ALGEBRA.

Therefore to obtain more anſwers than the above rule will give, take, inſtead of the differences belonging to any couple of rates, any multiple thereof, whatever.

Do this with as many couple of rates, as you pleaſe; through which there will be had a new ſet of differential numbers, exhibiting freſh anſwers. And thus by repeating the operation with different multiples, any number of anſwers may be derived; for the variety is infinite, or in general (though it may ſeem a paradox) infinitely infinite, or an infinity of infinity.

EXAMPLE. How much ſherry at 2s. 3d. canary at 2s. 9d. and port at 1s. 2d. per quart, muſt be taken to form a compound of the value of 1s. 6d. per quart?

Pence

18 | 33 27 14 | 4 4 9 15 | 4 = quantity of canary; 4 = ditto ſherry; 24 = ditto port

Hence, to make the mixture, there may be taken 4 quarts of canary, 4 quarts of ſherry, and 24 of port, or any quantities in thoſe proportions; or, if the differences of either, or both the couples be multiplied by any aſſigned number, other proportions will be had that will ſatisfy the inquiry, even (by repetitions) to a number greater than any aſſignable one.

Thus, if the differences 4 and 15, belonging to 33 and 14, be doubled, then the proportions will become 8, 4, and 39, reſpectively; if trebled, they will be 12, 4, 54; and ſo on, the proportions ever varying as a different multiple is applied.

Again, if the differences 4 and 9, belonging to 27 and 14, be doubled, and not the other, then the proportions will be 4, 8, and 33, reſpectively; if trebled, they will be 4, 12 and 42, and ſo on for any other multiple.

Therefore, it is evident, that this Example admits of an infinitely infinite variety of proportions.

SECT. III. OF ALLIGATION PARTIAL.

RULE. Find the proportions as for Alligation Alternate; then ſay, as the difference or proportionate number, belonging to the ſimple or ingredient, whoſe quantity is given, is to the difference or proportionate number, belonging to any other ſimple, &c. ſo is the quantity of the former ſimple, &c. to the quantity of the latter.

And thus the quantities of each ſimple may be found ſo as to form the propoſed compound, when the quantity of one of the ſimples is given.

If the quantities of two or more ſimples are given, and it is required to determine the quantities of ſeveral others ſo as to form a given compound, then by Alligation Medial find the quality, rate, or value of a mixture compoſed of the ſimple, whoſe quantities are given, and ſubſtitute the whole of the ſame, inſtead of the ſaid given quantity; and ſo they will be reduced, as it were, to one ingredient, whoſe quantity and rate, or value, &c. is given; and therefore, the unknown quantities will be found by the preceding rule.

QUESTION. What quantity of gold of 15, of 17, and of 22 carats fine, muſt be mixed with 6 oz. of 18 carats fine, ſo that the compoſition may be of 20 carats fine?

20 | 15 17 22 18 | 2 2 5,3,2 2 | 2 2 10 2

Then as 2 : 6 : : 2 : 6 oz. of 15 carats fine
2 : 6 : : 2 : 6 do. of 17 ditto
2 : 6 : : 10 : 30 do. of 22 ditto

Hence there muſt be 6 oz. of 15 carats fine, 6 oz. of 17 carats fine, and 30 oz. of 22 carats fine, mixed with the 6 oz. of 18 carats fine.

N. B. If the quantities of two had been given, as for inſtance, if not only the 6 oz. of 18 carats fine had been given, but alſo the 6 oz. of 15 carats fine, then by the firſt rule they are reduced to 12 oz. of 16½ carats fine.

When the queſtion is reduced to this, viz. to find how many ounces of 17 carats fine, and 22 carats fine, muſt be mixed with 12 oz. of 16½ carats fine, ſo that the compoſition may be of 40 carats fine; and the anſwer is 12 oz. of 17 carats fine, and 39 of 22 carats fine; which numbers, though different from the former, do equally anſwer the conditions of the queſtion; for if, inſtead of the differences belonging to the couplet 17 and 22, the double thereof had been taken in the former caſe (which, according to the rule, would have been equally right) then the numbers in the firſt anſwer would have been the ſame as in this; or, if in the latter caſe, the ſame differences had been multiplied by ½, or which is equivalent, if the half thereof had been taken, inſtead of working with the whole, then the numbers in this anſwer would have been the ſame as in the former.

But note, if after the ſeveral ingredients are reduced to one as above, that the rate or value thereof, together with the ſeveral rates or values of the reſt of the compounds, be all either above or below the propoſed rate or value of the whole compound, then the caſe is impoſſible.

This method of proceeding, when the quantities of two or more ſimples are given, I have not ſeen exemplified elſewhere.

SECT. IV. OF ALLIGATION TOTAL.

RULE. When the ſum of all the quantities to be mixed is given, add up all the differences, or proportionate numbers together; then ſay, by the Rule of Three, as that ſum is to the whole given quantity, ſo is each particular difference or proportionate number to its reſpective quantity.

QUESTION. A goldſmith has gold of different ſorts, viz. of 24, 23, 22, and 21 carats fine, reſpectively, as alſo a quantity of alloy, from which he wants to make a maſs of 200 oz. that ſhall be 20 carats fine; how much of each ſort muſt he take?

20 | 24 23 22 21 0 | 20 20 20 20 4,3,2,1 | 20 20 20 20 10 | 90

Then, as 90 : 200 : : 20 : 44 4/9 oz. which is the quantity that the goldſmith muſt take of 24, 23, 22, and 21 carats fine reſpectively.

Alſo as 90 : 200 : : 10 : 22 2/9 oz. the quantity of alloy.

N. B. Alloy is reckoned at 0 carats fine.

SCHOL. If not only the whole quantity, but alſo the quantity of ſome particular ingredient is given; then find the rate, quality, or value of the compound, as though that particular ingredient was not included; which is done thus,

Multiply the quantity of the whole compound by its propoſed quality, rate, or value, &c. Alſo multiply the given quantity by its rate or value, &c. and ſubtract the latter product from the former. Then divide the remainder by the difference between the whole weight and the given weight, and the quotient will be the value, rate, &c. of the compound, provided the quantity and quality of the given ingredient were deducted therefrom. Therefore

fore make the quantity of the compound equal to the difference between the whole quantity and the given quantity, and its quality or rate, &c. equal to the anſwer brought out as above, and proceed with the remaining ingredients to find their reſpective quantities, according to the foregoing Rule.

Thus, in the laſt Example, if the quantity of 24 carats fine had been given $=44\frac{4}{9}$ oz. and it had been required to determine the quantities of the reſt; then $200\times 20=4000$, and $24\times 444\frac{4}{9}$, $=10666\frac{2}{3}$; and $4000-10666\frac{2}{3}=2933\frac{1}{3}$. Alſo $200-44\frac{4}{9}=155\frac{5}{9}$; and $2933\frac{1}{3}\div 155\frac{5}{9}=18\frac{9}{17}$ carats; the fineneſs of the maſs, provided the $44\frac{4}{9}$ oz. of 24 carats were not included.

Therefore the queſtion is now reduced to this, viz. to find what quantities of 23, 22, and 21, carats fine, and of alloy muſt be mixed together to form a maſs of $155\frac{5}{9}$ oz. weight that ſhall be of the fineneſs of $18\frac{9}{17}$ carats; and the operation will ſtand as under:

$$18\tfrac{9}{17}\left|\begin{array}{l|l}23 & 18\frac{9}{17}\\ 22 & 18\frac{9}{17}\\ 21 & 18\frac{9}{17}\\ 0 & 4\frac{1}{17}\frac{2}{17}\end{array}\right.\quad\left.\begin{array}{l}18\frac{9}{17}\\ 18\frac{9}{17}\\ 18\frac{9}{17}\\ 9\frac{7}{17}\end{array}\right\}\begin{array}{l}\text{Then as } 66:155\tfrac{5}{9}::18\tfrac{9}{17}:44\tfrac{4}{9}, \text{ the}\\ \text{quantity of } 23,22 \text{ and } 21 \text{ carats fine}\\ \text{reſpectively.}\\ \text{And as } 66:155\tfrac{5}{9}::9\tfrac{7}{17}:22\tfrac{2}{9} \text{ the}\\ \text{quantity of alloy; the ſame as before.}\end{array}$$

66

And thus may any other ſimilar caſe be ſolved; alſo if the whole quantity, and likewiſe the quantity of two or more of the ingredients be given, the anſwer will be obtained in the ſame manner, only the ſeveral ingredients that are given muſt firſt of all be reduced to one ingredient, as directed in the rule for Alligation Partial.

N. B. This caſe I have not ſeen treated on in Alligation by any author before.

CHAP. XIV. EXCHANGE.

I. Exchange is the bartering of money, and conſiſts in finding what quantity of money of one place is equal to a ſpecified ſum of another, according to a given courſe of exchange.

II. The Courſe of Exchange is ſuch a variable ſum of the money of one place, as is propoſed to be given for a certain conſtant ſum of that of another.

III. The Par of Exchange is the intrinſic equality between two pieces or ſums of money, one of which is the conſtant piece or ſum to which the courſe is compared.

IV. The Agio is the difference of the value of current money and bank money; for the bank money in Foreign countries is finer than the current money.

The operations are all managed by the Rule of Three, Practice, &c.

SECT. I. THE EXCHANGE WITH IRELAND, AMERICA, AND THE WEST INDIES.

In thoſe places the accounts are kept in pounds, ſhillings and pence, as in England. The courſe of exchange with Ireland is from 5 to 12 per cent. in favour of England; according to the balance of trade; and the par is reckoned at 108l. 6s. 8d. Iriſh, per 100l. ſterling.

In the Weſt Indies, 5l. ſterling is accounted worth 7l. currency.

EXAMPLE I. Dublin remits to London 690l. Iriſh, how much ſterling muſt Ireland be credited, the courſe of exchange being 8 per cent?

Here, As 108l. : 690l. :: 100l. : $\frac{690\times 100}{108}=\frac{69000}{2\times 54}=\frac{34500}{54}$ $=\frac{34500}{6\times 9}=\frac{5750}{9}=638$l. 17s. $9\frac{1}{9}$d. and $\frac{1}{3}$ of a farthing, the Anſwer.

EXAMPLE II. London remits to Ireland 787l. 15s. ſterling, how much Iriſh muſt London be credited, exchange at $10\frac{1}{2}$ per cent?

Here, As 100l. : 787. 75 :: 110l. 5 : $\frac{110.5\times 787\ 75}{100}=$ 870.4637 5l. = 870l. 9s. $3\frac{1}{4}$d. and $\frac{2}{25}$ of a farthing, the Anſwer.

N. B. Through an *odd miſtake*, Mr. Bonnycaſtle, in his Arithmetic, has brought out the anſwer to this queſtion, 791l. 13s. $3\frac{1}{2}$d. and $\frac{2}{10}$ parts, which is 78l. 16s. too little.

EXAMPLE III. Virginia is indebted to London 550l. ſterling: how much currency will London be credited at Virginia, when the exchange is $33\frac{1}{3}$ per cent?

Here, As 100l. : 550 :: $133\frac{1}{3}$: $\frac{550\times 133\frac{1}{3}}{100}=733\cdot 33\frac{1}{3}$l. = 733l. 6s. 8d. the Anſwer.

SECT. II. THE EXCHANGE WITH HOLLAND, FLANDERS, AND GERMANY.

Accounts in theſe places are ſometimes kept in pounds, ſhillings and pence, but frequently in guilders, ſtivers and pennings. The money of Holland and Flanders is called Flemiſh, and they exchange by the pound ſterling. The exchange is from 33s. 6d. to 36s. Flemiſh per pound ſterling. The agio is from 3 to 6 per cent for current.

Note. Eight pennings make 1 grote or penny; 2 grotes, 1 ſtiver; 6 ſtivers, 1 ſchilling; 20 ſtivers, 1 florin or guilder; $2\frac{1}{2}$ florins, 1 rix-dollar; and 6 florins, 1 pound Flemiſh.

PROB. I. *To turn current Money into Banco.*

RULE. Add the agio to 100, they ſay as that ſum is to any given ſum current, ſo is 100 to the value of the ſaid ſum current in banco.

PROB. II. *To turn Banco Money into Current.*

RULE. As 100 is to any given ſum banco, ſo is 100 with the agio, added to it, to its value current.

N. B. The exchange is ſuppoſed to be in bank money, and therefore current money muſt be always reduced to banco, before the exchange is made.

PROB. III. *To change Sterling Money into Flemiſh.*

RULE. As 1l. ſterling is to the ſum ſterling given, ſo is the given rate to the Flemiſh ſought.

PROB. IV. *To change Flemiſh Money into Sterling.*

As the given rate is to the given ſum Flemiſh, ſo is 1l. ſterling to the ſterling required.

N. B. Theſe caſes may frequently be commodiouſly wrought by the rules of practice.

EXAMPLE. Suppoſe there be due at Rotterdam 6316 guilders, 1 ſtiver and 15 pennings current money, and the agio be $4\frac{7}{8}$ per cent: how much ſterling money does it come to, the exchange being at 33s. $5\frac{1}{2}$d. Flemiſh per pound ſterling?

Firſt reduce the current money into banco, thus: As $104\frac{7}{8}$ cur. : 6316 guild. 1 ſtiv. 15 pen. cur. : : 100 bank : 6022 guild. 10 ſtive. banco.

Now reduce the banco into Flemiſh, thus: 6022 guild. : 10 ſtiv. Flemiſh is equal to 1003l. 15s. Flemiſh, which is found by dividing by 6, becauſe 6 florins or guilders is 1l. Flemiſh. Then as 33s. $5\frac{1}{2}$d. : 1003l. 15s. : : 1l. : 600l. ſterling, the Anſwer; and the like for other queſtions of this nature.

SECT. III. THE EXCHANGE WITH FRANCE.

The French accounts are kept in livres, ſols, and deniers, exchange being made by the French crown, the par of which is 4s. 6d. ſterling.

Note I. Twelve deniers make 1 ſol or ſou; 20 ſols, 1 livre, and 3 livres, 1 crown or ecu. Alſo 10 livres make a piſtole, and 24 livres, 1 louis d'or, or guinea.

Note II. The livres are imaginary money, but the crowns, ſols, and deniers are real.

Note III. The term tournois is only a note of diſtinction of the French money, as ſterling is of the Engliſh.

Note IV. In the French exchange, you muſt diſtinguiſh between exchange money and book money. The exchange money is called money d'or, and is expreſſed in crowns, ſols, and deniers d'or. The book money is called tournois, and is expreſſed in livres, ſols, and deniers tournois. Alſo crowns, ſols, and deniers d'or, being multiplied by 3, throughout, give livres, ſols, and deniers tournois, or book money; and, on the contrary, book money, being divided by 3, gives the exchange money.

Note V. The exchange is from 30d. to 32d. per crown or ecu.

EXAMPLE. How many livres, &c. tournois, will 360l. ſterling amount to, the exchange being at 30d. per crown, or ecu?

Here, as 30d. : 360l. (or 86400 pence) :: 1 ecu : $\frac{86400}{30}=$ 2880 crowns, or ecus, which multiplied by 3, gives 8640 livres tournois.

SECT. IV. THE EXCHANGE WITH SPAIN.

In Spain they keep their accounts in piaſtres, rials, and maravedies, reckoning 34 maravedies to a rial, and 8 rials to a piaſtre, *peſo*, or piece of eight, old money, by which they exchange, the par being 4s. 6d. The piaſtre is imaginary, but the rials and maravedies are real. Alſo London exchanges with Spain in pieces of eight, new money, of 10 rials.

Note, likewiſe, 5 piaſtres is a Spaniſh piſtole, and 2 piſtoles is a doubloon.

EXAMPLE. How many piaſtres ſhall I receive in Spain for 510l. ſterling, the exchange being at 50d. per piaſtre?

Here, as 50d. : 510l. (or 122400 pence) : : 1 piaſtre : $\frac{122400}{50}$ $=\frac{24480}{760}=2448$, the Anſwer.

N. B. In Genoa, and Leghorn, they keep their accounts in ſols and deniers, as in France, but exchange by the piaſtre, as in Spain. At Venice alſo, accounts are by ſome kept in the ſame manner, and by others, in ducats and groſs, reckoning 24 groſs to a ducat.

Examples of exchange with other countries might be given, but as they are all founded on the ſame principles of computation, it would be ſuperfluous to enumerate them.

CHAP. XV. INTEREST.

I. Intereſt is the premium or reward allowed for the loan or uſe of any ſum of money for any appointed time.

II. The Principal is the money lent or put out to intereſt.

III. The Rate of Intereſt is the Intereſt of 100l. for a year, but frequently the Intereſt of 1l. for a year is termed the Rate of Intereſt.

IV. The Amount of a ſum of money at the expiration of a given time, conſiſts of the Principal, together with its Intereſt, for that time.

V. Alſo, Intereſt is either Simple or Compound.

VI. Simple Intereſt is that which is charged only upon the Principal from the time of its being put out to Intereſt, or of its becoming due, if an arrear.

VII. Compound Intereſt, or Intereſt upon Intereſt, is that which is continually derived from both Principal and Intereſt, ſo that

that the Intereſt itſelf, as it ariſeth, is ſuppoſed to be perpetually gaining Intereſt, as well as the Principal.

I ſhall treat of them both diſtinctly; and firſt,

SECT. I. OF SIMPLE INTEREST.

All the queſtions of Simple Intereſt are reſolved by the Rule of Three; but, as under that Rule I have given no Examples of Intereſt, judging it more methodical to handle the ſubject by itſelf, I ſhall add a few by way of precedent and exerciſe.

EXAMPLE I. What is the Intereſt of 550l. for a year, at 5l. per cent.

As 100l. : 550l. :: 5l. : (Anſwer.)

Then $\frac{550\times 5}{100}$ = 5·5×5 = 27·5l. = 27l. 10s. the Anſwer.

N. B. In caſes like this, where the Intereſt is at 5 per cent. it may be had by dividing the given ſum by 20; for 5 is a conſtant multiplier, and 100 is a conſtant diviſor, and $\frac{5}{100}$ is = $\frac{1}{20}$.

In the above Example, the 20th part of 550l. is 27l. 10s. as before.

EXAMPLE II. What is the Intereſt of 575l. 12s. 6d. for three years at 5 per cent. per annum, Simple Intereſt?

This is done by the Double Rule of Three, as follows:

As 100l. : 575l. 12s. 6d. :: 5l. : (1ſt Anſwer.)

As 1 year : 3 years : : 1ſt Anſwer : (Anſwer required.)

Then $\frac{575\text{l. }12\text{s. }6\text{d.}\times 5\times 3}{1\times 100} = \frac{575\text{l. }12\text{s. }6\text{d.}\times 3}{20} =$

$\frac{1726\text{l. }17\text{s. }6\text{d.}}{20}$ = 86l. 6s. 10½d. the Anſwer required.

Here, when the Intereſt is at 5 per cent. and the time is any number of complete years, the Anſwer is had by multiplying the principal by the time, and dividing the product by 20.

EXAMPLE III. What is the Intereſt of 894l. 10s. 9d. for 120 days, at 4 per cent. per annum, Simple Intereſt?

By the Double Rule of Three, as below.

As 100l. : 894l. 10s. 9d. : : 4l. : (1ſt Anſwer.)

And, As 365 days : 120 days : : 1ſt Anſwer : (Anſwer required.)

Then $\frac{894\text{l. }10\text{s. }9\text{d.}\times 4\times 120}{100\times 365} = \frac{3578\text{l. }3\text{s.}\times 12}{10\times 365} =$

$\frac{42937\text{l. }16\text{s.}}{10\times 365} = \frac{4293\text{l. }15\text{s. }7\frac{1}{2}\text{d.}}{365}$ = by dividing by 5 = $\frac{858\text{l. }15\text{s. }1\frac{1}{2}\text{d.}}{73}$

= (by diviſion as below) 11l. 15s. 3¼d. the Anſwer.

£. OPERATION.

73) 858 15 1½ nearly.
73 (11
128
73
55
20
73) 1115 (15
73
385
365
20
12
73) 241 (3
219
22
4
73) 90 (1
73
17

Anſwer 11l. 15s. 3¼d.

Or ſhorter, thus.

	£.	s.	d.
⅒	858	15	1½
⅒	85	17	6
½	8	11	9
⅒	2	17	3
⅒	0	5	8¼ nearly
⅒	0	0	6¼
	£ 11	15	3¾
	Subtract		¼
	£ 11	15	3½ Anſwer.

Or, Decimally, thus,

858.75
5) 8.5875
2.8625
.2862
286
11.7648
leſs 11
£ 11.7637 Anſwer.
= £ 11 15 3½

The ſhort method of dividing by 73, is thus;

Divide the given ſum by 100 (or which is the ſame by 10 and 10.) Then take the ½ part of the quotient, and the ⅒ part of that part, and alſo the ⅒ part of this latter part. Add the four quotients together, and the ſum will be the Anſwer nearly.

And to correct the ſame for every 500l. in the Anſwer thus obtained, ſubtract 1 ſhilling, and ſo on in proportion for any greater or leſs ſum, viz. for 250l. ſubtract 6d. for 125l. abate 3d. and for each of the intermediate ten pounds, as well as for thoſe below, deduct a farthing; obſerving, to take the neareſt number of tens, whether the ſame ſhall exceed, or fall ſhort of the ſaid ſum.

This method if decimals are uſed as in the 2d ſhort method, is exceeding eaſy; and the decimal to be annexed to the pounds, will be had by dividing the number of ſhillings by 20 (which is no greater difficulty than to take the half thereof) rejecting the pence; but calling the number of ſhillings, one more when the pence exceed ſixpence; as the error in ſo doing can never amount to the ½ part of a farthing, which may always be corrected, ſo as it can never at all affect the farthings in the valuation, by adding 1 to the figure in the fourth place of the decimal, before it is valued, for every two pence that was left out of the calculation by ſuch method of proceeding; or by ſubtracting therefrom 1, for every two pence that was thereby included above what ought to have been.

In the decimal method, the correction to be ſubtracted from the ſum of the quotients muſt be $\frac{5}{10000}$ part thereof; and the value of the decimal part in the Anſwer is had by inſpection, as I have ſhewn in the Reduction of Decimals.

COR. From the foregoing proceſs by the Double Rule of Three, it appears, that the ſimple intereſt of any ſum of money, for any number of days at a given rate of intereſt, is found by multiplying the principal, the rate of intereſt, and the number of days together, and dividing the product by 36500.

And to divide by 36500, obſerve theſe rules:

I. Write down the given number, and under it, its tenth part; alſo take the $\frac{1}{100}$ part of this part, and write below it; or which is the ſame, multiply it by 4, and ſet the product two figures forward to the right hand; then from the ſum of the two firſt numbers ſubtract the latter (which is eaſy to do in the courſe of adding up, when it is once familiarized) and divide the quotient by 40000, and it will give the anſwer nearly; which muſt be corrected by deducting from it the $\frac{1}{10000}$ part, as before.

In working by this rule, when you come to divide, both the ſhillings and pence may be neglected; only, if the ſhillings are above 10, it will be as well to make the pounds 1 more; but that is not requiſite, as the error, without that, can never amount to the $\frac{1}{25}$ part of a farthing. Thus the operation is rendered exceeding eaſy.

II. Or the fifth part of the number to be divided, may be taken and that divided by 7300, which will be done by the ſame method that I have given for dividing by 73, only at ſetting out, two more places muſt be pointed off as decimals; viz. the firſt diviſor muſt be 10000 inſtead of 100. This, as well as the preceding method, will want no other correction than the ſubtracting of the $\frac{5}{10000}$ part.

III. Or thus, Write down the number to be divided by 3650; and underneath it write the $\frac{8}{10000}$ part thereof; or which is the ſame, ſet the product by 6, three places forward to the right hand. Alſo multiply this part by 12, placing the product one figure backward, to the left hand: then the ſum of the two under numbers, ſubtracted from the upper number, and the remainder divided by 1000, will give the Anſwer to be corrected as before.

I could give other methods of finding the firſt approximate Anſwer, but none ſeem better adapted to practice than theſe: which methods are ſolely my own, and have never been publiſhed before.

EXAMPLE V. What is the intereſt of 1422l. 10s. 6d. for 25 days, at 3½ per cent. per annum?

1ſt Method of Dividing.

124471
+12447
—498
4000) 136420
34·105
— 3
£ 34·102 Anſwer.
Or £ 3. 8s. 2¼

l.	s.	d.
1422	10	6
		3½
4267	11	6
711	5	3
4978	16	9
		5
24894	3	9
		5
£ 124470	18	9

2d Method of Dividing.

£.
5) 124471.
3) 24·894
8298
830
83
34·105
—3
£ 34·102

3d Method of Dividing.

124471
—746·826
—8962
34·105
3
£. 34·102 Anſwer.

SCHOL. I. The dividing by 3650 or 365 is the ſame as the above, only in the quotient there will be one or two more places of the whole numbers reſpectively, and it will be requiſite to annex to the pounds the decimal parts anſwering to the ſhillings, and in the latter caſe when the pence are above ſix-pence it will be as well to call the ſhillings one more, and then no error can ariſe.

SCHOL. II. Hence when the number of days is diviſible by 10 or 100, the principal may be multiplied by ⅒ or $\frac{1}{100}$ part thereof inſtead of the whole, and the diviſion made as by 365, or 3650, accordingly.

SCHOL. III. When the rate of Intereſt is 5 per cent. the principal need only to be multiplied by the time, and the product divided by 7300; in which caſe the ſhillings, &c. may be rejected, or the pounds increaſed 1 more when the ſhillings exceed 10, as was ſhewn in the method for dividing by 36500.

SCHOL. IV. When the rate of Intereſt is 5 per cent. and the number of days is diviſible by 10 or 100, then the principal need only

only to be multiplied by $\frac{1}{5}$ or $\frac{1}{100}$ part of the days, and the product divided by 73, or 730; obſerving to retain the decimal of the ſhillings; and in the former caſe, regard being had to the pence, when above ſixpence, as was before ſhewn.

In dividing by 730, one figure more muſt be pointed off to the decimals, than is directed to be done in the dividing by 73.

Schol. V. When the given time conſiſts of years, and days, the intereſt may be calculated firſt for the years and then for the days, and the ſum of both will be the Anſwer; or, when the odd time is given in common months or weeks, without days, it may in ſome caſes be ſufficient to take aliquot parts of the intereſt for a year, for ſuch odd time.

Thus, for 6 months, to taken $\frac{1}{2}$; for 4 months, $\frac{1}{3}$; for 3 months, $\frac{1}{4}$; for 2 months, $\frac{1}{6}$; and for 1 month, $\frac{1}{12}$. Alſo for 2 weeks, to take the $\frac{1}{2}$; and for 1 week, the $\frac{1}{4}$ of the intereſt for 1 month, &c.

This way, however, is a looſe method of calculating, and ſhould never be adopted where ſtrict accuracy is required.

Schol. VI. If the amount, at Simple Intereſt of any ſum of money for any propoſed time, at a given rate, per cent. is required, the intereſt muſt be found by the foregoing rules, and added to the principal.

Example V. If the Simple intereſt of 575l. 12s. 6d. for a certain time, at 5 per cent. be 86l. 6s. 10½d. it is required to determine how long the ſame was out at intereſt?

l. pence. l. s. d. pence. year.
As 100(or 24000): 575 12 6 (or 138150): : 1 : (1ſt Anſwer.)
l. farthings. l. s. d. farthings.
And as 5 (or 4800): 86 6 10½(or 82890): : 1ſt Anſ.: (An. req.)

Then $\frac{24000\times1\times82890}{138150\times4800}=\frac{5\times8289}{13815}=\frac{8298}{2763}=3$ years, the Anſwer.

Cor. I. Hence, when the principal, intereſt, and rate of intereſt, are given to find the time at Simple intereſt.

The rule is, multiply the given intereſt by 100l. for a dividend; and the rate per cent. and the principal together for a diviſor; and the quotient will give the Anſwer in years, or years and parts, or parts of a year and to know the number of days, if the time be not years complete, multiply the dividend, if the time be under a year; or, the remained, if it be above a year, by 365; then divide by the ſaid diviſor, and the quotient will be the odd days.

But note, before the above rule is applied, the 100l. and the given principal muſt be reduced to one and the ſame denomination; likewiſe the rate per cent. and the given intereſt muſt alſo be reduced to the loweſt denomination mentioned in the intereſt; or, the odd money of the given principal and intereſt, if any, may be reduced to the decimal part of a pound, and annexed to the pounds, and then no other reduction will be neceſſary; only in multiplying and dividing, the rules for managing decimals muſt be ſtrictly obſerved.

Cor. II. If the intereſt, the rate of intereſt, and the amount, be given to find the time, ſubtract the intereſt from the amount, and it will leave the principal, with which, and the reſt of the data, proceed as before.

Cor. III. If the rate of intereſt, the principal, and amount, be given to find the time, ſubtract the principal from the amount, and it will leave the intereſt; and ſo the time will be found according to the aforeſaid rule.

N. B. Other rules might have been given for theſe caſes, But none more eaſy than the above; and therefore it would be both needleſs and ſuperfluous to enlarge further on the matter.

Cor. IV. If inſtead of the rate of intereſt, the time be given, and the rate of intereſt be required, then multiply the principal by the time for a diviſor; the dividend will be as before: and the quotient will be the rate of intereſt. But note,

1ſt. If the time be days, they muſt either be reduced to the decimal parts of a year, or otherwiſe the dividend, beforementioned, muſt be multiplied by 365, for a roper dividend in this caſe.

2d. If the time be years and days, then the decimal for the odd days may be taken, and annexed to the years; or the whole may be reduced into days, and the proceſs conducted according to the laſt note.

3d. The Anſwer will be of the ſame denomination into which the given intereſt was reduced; which muſt always, as was obſerved, be brought into the loweſt, if decimals are not uſed.

Cor. V. If the rate of intereſt, the time and the intereſt be given to find the principal, then the rate muſt be multiplied by the time for a diviſor; the dividend being as before, viz.=the intereſt multiplied by 100l. and the Anſwer will be had in pounds, or pounds, and parts of a pound.

N. B. All theſe caſes follow eaſy enough from the Rule of Three.

SECT. II. COMPOUND INTEREST.

Problem I. The principal, time, and rate of intereſt, being given, to find the amount or intereſt.

Rule. To 1l. add the decimal, anſwering to the intereſt of 1l. for a year, which, at 3 per cent, is 03; at 3½, is .035; at 4, is .04; at 4½, is .045; at 5, is .05, &c. and this is the amount of 1l. for a year. Then involve this amount to the power denoted by the time, viz. to the ſecond power, if it is 2 years; to the third power, if the time is 3 years; to the fourth, if 4 years, &c. and it will give the amount of 1l. for ſuch time; and this multiplied by the principal (taken decimally if there be odd money) will give the amount of the principal in pounds and decimal parts, from which ſubtract the principal, and it will leave the intereſt.

Example. What is the amount of 550l. for 4 years, at 5 per cent. Compound Intereſt?

Here 1.05 is the amount of 1l. for a year, which involved to the fourth power, is 1.5250625; which multiplied by the principal, 550l. gives 668.5284375l.=668l. 10s. 6¾d. the Anſwer.

From this ſubtract 550l. and the remainder is 118l. 10s. 6¾d. the intereſt.

Schol. When the time runs high, or is not given in complete years, logarithms ſhould be uſed, or the trouble in ſome caſes would be almoſt immenſe.

But by logarithms, any caſe of this ſort is ſolved with the utmoſt diſpatch. The rule is this, take the logarithm of the amount of 1l. and multiply it by the time, taken in years; or, if there be odd days, the days muſt be taken in fractional or decimal parts of a year; and to the product, add the logarithm of the principal in pounds, or pounds and fractional or decimal parts of a pound, if there be odd ſhillings, and the ſum will be the logarithm of the amount; then look in the table of Logarithms for the correſponding number, and it will be the amount itſelf in pounds and decimal parts.

Example. What is the intereſt of 350l. 10s. for 5¼ years, at 3½ per cent. per ann. Compound Intereſt?

Here the amount of 1l. for year, is 1.035l. and the logarithm thereof, is .0149403; which multiplied by 5¼ = .0784366. Alſo 350l. 10s = 350.5l the logarithm of which is 2.544688, and this added to .0784366 = 2.6231246 = the logarithm of the amount; and conſequently the amount itſelf, is 419.8896l. From this, ſubtract 350.5, the principal, and the remainder is 69.3896=69l. 7s. 9¾d. the intereſt required.

Problem II. The intereſt, rate of intereſt, and the principal, or amount, being given to find the time, at Compound Intereſt.

Rule. From the logarithm of the amount, ſubtract the logarithm of the principal, and divide the remainder by the logarithm of the amount of 1l. for a year, and the quotient will be the time required.

Example. If the Intereſt of 350l. 10s. at 3½ per cent. per annum, Compound Intereſt, be 69l. 7s. 9¾d. it is required to determine how long the ſame was out at intereſt?

Here, the Intereſt, 69l. 7s. 9¾d = 69.3896l. and the principal 350l. 10s. = 350.5l. conſequently the amount is 419.8896l. The logarithm thereof is 2.6231246. Alſo the logarithm of the principal (350.5l.)=2.544688; which ſubtracted from 2.6231246, leaves .0784366, and this divided by .0149403, (the logarithm of the amount of 1l. for a year)= 5.25 years, or 5¼ years, the Anſwer.

Problem III. Given the intereſt, the time, and the amount, or principal, to find the Rate of Intereſt.

Rule. For the logarithm of the amount, ſubtract the logarithm of the principle, and divide the remainder by the time, ſo will the quotient be the logarithm of the amount of 1l. for a year. Then the number anſwering thereto, will be the amount itſelf; from which ſubtract 1l. multiply the remainder by 100; and the product will be the Rate of Intereſt required.

Example. The Compound Intereſt of 350l. 10s. for 5¼ years. being 69l. 7s. 9¾d. it is required to determine at what rate per annum, the ſaid ſum was put out to Intereſt?

Here, as in the laſt Example, the amount is 419.8896l. and the logarithm thereof is 2.6231246. Alſo the logarithm of the principal (350.5l.) is 2.544688; and this ſubtracted from the former, leaves .0784366; which being divided by 5.25, gives .0149403, the logarithm of 1.035l. and therefore .035l. is the intereſt of 1l. for a year; and 3.5 (or 3½ per cent.) is the rate of intereſt required.

Schol. To facilitate the computations of Compound Intereſt, it has been common to give tables of the amount of 1l: at the different Rates of Intereſt, calculated for as many years as it is probable will occur in practice.

Theſe, however, appear unneceſſary here, as in the Syſtem of Annuities, Chap. I. I have given ſuch tables as will always anſwer the ſame purpoſe, with their uſe at large; to which I refer the reader for further information.

CHAP. XVI. DISCOUNT.

Diſcount is but a particular caſe of intereſt, being confined to the ſolution of this Problem, viz. Given the amount, the time, and Rate of Intereſt, to find the Intereſt.

In which caſe the Intereſt is termed the Diſcount; becauſe, it is that money which ought to be diſcounted, or allowed, for the payment of a ſum (equivalent to the amount) at ſo long a time before it becomes due, as is denoted by the given time.

Alſo the principal, in that caſe, is termed the preſent value; becauſe it is that money which a creditor ſhould receive in preſent payment, in lieu of a ſum equivalent] to the amount, and due not till ſuch a period hence, as is expreſſed by the given time.

In Simple Intereſt this, like the reſt of the caſes, is performed by the Rule of Three.

EXAMPLE. What is the diſcount of 573l. 15s. due 3 years hence, at 4½ per cent. Simple Intereſt?

By Decimals, thus:

Year Years Int. of 100l. for a year.

As 1 : 3 :: 4.5l. : the Intereſt of 100l. for 3 years, = 4.5×3=13.5l.

The Amt. of 100l. for 3 years | The given Amount | Dif. of 113.5l. for 3 years.

Then, as 100+13.5 (or 113.5l.) : 573.75l. :: 13.5 : the Diſcount of 573.75l. for 3 years $= \frac{573.75 \times 13.5}{113.5} = \frac{573.75 \times 2.7}{22.7} = \frac{1549.125}{22.7} = 68.2434$l. nearly=68l. 4s. 10d½. the Anſwer.

Hence this rule: Find the amount of 100l. for the given time, according to the proper Rate of Intereſt. And then ſay, as the amount of 100l, is to the ſum to be diſcounted; ſo is the intereſt of 100l. for the ſaid time, to the Diſcount required; and the Diſcount ſubtracted from the given ſum, leaves the preſent value, or the money, which the ſaid given ſum is worth in ready caſh.

SCHOL. When Compound Intereſt is uſed, find, according to the propoſed rate of Intereſt, the amount of 1l. by the method of Compound Intereſt for the given time. Then divide the given ſum by that amount, and it will give the preſent value; which, ſubtracted from the ſaid ſum, leaves the Diſcount.

In the foregoing Example, the amount of 1l. for 3 years, = 1.141166125; and $\frac{573.75}{1.141166} = 502.77523$l. And this ſubtracted from 573.75l. leaves 70.97477l. = 70l 19s. 6d. nearly, = the Diſcount, at Compound Intereſt.

The rule in this caſe, by logarithms, is as follows: take the logarithm of the amount of 1l. for a year, and multiply it by the time, in years, or decimal parts of a year, and ſubtract the product from the logarithm of the ſum to be diſcounted, taken decimally, and the remainder will be the logarithm of the preſent value.

Then the number in the tables anſwering thereto, is the preſent value itſelf; which, ſubtracted from the ſaid given ſum, gives the Diſcount as before.

N. B. The moſt correct and uſeful book of logarithms, of a reaſonable price, is that of which Dr. Hutton, F. R. S. and Profeſſor of Mathematics, at the Royal Academy at Woolwich, is the author.

He has been at extreme pains in comparing, amending, and enlarging the beſt editions of Sherwin's Tables; and has alſo given, by way of introduction, a valuable hiſtory of Logarithms, with the various methods of conſtructing them, and their application, in a variety of caſes.

CHAP. XVII. EQUATION OF PAYMENTS.

Equation of Payments is the method of finding a time, at which, if ſeveral debts, due at different periods, be all paid at once, neither party ſhall either gain or loſe thereby.

The common rule is this:

Multiply each payment by the time at which it will become due from the preſent time, or from any fixed time that ſhall not be after the firſt payment; then divide the ſum of the products by the ſum of the payments, and the quotient will be the equated time required, reckoning from the ſaid fixed time.

EXAMPLE. A owes B three ſeveral ſums of money; viz. 100l. due at the end of 6 months; 500l. due at the end of 12 months; and 400l. due at the end of 15 months; what is the equated time for paying the whole?

Here 100×6=600; 500×12=6000; and 400×15=6000. Alſo, 600 + 6000+6000 = 12600; and 100 + 500 + 400 = 1000.

Then $\frac{12600}{1000}$ = 12.6 months, or 12 months and 18 days, allowing 30 days to the month, the equated time required.

SCHOL. This method, though much practiſed on account of the eaſy mode of calculation, is not ſtrictly true, as it neither agrees with the principles of Simple or Compound Intereſt. However, where the whole time concerned is not long, it will deviate but very little from the truth at Simple Intereſt.

The error of this method lies in making no difference between the intereſt and the diſcount, whereas the latter is ever leſs than the former. The equated time, by the above Rule, will be always ſomething too great.

But when the period between the firſt and laſt payments is conſiderable, the equated time ſhould be aſcertained according to the principle of compound Intereſt, as it will be inequitable if only Simple Intereſt is regarded. And, as the calculation according to Simple Intereſt is ſo very tedious that no author which I have read has given themſelves the trouble of inveſtigating a true method for more than two payments; and even for two payments none have been ſtrictly accurate, except Mr. Burrow and Mr. Bonnycaſtle; and as the method already given is ſufficient when the time between the firſt and laſt payment is not very great, it would only be introducing ſuperfluous matter to deliver any thing further on this ſubject, ſaving the Rule of Compound Intereſt, which is this:

Find the preſent value of each ſeparate payment, diſcounted at Compound Intereſt, according to the given rate of intereſt, from the time of its becoming due, to the time of the firſt payment. Then, making the ſum of all the preſent values a principal, find in how long a time, at Compound Intereſt, the ſame would amount to the ſum of the payments, and that will be the time required.

The application hereof is eaſy enough from what has been delivered in the Rules of Compound Intereſt and Diſcount, without intruding further Examples.

CHAP. XVIII. OF PROGRESSION.

Progreſſion is either Arithmetical or Geometrical: the former ariſes from the continued Addition of ſome Common Number, and the latter from the repeated Multiplication or Diviſion by ſome ſuch numbers.

SECT. I. ARITHMETICAL PROGRESSION.

DEFINITION I. An Arithmetical Progreſſion is a ſeries or rank of numbers, wherein each ſucceeding number either increaſes or decreaſes by ſome common difference.

II. The Common Difference is called the Arithmetical Ratio of ſuch Progreſſion.

III. Each number in the Progreſſion is called a Term.

IV. The Term which immediately precedes another, is named the Antecedent of that other; and that other is named the Conſequent of the preceding Term.

V. The firſt and laſt Terms of a Progreſſion are called the Extremes; and the other Terms, the Means.

THEOREM I. In any even number of continued arithmetical proportionals, the ſum of the extremes is equal to the ſum of any two means that are both equally diſtant.

Thus, in the Progreſſion, 2, 4, 6, 8, 10, 12, the ſum of the extremes, viz. 12 + 2, is equal to the ſum of any two equidiſtant means; viz. 10 + 4 or 8 + 6.

THEOREM II. In any odd number of continued arithmetical proportionals, the double of the middle term is equal to the ſum of any two terms that are equally diſtant.

Thus, in the Progreſſion, 1, 3, 5, 7, 9, the double of the middle term (5) is 10=1 + 9=7+3.

THEOREM III. The difference between any two terms in an arithmetical progreſſion is equal to the difference between any other two in that progreſſion that are at the ſame diſtance from each other.

Thus, in the ſeries 2, 5, 8, 11, 14, 17, 20, the difference between any two terms, for inſtance, between 2 and 8, is equal to the difference between any other two terms that are alike remote from each other; viz. to the difference between 5 and 11, 8 and 14, 11 and 17, and 14 and 20.

COR. I. If there are two arithmetical ſeries, having the ſame common difference, then the difference between any two terms in the one is equal to the difference between any two terms in the other, taken at the ſame diſtance from one another in each.

COR. II. Any ſeries which conſiſts of a conſiderable number of terms, may be reſolved into two or more ſeries, whoſe ratio or common difference ſhall be double or treble, &c. to that of the given one.

THEOREM IV. If there be two ranks of numbers in arithmetical progreſſion, having the like number of terms in each, their ſum will be in arithmetical progreſſion, whoſe ratio or common difference ſhall be equal to the ſum of the ratios of the two given progreſſions.

Thus, let the 1ſt rank be 5, 7, 9, 11, 13, 15, 17, com. diff.=2.
2d rank 3, 6, 9, 12, 15, 18, 21, com. diff.=3.
Their ſum = 8, 13, 18, 23, 28, 33, 38, a progreſſion whoſe common difference is 5.

THEOREM V. If three numbers are in Arithmetical Progreſſion, the rectangle of the extremes, together with the ſquare of the common difference, is equal to the ſquare of the middle term.

Thus, if the quantities be 4, 6, 8, the rectangle of the extremes, viz. 4×8 or 32, added to the ſquare of the common difference, viz. 4 (or 2×2) =32+4=36= the ſquare of the middle term, viz. 6×6.

THEOREM VI. The product of the ſum of the extremes, by the number of terms in any Arithmetical Progreſſion, is equal to twice the ſum of the ſum of the ſeries; and conſequently, the ſum of the ſeries is equal to half that product.

Thus, let the ſeries be 5, 8, 11, 14, 17.

Then, $\frac{5 + 8 + 11 + 14 + 17}{2}$, or the ſum of the ſeries = $\frac{17+5 \times 5}{2} = \frac{22 \times 5}{2}$ = 11 × 5=55.

COR. I. Twice the ſum of any arithmetical ſeries divided by the ſum of the extremes, is equal to the number of terms.

COR. II. Twice the ſum of the ſeries, divided by the number of terms, is equal to the ſum of the extremes; and, therefore, if one extreme is given, the other is had by Subtraction.

THEOREM VII. In any arithmetical ſeries, the laſt term in an increaſing progreſſion, or the firſt term in a decreaſing one, is equal to the ſum of the other extreme, and the product under the number of terms, leſs 1, and the common difference.

Thus; let the ſeries be 3, 6, 9, 12, increaſing; or 12, 9, 6, 3, decreaſing.

Then 3+9 (or 3×3)=12=the laſt term in the former, or the firſt term in the latter ſeries.

THEOREM

THEOREM VIII. In any arithmetical series, the first term in an increasing progression, or the last in a decreasing one, is equal to the difference between the other extreme; and the product under the number of terms, less 1, and the common difference.

Thus, in the foregoing series, 12−9=3, the first term in the increasing progression, and the last in the decreasing one.

COR. I. The ratio, or common difference, is equal to the difference of the extremes, divided by the number of terms, less 1.

COR. II. The quotient produced by dividing the difference of the extremes by the ratio, or common difference, is equal to the number of terms, less 1; and consequently, the said quotient, more 1, is equal to the number of terms.

THEOREM IX. If the roots of a series of square, cube, biquadrate, &c. numbers, are in arithmetical progression, the 2d, 3d, 4th, &c. differences of such square, cube, biquadrate, &c. numbers respectively are equal.

Roots	1, 3, 5, 7, 9	
Squares	1, 9, 25, 49, 81	1st diff. 8, 16, 24, 32 2d diff. 8, 8, 8 equal
Cubes	1, 27, 125, 343, 729	1st diff. 26, 98, 218, 386 2d diff. — 72, 120, 168 3d diff. — — 48, 48 equal

ART. I. *Questions in Arithmetical Progression.*

QUESTION I. A master hires a servant for 6 weeks, and agrees to pay him for the first day, two-pence, for the second, four-pence, for the third, six-pence, and so on, advancing his wages two-pence per day. What is the amount of the six weeks wages?

Here the first term is 2, the ratio 2, and the number of terms 42. And by Theorem VII. the last term is $41 \times 2 + 2 = 82 + 2 = 84$.

Also, by Theorem VI. $\frac{84+2\times 42}{2}$ = sum of the series = $86 \times 21 = 1806$ pence = 7l. 10s. 6d. the Answer.

QUESTION II. A person undertakes to walk 400 miles; and to walk 31 miles the first day, and encrease each day's journey by a certain constant portion, in such sort, that the last day's journey shall be 49 miles. It is required to determine how long he will be in performing this undertaking, and what will be the increase wherewith he will daily mend his pace?

Here there is given the sum of the series, and the extremes.

And, by Theorem VI. Cor. I. $\frac{400\times 2}{31+49} = \frac{800}{80} = 10$ = the number of days he would be on his journey: also, by Theorem VIII. Cor. I. $\frac{49-31}{10-1} = \frac{18}{9} = 2$, the miles he walked each day more than on the preceding day.

QUESTION III. A person paid off, by instalments, a certain debt; the first payment was 20s. the next 25s. the next 30s. and so on; increasing the payment each time by 5s. Now the last payment was ten guineas. I demand what was the debt, and in how many payments the same was discharged?

By Theorem VIII. Cor. II. the number of payments is $= \frac{210-20}{5} + 1 = \frac{190}{5} + 1 = 38 + 1 = 39$. Then, by Theorem VI. the debt is $= \frac{210+20\times 39}{2} = \frac{230\times 39}{2} = 115 \times 39 = 4485$ shillings = 224l. 5s.

ART. II. *A Synopsis of the different Cases in Arithmetical Progression.*

Case.	Given.	Required.	Solution.
1	$a, d, n,$	$l, s,$	$l = a + n - 1 \times d$ $s = na + n - 1 \times \frac{1}{2}nd$
2	$a, d, l,$	$n, s,$	$n = \frac{l-a}{d} + 1$ $s = \frac{l-a+d\times l+a}{2d}$
3	$a, l, s,$	$d, n,$	$d = \frac{l+a\times l-a}{2s-l-a}$ $n = \frac{2s}{l+a}$
4	$a, n, s,$	$d, l,$	$d = \frac{2s-2an}{n-1\times n}$ $l = \frac{2s}{n} - a$
5	$a, n, l,$	$d, s,$	$d = \frac{l-a}{n-1}$ $s = \frac{a+l}{2} \times n$
6	$s, n, d,$	$a, l,$	$a = \frac{s}{n} - \frac{n-1}{2} \times d$ $l = \frac{s}{n} + \frac{n-1}{2} \times d$
7	$a, d, s,$	$n, l,$	$n = \frac{\sqrt{2a-d^2 + 8ds} - 2a-d}{2d}$ $l = \frac{\sqrt{2a-d^2 + 8ds} - d}{2}$
8	$d, n, l,$	$a, s,$	$a = l - n - 1 + d$ $s = \frac{2l-nd+d}{2} \times n$
9	$d, l, s,$	$a, n,$	$a = \frac{\sqrt{d+2l+d^2 - 8ds}}{2}$ $n = \frac{2l+d+\sqrt{2l+d^2 - 8ds}}{2d}$
10	$l, n, s,$	$a, d,$	$a = \frac{2s}{n} - l$ $d = \frac{2ln-2s}{n-1\times n}$

Note in the above
- a = least term
- l = greatest term
- n = number of terms
- d = common difference
- s = sum of the series

ART. III. *Of Figurate or Polygonal Numbers.*

I. The sums of numbers in a continued arithmetic proportion from unity, are called Figurate or Polygonal Numbers.

II. The several sums of a series of Figurate Numbers, are called Solid Figurates or Pyramids. Also, the sums of the Pyramids are named Second Pyramidals; Pyramidals, the Sums of Second Pyramidals. Third Pyramidals; and so on.

Arithmetical Series.	Diff. 1. 1, 2, 3, 4, &c.	Diff. 2. 1, 3, 5, 7, &c.	Diff. 3. 1, 4, 7, 10, &c.	Diff. 4. 1, 5, 9, 13, &c.
Figurates of the	Triangulars	Squares.	Pentagonals	Hexagonals.
First order	1, 3, 6, 10	1, 4, 9, 16	1, 5, 12, 22	1, 6, 15, 28
Second order	1, 4, 10, 20	1, 5, 14, 30	1, 6, 18, 40	1, 7, 22, 50
Third order	1, 5, 15, 35	1, 6, 20, 50	1, 7, 25, 65	1, 8, 30, 80

Note. All the figurate orders of the series, 1, 2, 3, 4, &c. where the difference is 1, are of the triangular kind; because the units of each number in the first order (after the first) may be regularly disposed in a triangular form; viz. trees, or any other things to the amount of those numbers, may be so disposed. Also, all the orders of the series, 1, 3, 5, 7, where the difference is 2, are of the square kind, because the numbers in the first order form squares: and all the orders of the series, 1, 4, 7, 10, where the difference is 3, are of the pentagon kind, because the numbers in the first order form pentagons; where the difference is 4, they are of the hexagon kind: and, in general, all the orders of any series are denominated after the name of that polygon whose number of sides or angles exceed the common difference by 2.

Note also. The number of terms composing any figurate number of the first order, shews the number of units to be disposed on each side of the polygon to which it relates.

PROBLEM I. Given the side or number of terms composing any figurate of the first order, and the common difference of the arithmetical series from which it is derived, to find the figurate number.

RULE. Multiply the side or number of terms, less 1, by half the product under the side and common difference: to the result add the said side, and it will be the Answer required.

EXAMPLE Let the common difference of the arithmetical series be 4, and the number of terms 10; what is the figurate number?

Here $10 + 10 - 1 \times \frac{4\times 10}{2} = 10 + 9 \times 2 \times 10 = 10 + 180 = 190$ the figurate number required.

COR. I. Since a figurate number of this order is = to the sum of all the given number of terms in the arithmetical series, it follows, that this case is equivalent to the finding of the sum of an arithmetic series proceeding from unity, the common difference and number of terms being given.

COR. II. If the number of the sides or angles of the polygon, instead of the common difference of the arithmetical series had been given, the case would have been the same, since the number of sides or angles, less 2, is = common difference.

PROBLEM II. Given a figurate number of the first order, and the common difference of the arithmetical series, to find the side, or number of terms composing it.

RULE. To 8 times the given number, add the common difference, and from the sum subtract 4; then multiply the remainder by the difference, add 4 to the product, divide the sum by 4 times the square of the difference, and extract the square root of that quotient. Also take the difference between 2, and the common difference, and divide the same by twice the difference; then, if the common difference was above two, the quotient thus obtained must be added to, but, if less, subtracted from, the said square root, and the result will be the Answer.

If

If the common difference be 2, the ſquare root itſelf is the Anſwer.

EXAMPLE. Let the figurate number be 190, and of the hexagon kind, what number of terms is it compoſed of, or what term is it in the figurate rank?

Here 6=number of ſides, and 6—2=4, the common difference. Alſo $190\times8+4-4=1520$.

And $\frac{1520\times4+4}{4.4^2}=\frac{1520+1}{4^2}=\frac{1521}{4\times4}=\frac{380.25}{4}=95.0625$.

Then $\sqrt{95.0625}=9.75$. Likewiſe $\frac{4-2}{2\times4}=\frac{2}{8}=\frac{1}{4}=.25$; and 9.75+.25=10, the Anſwer ſought.

COR. I. This caſe amounts to the ſame thing, as finding the number of terms in an arithmetic ſeries, proceeding from unity; by having the ſum of the ſeries, and the ratio or common difference given.

PROB. III. To find any aſſigned term of a triangular ſeries of any given order.

RULE. Let n denote the place of the term in the ſeries, and m the number expreſſing the given order; then, if as many terms of the following ſeries, as is denoted by $m+1$, be multiplied together, the reſult will be the Anſwer.

Note alſo, the denominator of the laſt term, included in the operation, is always $=n$.

The ſeries, $n, \frac{n+1}{2}, \frac{n+2}{3}, \frac{n+3}{4}, \frac{n+5}{6}, \frac{n+6}{7}$, &c. *ad infinitum*.

EXAMPLE. What is the 6th term of a ſeries of the 5th order of the triangular kind?

Here $n=6$; and $m=5$; and therefore the number of terms to be multiplied $=5+1=6$.

Conſequently, $6\times\frac{7}{2}\times\frac{8}{3}\times\frac{9}{4}\times\frac{10}{5}\times\frac{11}{6}=\frac{6\times7\times8\times9\times10\times11}{2\times3\times4\times5\times6}$

$=\frac{7\times2\times9\times2\times11}{6}=7\times2\times3\times11=462$, the Anſwer.

COR. The ſum of n terms, in any order, is equal to the nth term in the next ſuperior order. Hence, the above Anſwer, is equal to the ſum of 6 terms in the 4th order.

PROBLEM IV. To find the figurate number in any place of any order, and of what ſpecies ſoever the polygon is.

RULE. Find by the laſt Problem the figurate number, in the given place, and order, of the triangular ſpecies: alſo find the figurate number, in the preceding place of the ſaid order, and ſpecies; and multiply the ſame by the number of the order, leſs 2; to the product, add the firſt found figurate number, and the ſum will be the anſwer ſought.

EXAMPLE. Let it be required to find the fourth term in the ſeries of the third order of pentagonals.

Here $n=4$; and $m=3$; and, therefore, the fourth term in the triangular ſeries $=4\times\frac{4+1}{2}\times\frac{4+2}{3}\times\frac{4+3}{4}=\frac{4\times5\times6\times7}{2\times3\times4}=5\times7=35$. And the preceding term in that order, &c. $=\frac{3\times4\times5\times6}{2\times3\times4}=3\times5=15$. Then $15\times\overline{3-1}=15\times2=30$, and $30+35=65$, the Anſwer.

COR. The like remark takes place here as in the preceding Problem, ſo that this Anſwer is equal to the ſum of 4 terms of the ſeries in the 2d order of pentagonals, or the ſecond order of the 3d ſpecies of figurates.

SECT. II. GEOMETRICAL PROGRESSIONS.

I. Any ſeries of numbers increaſing by a conſtant multiplication, or decreaſing, by a conſtant diviſion, is ſaid to be in geometrical progreſſion, thus: 2, 4, 8, 16, 32, &c. is an increaſing ſeries by a continual multiplication by 2, and 81, 27, 9, 3, 1, &c. is a decreaſing ſeries by a conſtant diviſion by 3.

II. The number, by which the ſeries is conſtantly multiplied, or divided, is called the ratio.

III. Duplicate, triplicate, quadruplicate, &c. ratio, is the ſquare cube, biquadrate, &c. of ſome given ratio.

IV. The greateſt and leaſt terms are called the extremes, and the intermediate terms the means.

V. The antecedent of any term, is that term which immediately precedes it; and the conſequent of any term, is that term which follows next in order after it.

THEOREM I. In any ſeries of numbers, in geometrical progreſſion, the product of the extremes is equal to the product of any two means equally diſtant from the extremes. Thus, in the geometric progreſſion, 3, 6, 12, 24, 48, 96, the product of the extremes, viz. 3×96 (or 108) $=6\times48=12\times24$.

COR. In a ſeries where the number of terms is odd, the product of the extremes is alſo equal to the ſquare of the middle term.

THEOREM II. If out of any geometric ſeries, there be taken any ſeries of equidiſtant terms, that ſeries will alſo be in geometric progreſſion.

Thus in the ſeries 1, 3, 9, 27, 81, 243, 1029, &c. there be taken the terms, 3, 27, 243, theſe terms are alſo in geometrical progreſſion, and are in the triplicate ratio of the former.

COR. Hence, any geometric ſeries, where the number of terms is conſiderable, may be reduced in two or more other ſeries.

THEOREM III. If there be a ſeries of terms in geometric progreſſion, their reſpective differences will alſo be in the ſame geometric progreſſion. Thus, in the ſeries 1, 3, 9, 27, 81, 343, &c. the differences 3—1, 9—3, 27—9, 81—27, &c.=2, 6, 18, 54, reſpectively, are in the ſame geometric progreſſion, with the given ſeries, viz. the ratio in both progreſſions is the ſame.

COR. Hence, the differences of theſe differences; and again, the differences of theſe latter differences, will be in the ſame geometric progreſſion.

THEOREM IV. The laſt term in any deſcending geometric ſeries, or the firſt term in any aſcending one, is equal to the other extreme divided by the ratio, raiſed to the power denoted by the number of terms, leſs 1.

Thus, in the ſeries 2, 6, 18, 54, aſcending; or 54, 18, 6, 2, deſcending; the firſt term in the former, or laſt in the latter, is equal to 54, divided by the cube of the ratio, viz. by 3^3, or 27; $=\frac{54}{27}=2$.

COR. I. The laſt term in any aſcending ſeries, or the 1ſt in any deſcending one, is equal to the other extreme, multiplied by the ratio, raiſed to the power, denoted by the number of terms, leſs 1.

COR. II. In general the nth term of an aſcending ſeries, is equal to the firſt term, multiplied by r^{n-1}; where r is put to denote the ratio.

COR. III. The nth term of any deſcending ſeries, is equal to the firſt term, divided by r^{n-1}.

THEOREM V. In any geometric ſeries, whether aſcending or deſcending, the difference between the ſquare of the firſt term, and the product of the ſecond and laſt, divided by the difference between the firſt and ſecond terms, is equal to the ſum of all the ſeries.

Thus in the aſcending ſeries 2, 4, 8, 16, 32, the ſquare of the firſt term (2) is 4; the product of the ſecond and laſt $=4\times32=128$; and 128—4 $=124$. Alſo the difference between the firſt and ſecond terms $=4-2=2$; and $\frac{124}{2}=62$, the ſum of the ſeries.

Again, in the deſcending ſeries 32, 16, 8, 4, 2, the ſquare of the firſt term (32) is $32\times32=1024$; the product of the ſecond and laſt $=16\times2=32$; and 1024—32=992. Alſo the difference between the firſt and ſecond terms $=32-16=16$; and $\frac{992}{16}=\frac{248}{4}=62$, the ſum of the ſeries, as before.

COR. I. Or, if the difference between the firſt and laſt terms be divided by the difference between the firſt and ſecond terms, and the quotient be multiplied by the ſecond term; then this product, added to the firſt term, will be the ſum of the ſeries, whether the ſame be an aſcending or deſcending one.

COR. II. If the greateſt term of any geometric ſeries, be multiplied by the ratio; and, if from the product, the leaſt term be ſubtracted, and the remainder divided by the ratio, leſs 1, the quotient will be the ſum of the ſeries.

COR. III. If in any geometric ſeries, the difference between the greateſt and leaſt terms, be divided by the ratio, leſs 1; and, if the quotient be added to the greateſt term, the reſult will be the ſum of all the ſeries.

COR. IV. If the ratio of any geometric ſeries, be raiſed to the power denoted by the number of terms, and 1 be ſubtracted therefrom; and, if this remainder be divided by the ratio, leſs 1, and the quotient be multiplied by the leaſt term, the product will be the ſum of the ſeries.

COR. V. If the ratio of any geometric ſeries, be raiſed to the power denoted by the number of terms, and 1 be ſubtracted therefrom; and, if this remainder be divided by the next inferior power of the ratio, or by the ratio raiſed to the power, denoted by the number of terms, leſs 1, and this quotient be multiplied by the greateſt term, the product will be the ſum of all the ſeries.

COR. VI. In any infinite decreaſing geometric progreſſion, if the ſquare of the firſt term be divided by the difference between the firſt and ſecond terms, the quotient will be the ſum of the ſeries.

COR. VII. If in any infinite decreaſing geometric progreſſion the product of the firſt and ſecond terms be divided by the difference of thoſe terms, and the quotient added to the firſt term, the reſult will be equal to the ſum of the ſeries.

COR. VIII. If in any infinite decreaſing geometric progreſſion, the firſt term be multiplied by the ratio, and the product be divided by the ratio, leſs 1, then the quotient will be the ſum of the ſeries.

COR. IX. If the ſum of an infinite decreaſing geometric progreſſion, be divided by the difference between the ſum and the firſt term, the quotient will be the ratio of ſuch ſeries.

COR. X. If the ſum of an infinite decreaſing geometric progreſſion, be divided by the ratio, and the quotient ſubtracted from the ſaid ſum, or multiplied by the ratio, leſs 1, the remainder in the former caſe, or the product in the latter, will be the firſt term.

N. B. Moſt of the operations in geometric progreſſion, are beſt wrought by logarithms; as through their uſe, Multiplication is performed by Addition; Diviſion, by Subtraction; Involution, by Multiplication; and Evolution, by Diviſion.

QUESTIONS

Questions in Geometric Progression.

QUESTION I. What debt will be discharged in 9 months, by paying 3l. the first payment, 6l. the second, 12l. the third, and so on, doubling the payment each time; and what will be the last payment?

Here, by Theorem V. Cor. IV. $\frac{2^9-1}{2-1} \times 3 =$ the debt $=$ $2^9-1\times3$; also, $2^9=2\times2\times2\times2\times2\times2\times2\times2\times2=512$; and therefore $512\times3=1536$l. the debt.

And, by Theorem IV. Cor. I. $2^8\times3=$ last payment $=256\times3=768$l.

QUESTION II. What debt will be discharged by monthly payments in geometric progression, the first payment being 1l. and the last 2048l. the ratio being 2?

Here, by Cor. III. $\frac{2048-1}{2-1} + 2048 = 2047 + 2048 =$ 4095l. the Answer.

QUESTION III. Suppose a body to move perpetually after this manner; viz. the first year 20 miles, the second, 19 miles, the third, $18\frac{1}{19}$, and so on, in a geometric progression, whose ratio is $\frac{19}{20}$, how far will it move in an eternity, or what is the distance beyond which it can never pass?

Here, by Theorem V. Cor. VIII. 20. $\times \frac{20}{19} + \frac{1}{19}; = \frac{20\times20\times19}{19} = 20\times20 = 400$ miles, the distance required.

A Synopsis of the different Cases in Geometric Progression.

Case.	Given.	Required.	Solution.
1	$a, r, n,$	$l, s,$	$l = ar^{n-1}$ $s = \frac{rn-1}{r-1} \times a$
2	$a, r, l,$	$s, n,$	$s = \frac{l-a}{r-1} + l$ $n = \frac{\log. l - \log. a}{\log. r} + 1$
3	$a, r, s,$	$l, n,$	$l = s - \frac{s-a}{r}$ $n = \frac{\log. rs-s \times s+a - \log. a}{\log. r}$
4	$a, l, s,$	$r, n,$	$r = \frac{s-a}{s-l}$ $n = \frac{\log. l - \log. a}{\log. s-a \ldots \log. s-l} + 1$
5	$a, n, s,$	$r, l,$	r will be had by solving this equation, viz. $-rn + \frac{rs}{a} = \frac{s-a}{a}$; and l will be had by solving this equation, $l \times s-l\overline{\vert n-1} = a \times s-a\overline{\vert n-1}$
6	$a, n, l,$	$r, s,$	$r = \sqrt[n-1]{\frac{l}{a}}$ $s = \frac{l-a}{l \div a\overline{\vert \frac{1}{n-1}} - 1} + l$
7	$r, n, l,$	$a, s,$	$a = \frac{l}{rn-1}$ $s = \frac{rn-1}{r-1} \times \frac{l}{rn-1}$
8	$r, n, s,$	$a, l,$	$a = \frac{r-1}{rn-1} \times s$ $l = \frac{rn-1}{rn-1} \times r-1$
9	$r, l, s,$	$a, n,$	$a = s-s-l\times r$ $n = \frac{\log. l - \log. s-s-l\times r}{\log. r} + 1$
10	$n, l, s,$	$a, r,$	a will be had by solving this equation, viz. $a \times s-a\overline{\vert n-1} = l \times s-l\overline{\vert n-1}$; and r will be had by this equation, viz. $-rn + \frac{s}{s-l} \cdot r^{n-1} = \frac{l}{s-l}$

Note in the above Synopsis, a = least term; l = greatest term; s = sum of the series; n = number of terms; r = ratio.

CHAP. XIX. OF HARMONIC PROPORTION.

I. When three terms are so disposed that the difference between the first and second is to the difference between the second and third, as the first term is to the third, they are said to be harmonically proportional.

II. When four terms are so disposed, that the difference between the first and second is to the difference between the third and fourth, as the first term is to the fourth, they are also harmonically proportional.

III. If the terms of an harmonic proportion be continued, then it is called an Harmonic Progression.

PROBLEM I. Given two terms to find a third in harmonic proportion.

RULE. Divide the product of the two terms by the difference between twice the first and second term, and the quotient will be the third term of the proportion; but if it be the second and third term that is given, and the first term is wanted, then divide their product by the difference between twice the third term and the second, and the quotient will be the first term.

Note. The first or third term (according as the case shall be proposed) must be greater than half the second, otherwise the question will be impossible.

EXAMPLE. Let the first and second terms be 10 and 15, respectively, what is the third term in an Harmonic Proportion?

Here $\frac{10\times15}{20-15} = \frac{10\times3}{4-3} = 30$, the Answer.

PROBLEM II. Given three terms to find a fourth in harmonic proportion.

RULE I. If the three first terms be the first, second, and third, then divide the product of the first and third by the difference between twice the first term and the second term, and the quotient will be the fourth term of the proportion.

Note. Here the first term must be proposed greater than half the second, or the case will be impossible.

II. If the given terms be the second, third, and fourth, to find the first, then divide the product of the second and fourth by the difference between twice the fourth term and the third, and the quotient will be the first term.

Here the fourth term must be greater than half the third.

EXAMPLE. Let the second, third, and fourth terms be 16, 24, and 60, respectively, what is the first term?

Here $\frac{16\times60}{120-24} = \frac{16\times5}{10-3} = \frac{8\times5}{5-1} = \frac{40}{4} = 10$, the Answer.

CHAP. XX. OF FALSE POSITION.

False Position is either single or double, and each takes its name from having this property of attaining to the true answer of questions, by the supposition of a false number or numbers.

Questions which belong to position are such as cannot be easily solved by the common rules. Where one supposition only is used, the method is called Single Position; where two suppositions are made, it is named Double Position.

SECT. I. SINGLE POSITION.

In cases where the results are proportional to their suppositions, the following Rule will give the Answer.

RULE. Suppose some fit number at pleasure to denote the Answer, and try according to the tenor of the question, whether the same be true or false. If it answer the conditions of the question, you have hit upon the right number; but if not, you must observe what the false result or conclusion is. Then say, by the Rule of Three, As the false conclusion is to the true number given, so is the false supposition to the true Answer.

QUESTION. A gentleman dying left 10000l. among his three sons, A, B, C, in such proportion, that A's part should be one sixth of B's part, and B's part five sixths of C's part. What was the share of each.

Suppose A's part $=$ 500l. then B's $=$ 3000l. and C's $=$ 2500l. their sum is 6000l. which should have been 10000l, therefore

As 6000l. : 10000l. :: 500l. to A's part $= \frac{5000000}{6000} = \frac{5000}{6} =$ 833l. 6s. 8d. and consequently, B's share $=$ 5000l., and C's $=$ 4166l. 13s. 4d. which together make 10000l.

SECT. II. DOUBLE POSITION.

RULE. Suppose two fit numbers, and proceed with each, as the conditions of the question direct; then, if either of the numbers so taken shall answer all the conditions, you have it upon the true Answer; but, if not, observe what the errors are; viz. how much is the excess or defect of each supposition, writing the suppositions one under another, with their errors opposite to them. This done, multiply the numbers crosswise; viz. the first supposition by the last error, and the last supposition by the first error; then, if the suppositions are of different kinds, viz. one greater than the truth, and the other less, divide the sum of those products by the sum of the errors; but, if the suppositions are alike, viz. either both greater or both less than the truth, divide the difference of the products by the difference of the errors; so will the quotient in either case be the Answer required.

Or, you may proceed to find a correction to be added to either supposition. Thus say, as the difference of the errors, if alike, or sum, if they are unlike, is to the difference of the suppositions, so is either error to the correction to be added to or subtracted from the supposition to which it belongs, according as the same was less or greater than the truth. And here, in order to prevent mistakes, it will be proper, when a supposition is less than

the truth to annex thereto the sign (+) to shew that the correction is to be added; and when greater, the sign (—) to denote that the correction is to be subtracted.

Question I. Two persons, A and B, were discoursing of their money; A said to B, give me 5 guineas of your money, and I shall have just as much as you. No, replied B to A, rather give me 5 guineas of your money, and I shall have just three times as much as you. How much money had each?

Here, suppose A had 10 guineas; then according to the first condition of the question, B must have had 20; then, by the second condition, if A gave B 5 guineas, A will have 5, and B 25; but thrice A's, viz. 15, should have been equal to B's; therefore, this supposition of A's money comes short by 10.

Again: Suppose A had 18 guineas, then, according to the first condition, B must have had 28; and, by the second condition, if 5 be taken from A's and put to B's money, A will have 13 guineas, and B 33 guineas. But thrice A's, in this case, (viz. 39) should be just equal to B's. Wherefore this supposition exceeds the truth by 6. So I write down the suppositions with their errors, and proceed as under.

1st Method.		Error		2d Method.		Error.
1st Suppos.	10	10	16	1st Suppos.	10+	10
2d Suppos.	18	6		2d Suppos.	18—	6

Prod. 180. 60 Prod. Difference 8 16 Sum.
Add 60
16)240(15 Answer.
16
80
80

Then, as 16 : 8 : : 6 : 3. the Cor.
And 18—3=15, the Answer
Or, as 16 : 8 : : 10 : 5, the Cor.
And 10+5=15, the Answer.

Question II, A and B, working together on the same work, can earn 40 shillings in 6 days; A and C together can earn 54 shilling in 9 days; and B and C 80 shillings in 15 days. It is required to determine, what each person, alone, can earn per day?

Here suppose A can earn 3 shillings per day, then it is plain that B must earn 22 shillings in 6 days, and C must earn 54 shillings in 9 days, or as much as A; wherefore, B and C together will, at this rate, earn 100 shillings in 15 days, which is 20 shillings more than is allotted to them by the question; and, as it is evident that the wages of B and C will decrease when those of A are increased, it follows, that the value of A's wages has been assumed too small. Wherefore, for a second supposition, suppose A's wages to be 4 shillings per day, then B must earn 16 shillings in 6 days, and C 18 shillings in 9 days; and therefore, B and C together would earn 70 shillings in 15 days, which is 10 shillings too little; and therefore the supposition of 4 shillings a day for A is too much.

Hence the following operation:

By 1st Method.		Error.		Or thus, by 2d Method.		Error
1st Suppos.	3	20	30	1st Suppos.	3+	20
2d Suppos.	4	10		2d Suppos.	4—	10

Prod. 80 30 Prod. Difference 1 30 Sum
Add 30
30)110
3s. 8d. Answer.

As 30 : 1 : : 20 : $\frac{2}{3}$s.=8d.
which added to 3, gives 3s. 8d.

So it appears, that A can earn 3s. 8d. per day, or 22 shillings in 6 days; and therefore, B must earn 18 shillings in 6 days, or 3 shillings per day; and C must earn 21 shillings in nine days, or 2s. 4d. per day; and, consequently, B and C together will earn 80 shillings in 15 days agreeably to the question, which proves the Answer to be true.

It will be needless to give more Examples, as those who understand the above will find no difficulty in any other.

CHAP. XXI. OF PERMUTATION, COMBINATION, AND COMPOSITION OF QUANTITIES.

SECT. I. Of Permutation or Changes.

The Permutation of Quantities, is the shewing how many different ways the disposition or order of any given number of things may be changed. This is also called Variation or Alternation.

When it is required to find the number of Permutations or Changes of any given number of things different from each other, the following is the rule.

Rule. Multiply all the terms of the natural series of numbers, (viz. 1, 2, 3, 4, 5, 6, 7, &c. from 1, up to the given number, continually together, and the last product will be the Answer required.

Example I. How many changes can be rung upon 8 bells?

Here $1\times2\times3\times4\times5\times6\times7\times8=40320$, the Answer.

Example II. How many days can 7 persons be placed in a different position at dinner?

Here $1\times2\times3\times4\times5\times6\times7=5040$ days, or 13 yrs. 41 weeks, and 5 days, supposing three leap years to fall within that period.

When any number of things are given to find how many changes can be made out of them, by taking any proposed number of quantities at a time, observe the following rule.

Rule II. Take as many terms of a series of numbers, beginning at the number of things given, and decreasing by 1, as is denoted by the number of quantities to be taken at a time, and multiply them into one another, and the product will be the Answer.

Example. How many changes can be rung with four bells, out of eight?

Here $8\times7\times6\times5=1680$, the Answer.

If any number of things are given, whereof there is a certain given quantity of things of one sort, and a certain given quantity of another, and it is required to determine how many changes can be made out of them all, then observe this Rule.

Rule III. Let m denote the whole number of things; also let p denote the number of one sort, and q the number of things of another sort, &c. then $\frac{1\times2\times3\times4\times5 \text{ \&c. to } m \text{ terms.}}{1\times2\times3, \text{ \&c. to } p \text{ ter.} \times 1\times2\times3, \text{ \&c. to } q \text{ ter. \&c.}}$ will be the answer required.

Example. How many different numbers can be made out of the following figures, 1220005555?

Here the whole number (or m)=10; also, there being one 1, two 2's, three 0's, and four 5's, the Answer will be exhibited as follows, viz. $\frac{1\times2\times3\times4\times5\times6\times7\times8\times9\times10}{1.\times1\times2.\times1\times2\times3.\times1\times2\times3\times4}=1260$, the Answer.

If is required to find the changes of any given number of things, taking a given number at a time, in which there are several things of one sort, several of another, &c. then proceed as under.

Rule IV. Find all the different forms of Combination of all the given things, taking as many at a time as is specified in the question: also find the number of changes in any form, and multiply it by the combinations in that form. Do the same for each distinct form, and the sum of all the products will give the whole sum of the changes required.

Note. All the difficulty here, is to find the combinations required, and this is easily done when the quantities are but few, by joining together every two, every three, &c. till you come at the given number to be taken at a time, and then reckoning how many different forms there are, having given the number at a time, and how many in each form. But when the quantities are many, and often repeated, this method will be impracticable; so that recourse must then be had to Problem VI. following, to find these Combinations?

Example. How many changes can be made of every four letters out of these eight; viz. *aaabbbcc*?

Set down the quantities as though you were going to multiply them in an algebraical manner, and note down all the products accordingly, except such as happen to be the same as some of the foregoing, and such as are out of the question.

a, b, c,
a, b, c,
aa, ab, ac, bb, bc, cc,
a, b, c,
aaa, aab, aac, abb, acc, bbb, bbc, bcc,
a, b, c,
aaab, aaac, aabb, aabc, aacc, abbb, abbc abcc, bbbc, bbcc.

Here there are 4 of this form, *aaab*, and the number of changes is 4, } therefore $4\times4=16$
There are 3 of this form, *aabb*, and the changes are 6, } $3\times6=18$
And there are 3 of this form, *aabc*, and the changes are 12, } $3\times12=36$
Number of changes required 70

SECT. II. Combination.

The Combination of Quantities, is the shewing how often a less number of quantities or things can be taken out of a greater, and combined together, without considering their places, or the order they stand in. This is sometimes called Election or Choice.

Note. Here every parcel must be different from all the rest; and no two are to have precisely the same Quantities or Things.

Combinations of the same form, are those wherein there are the same number of quantities, and the same repetitions: as *a b c, b b d, e f f*, &c. are of the same form. Also, $A\,B^1\,C^1$, $D\,A^1\,E^1$, $C^1\,E\,D^1$, &c. are of the same form. But, $A\,B^1\,C$, $A\,B^1$, $A^1\,C^1$, &c. are of different forms.

Here observe, when any quantity is written with an index at the top, it denotes so many repetitions of that quantity; thus a^3 signifies $a\,a$, a^1, $a\,a\,a$, &c.

When is it required to find the number of combinations of any given number of things, all different from one another, and taken any given number at a time, the following is the rule.

Rule I. Let m denote the number of things, and n denote the number taken at a time.

Then $\frac{m\times m-1\times m-2\times m-3\times m-4, \text{ \&c. to } n \text{ terms.}}{1\times2\times3\times4\times5, \text{ \&c. to } n \text{ terms.}}$ = to the Answer.

Example. How many combinations can be made with three letters of the alphabet, reckoning but 24 letters in the alphabet?

Here $\frac{24\times24-1\times24-2}{1\times2\times3}=6\times23\times22=2024$, the Answer.

Cor. I. The number of Combinations of n things, taken out of m, is equal to the co-efficient of the $n+1$th term of a binominal, raised to the mth power.

Cor. II.

Cor. II. The number of all the poſſible Combinations of all the one's, two's, three's, &c. is one leſs than the ſum of all the co-efficients of a binominal raiſed to the mth power, and that is equal to 2^m-1. This is the number of all the elections.

Cor. III. There is the ſame number of Combinations of n things out of m, as of $m-n$ things out of m.

Cor. IV. There is but one Combination of m things out of m, whether they be all different, or ſeveral of one or more ſorts.

Cor. V. The number of Permutations of m things, taken n at a time, is equal to the like number of Combinations, multiplied into n terms of the natural ſeries, 1, 2, 3, 4, 5, &c.

When you would know the number of Combinations of any number of things, in which there are certain quantities of different ſorts, and in the combinations of which ſuppoſing any number to be taken at a time, proceed by Rule II.

Note here, when the quantity is often repeated, as *aaa*, *bbbb*, &c. they may be written thus a^3, b^4, &c. where the index ſhews the number of repetitions of any quantity, or how often it is to be taken.

Rule II. Place the number of things ſo that the greateſt indices may be firſt, and the reſt decreaſe in order. Then begin at the firſt letter, and join it with the ſecond, third, fourth, &c. to the laſt; alſo, take the ſecond letter and join it to the third, fourth, &c. and likewiſe the third, and proceed in the ſame way; and then the fourth, fifth, &c. till all be done; always taking care to reject ſuch combinations as you had before. Thus you have the combinations of all the two's.

Then, for all the three's, join the firſt letter of every one of the two's ſucceſſively; and then the ſecond and third, &c. to the laſt, leaving out ſuch combinations as are had before. So you will have the combinations of the three's.

Proceed the ſame way to get the combinations of all the four's, five's, &c. till you come at the given number to be taken at a time, and ſo you will at laſt get all the ſeveral forms of combination, and how many there are of each ſort.

But, when there are many terms, it will be proper to proceed in this manner: let the ſeveral ſorts of things denoted be a, b, c, d, &c. and the number be m, and let the quantity to be taken at a time be n; alſo, let p, q, r, s, &c. be the reſpective numbers of each ſort; ſo will a^p, b^q, c^r, d^s, &c. denote the repetitions of the ſeveral different ſorts of things, whether equal or unequal.

Likewiſe, let a^t, b^v, c^w, d^x, &c. be the form to be combined, the indices being t, v, w, x, &c. either equal or unequal; then the Rule for any Single Form will be as under.

Let A, B, C, D, &c. be the number of different letters, in the m things expoſed, the indices of which are equal to or greater than (t, v, w, x, &c. reſpectively) the indices in the n things. Then the number of combinations in that form, is $\frac{A \times B-1 \times C-2 \times D-3 \text{ \&c.}}{RS, \text{ \&c.}}$ continued to as many terms as there are different letters in the form propoſed; where $R=1\times2$, or $1\times2\times3$, or $1\times2\times3\times4$, &c. when any index in the form is twice, thrice, or four times, &c. repeated; and the like for S, &c.

The operation muſt be repeated for every form, and the ſum of all will give the number of combinations required.

Cor. Hence, before the required number of combinations can be determined, all the different forms of combination muſt be firſt found; the beſt method for which is thus:

Set down all the indices contained in the m quantities, taking the greateſt firſt, and the reſt in like order. Then, to get all the forms, write down the greateſt index firſt, and the next leſs, toward the right hand; and ſo on, till the ſum be equal to n; obſerving that the number of places cannot exceed the number of different letters.

Proceed from row to row, in breaking the leaſt figures, viz. thoſe towards the right hand, into others that are ſtill leſs, till they be units. And thus go on, figure by figure, from right to left, till the numbers are diminiſhed as low as the caſe will admit.

Example. How many combinations are there in a^4, b^3, c^2, d, e, taking 8 at a time?

Forms.	Combinations.
422	1
4211	6
41111	1
3221	3
32111	3
22211	1
Total	13 the Anſw.

Here the indices of the given quantity, are 42211; $n=8$, and the number of places, in any form, cannot exceed 5.

Here the method of deriving the forms in this Example is ſo obvious, that it is needleſs to ſay any thing about it; but it may be neceſſary to explain the application of the preceding Rule, in finding the number of combinations according to each form.

The firſt form is 422. Now there is but one index in the given quantity that contains the firſt index of this form (4); therefore, A=1; but there are three indices that contain the ſecond and third indices of this form; and therefore B=3, and C=3; alſo, ſince in the ſaid form there is one index, namely 2) that occurs twice, therefore $R=1\times2=2$.

Hence, by the Rule, the number of combinations $=\frac{1\times2\times1}{2}=1$; in the ſecond form, A=1, B=3, C=5, and D=5; alſo one index (viz. 1) occurs twice; therefore, $R=1\times2=2$.

Hence the number of combinations $\frac{1\times2\times3\times2}{2}=6$.

In the third form, A=1, B=5, and C=5, D=5; and E=5; and one index (viz. 1) occurs four times; therefore, $1\times2\times3\times4=24=R$; and the number of combinations $=\frac{1\times4\times3\times2\times1}{24}=1$.

In the fourth form, A=1, B=3, and C=3, D=5; and R=2; conſequently the number of combinations $=\frac{1\times2\times1\times2}{2}=2$.

In the fifth form, A=1, B=3, C=5, D=5, and E=5; and $R=1\times2\times3=6$; therefore, the number of combinations $=\frac{1\times2\times3\times2\times1}{6}=2$.

In the laſt form, A=3, B=3, C=3, D=5, and E=5; and here one index, (viz. 2.) occurs thrice, therefore, $R=1\times2\times3=6$; and another index (viz. 1.) occurs twice, therefore, $S=1\times2=2$; and, conſequently, the number of combinations $=\frac{3\times2\times1\times2\times1}{6\times2}=1$.

The ſum of all the combinations is 13, the Anſwer.

SECT. III. Compoſition.

The Compoſition of Quantities, is the taking a given number of quantities out of as many equal rows of different quantities, one out of every row, and combining them together.

Here no regard is had to their places, and it differs from Combination, in which there is but one row of things.

If you would find how many compoſitions of things, each conſiſting of any ſpecified number, can be taken out of a ſpecified number of rows, each containing any given number of things, proceed thus:

Rule. Involve the number of things in each row, to the power denoted by the number, that is, in each compoſition; or, which is the ſame, to the power denoted by the number, which expreſſes the quantity of rows, and the reſult will be the Anſwer.

Cor. If n be the number of rows, or number in each compoſition, and m = number of things in each row; then $\frac{m^{n+1}-m^n}{m-1}$, (or $\frac{m-1}{m-1}\times m^n$.) is equal to the number of compoſitions of all the one's, two's, three's, &c. to n.

Example I. How many combinations of three letters are there in three alphabets, each containing 24 letters?

Here $24^3=13824$, the Anſwer.

Example II. How many words can be formed out of the whole alphabet, ſuppoſing any compoſition from 2 to 24, to make a word.

Here $m=24$, and $n=24$; and by the above Corollory $\frac{24^{24}-1}{23}\times24=$ the number of words, if the compoſitions of 1 were included. Now the compoſitions of $1=24$; and therefore $\frac{24^{24}-1}{23}\times24-24=139724288887252999423128493402176$, the Anſwer required.

Other Problems of the like nature might be given; but they are ſuch, as are ſeldom wanted; and, indeed, more have been already introduced, than are to be met with in moſt books of Arithmetic.

CHAP. XXII. OF CIRCULATING DECIMALS.

SECT. I. Definitions and Preparative Introduction.

I. A Circulating, or Recurring Decimal, is that wherein one or more figures are continually repeating; as 42.3876666, &c. which is named a Single Circulate; and 285,2642642642, &c. which is called a Compound Circulate.

II. The recurring part of a Decimal, is named the Repetend.

III. A Single Repetend, is expreſſed by writing a point over the circulating figure, thus .2333, &c. is denoted by .2$\dot{3}$.

IV. A Compound Repetend, is diſtinguiſhed by putting points over the firſt and laſt repeating figures; thus .375375375, &c. is expreſſed .3$\dot{7}\dot{5}$.

V. Similar Circulating Decimals, are ſuch as conſiſt of the ſame number of figures, and begin at the ſame place, either before or after the Decimal point; thus 3.$\dot{4}$ and 4.$\dot{4}$ are Similar Circulates; ſo alſo are 3.4$\dot{2}$ and 5.2$\dot{7}$, &c.

VI. Diſſimilar Repetends, conſiſt of an unequal number of figures, and begin at different places.

VII. Similar and conterminous Circulates, are ſuch as begin and end at the ſame place; as 2.4$\dot{6}\dot{3}\dot{8}$, 5.3$\dot{2}\dot{4}\dot{6}$, and 7.5$\dot{4}\dot{3}\dot{5}$, &c.

N. B. Any Proper Vulgar Fraction, whoſe denominator is compounded of any other number than 2 and 5, will produce a circulating Decimal; which will always repeat before there are as many figures obtained, as there are units in the denominator.

Theorem. In any Circulating Decimal, the whole circulating

pating or repeating part, running on for ever, is equal to a Vulgar Fraction, whose numerator is the number repeating (or repetend) and the denominator as many 9's as there are figures in the repetend.

Cor. I. The circulation may be supposed to begin at any figure of the repetend.

Cor. II. If any circulating number be multiplied by any given number, the product will be a circulating number, and the repetend will consist of the same number of figures as before.

Cor. III. If a circulating decimal has a repetend of any number of figures, it may be considered as having a repetend of twice, thrice, or any multiple of that number. Thus, 4137, is equivalent to $4.\dot{1}3\dot{7}$, or $4.1\dot{3}7\dot{3}$, &c.

Cor. IV. If two or more numbers be added together that have repetends of equal places, the sum will have a repetend of the same number of places.

Prob. I. Having a vulgar fraction given in the lowest terms, and the denominator a prime, (but neither 2 nor 5) to find the number of figures that circulate in the decimal thereof.

Rule. Divide 99999, &c. by the denominator till 0 remains; then the number of 9's, made use of, will be equal to the number of places in the repetend.

Example. Let the fraction be $\frac{5}{7}$.

Then $7)\overline{999999}$ &c.
142857, and 0 remains.

So in taking 6 nines, there is no remainder; and consequently if the fraction $\frac{5}{7}$ be reduced to a decimal, it will have a repetend of six places.

Prob. II. Having a vulgar fraction in the lowest terms, and the denominator made up of two or more primes (2 and 5 excluded) to find the number of figures that circulate in the decimal thereof.

Rule. Find by the last Problem the number answering to each prime; also find by Prob. IV. of fractions, the least dividend that will divide by each such number without a remainder, and it will be equal to the number of figures in the repetend of the decimal.

Example. Let the fraction be $\frac{13}{11\times37}$, or, $\frac{13}{407}$.

Here the repetend by 11, consists of two places, and that by 37, of 3 places: also the least number that will divide by 2 and 3 is 6. Consequently the fraction $\frac{13}{407}$ will produce a repetend of 6 places.

Problem III. Having given any number of dissimilar repetends, to reduce them to similar and conterminous ones.

Rule. Find the least dividend that will divide by the several figures, denoting the number of places in the proposed repetends. Then that dividend will denote the number of places in each similar and conterminous repetend; then that number, whose repetend begins the farthermost to the right hand, (viz. at the greatest distance from the units figure) must be increased till the repetend consist of the due number of figures, as above mentioned; and then the decimals in the rest of the numbers must be augmented, if need be, so as to have a like number in each.

Example. Let the dissimilar repetend be $6.\dot{2}1\dot{4}$, $.\dot{1}5\dot{1}$, and $1.\dot{2}$.

Here the number of places in the first repetend is 3; in the second 2; and in the third 1; and the least number that will divide by each of these is 6.

Therefore there must be six places in the repetend, and consequently the numbers become $6.2\dot{1}4214$; $\cdot\dot{1}51515$; & $1.\dot{2}22222$ respectively; and thus they are made similar and conterminous. The nature of this process is farther evident from what has been said in Corollories I. and III. of the preceding Theorem.

Note, If a number be proposed that is not a repetend of itself, yet one or more cyphers (as decimals) may be annexed, and so it may be considered as having a repetend of cyphers.

SECT. II. Addition of Circulating Decimals.

Rule. Make the repetends similar and conterminous, if they are not so already; find the sum of the similar repetends; and divide the same by a number, consisting of as many nines as is the common number of places in the similar repetends; then the remainder will be the repetend of the required sum; and the quotient will be the number to be carried to the next column to be added as finite decimals.

Example. Let it be required to add $2.\dot{5}$; $62.3\dot{4}\dot{2}$; and $.3\dot{2}7$ together.

Here, the numbers being made similar, and placed in order for addition, will stand as they are here put down: and the sum of the repetends is 1252251, which divided by 999999, the quotient is 1, to be carried to the next row, and the remainder is 252252, to be put down for the repetend; and so the whole sum is $65.\dot{2}25\dot{2}252$, but it is obvious that this repetend may be taken in fewer figures; thus the above sum is $=65.\dot{2}25=65.2\dot{2}$.

$2.\dot{5}555555$
$62.\dot{3}42\dot{3}423$
$.\dot{3}273273$
$65.\dot{2}252252$

SECT. III. Subtraction of Circulating Decimals.

Rule. Make the repetends similar and conterminous, and subtract as in finite decimals; observing to make the last figure in the remainder 1 less, when the repetend in the number subtracted is greater than the repetend in the number subtracted from.

Example. From $35.1\ddot{2}$ take $2.7\dot{6}4$.

Here the numbers reduced to a like repetend, are $35.1\ddot{2}12$, and $2.7\dot{6}44$. And $35.1\ddot{2}12-2.7\dot{6}44=32.3568$. But the repetend in the number subtracted (viz. 44) being greater than the other (viz. 12) therefore I take 1 from the last decimal figure, and so the proper remainder is $32.3\dot{5}67$; the two last figures being a repetend.

SECT. IV. Multiplication and Division of Circulating Decimals.

Rule. By the foregoing Theorem, turn both the terms into their equivalent vulgar fractions, and find the product or quotient of these fractions as usual. Then, if the Answer is required in decimals, reduce the fractional product, or quotient, to a decimal.

Example I. Multiply $4.7\dot{2}$ by $3.\dot{6}$

Here $4.7\dot{2}=4.7\frac{2}{9}=4\frac{68}{90}$; $=\frac{425}{90}$; and $3.\dot{6}=3\frac{6}{9}=3\frac{2}{3}=\frac{11}{3}$.

Then, $\frac{425}{90}\times\frac{11}{3}=\frac{425\times11}{90\times3}=\frac{185\times11}{18\times3}=\frac{935}{54}=17\frac{17}{54}=17.3\dot{1}48$.

Example II. Divide $3.\dot{5}$ by $.\ddot{2}4$.

Here $3.\dot{5}=3\frac{5}{9}=\frac{32}{9}$; and $.\ddot{2}4=\frac{24}{99}$. And $\frac{32}{9}\div\frac{24}{99}=\frac{11}{3}\times\frac{99}{24}=\frac{12\times99}{9\times24}=\frac{44}{3}=14.666$, &c. $=14.\dot{6}$.

CHAP. XXIII. OF PERFECT NUMBERS.

A perfect number is one that is equal to the sum of all its aliquot parts.

Theorem. If any number of terms of the following geometric progression, 1, 2, 4, 8, 16, &c. be taken, and if the sum be a prime number, then such sum, multiplied by the last term, will give a perfect number.

Thus the sum of the two first terms $1+2=3$, a prime, and $2\times3=6$, a perfect number; for its aliquot parts are 3, 2 and 1, which make 6; and therefore 6, is a perfect number.

If three terms of the series are taken $1+2+4=7$, a prime; and $4\times7=28$, a perfect number.

Also $1+2+4+8+16=31$ a prime; and $31\times16=496$, a perfect number.

Likewise $1+2+4+8+16+32+64=127$, a prime; and $127\times64=8128$, a perfect number.

Again, if 13 terms of the series be taken, the sum will be 8191, a prime; which multiplied by the last term, (4096) gives 33550336, a perfect number.

This method will always find a perfect number; and, I believe, every perfect number, though that has not yet been demonstrated; nor has it been demonstrated what number of terms of the given series must be taken each time that the sum may be a prime; so that the finding whether the sum be a prime or not, in large numbers is exceeding tedious, and renders the process very intricate.

There are but few perfect numbers yet discovered; and Dr. Harris, in his Lexicon Technicum, says, there are but 10 such numbers between 1, and 1 million of millions.

A SUPPLEMENT TO CHAP. X.

The following Rule for extracting the Cube Root, is derived from the same principles as that in Sect. VI. Chap. X. but it will be still more commodious for practice.

Rule. Take $\frac{1}{3}$ of the difference between the number to be extracted, and the nearest Cube: also take the *sum of*, or *difference between*, the number to be extracted, and the said third part, according as such Cube is *less*, or *greater*, than the given number, and divide the result by the aforesaid Cube; then the square Root of the quotient, added to the assumed Root, will be equal to twice the required Root, *nearly*.

If more accuracy is requisite, the operation must be repeated.

Generally, If any number to be extracted be denoted by N, the index of the power by n, and an assumed Root, taken at pleasure (but as near as may be to the true one) by r, then will $\frac{1}{n-1}\times\sqrt{\frac{+n-2}{N\ominus\frac{n}{n}N\ominus r^n}{r^{n-2}}}+\overline{n-2}.r$, be equal to the required Root, *nearly*.

N. N. When the assumed Root (r) is too small, then $\frac{n-2}{n}N\ominus r^n$ must be *added*, to N; but when r, is too great, then the *difference* between this quantity and N must be taken. This approximation, commonly *trebles* the number of true figures in the Root at each operation.

The above *general method* I investigated after the copy of this System went to the press. It appears inferior to none for ease and expedition; and, I believe, I need not scruple to assert that it is *intirely new*.

I could add but little more to this System except duodecimal arithmetic and cross multiplication, which come with greater propriety in the treatise on mensuration: therefore those who wish to consult those particulars are referred to the Treatise.

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ARK, or *Noah's* ARK, a floating veſſel built by Noah for the preſervation of his family and the ſeveral ſpecies of animals during the deluge. The ark has afforded ſeveral points of curious enquiry among the critics and naturaliſts, relating to its form, capacity, materials, &c. The wood whereof it was built is called in the Hebrew *Gopher-wood*, and in the Septuagint, *ſquare timbers*. Some tranſlate the original *cedar*, others *pine*, others *box*, &c. Pelletier, prefers cedar, on account of its incorruptibility, and the great plenty of it in Aſia; whence Herodotus and Theophraſtus relate, that the kings of Egypt and Syria built whole fleets thereof, inſtead of deal. The learned Mr. Fuller, in his Miſcellanies, has obſerved, that it was nothing but that which the Greeks call κυπαρισσος, or the *cypreſs tree*; for, taking away the termination, *kupar* and *gopher* differ very little in ſound. This obſervation the great Bochart has confirmed, and ſhewn very plainly that no country abounds ſo much with this wood as that part of Aſſyria which lies about Babylon.

In what place Noah built and finiſhed his ark is made a matter of diſputation. But the moſt probable opinion is, that it was built in Chaldea, in the territories of Babylon, where there was ſo great a quantity of cypreſs in the groves and gardens in Alexander's time, that that prince built a whole fleet out of it for want of other timber. And this conjecture is confirmed by the Chaldean tradition, which makes Xithurus (another name for Noah) ſet ſail from that country. The dimenſions of the ark, as given by Moſes, are 300 cubits in length, 50 in breadth, and 30 in height; which ſome have thought too ſcanty, conſidering the number of things it was to contain; and hence an argument has been drawn againſt the authority of the relation. To ſolve this difficulty many of the ancient fathers, and the modern critics, have been put to very miſerable ſhifts: but Buteo and Kircher have proved geometrically, that, taking the common cubit of a foot and a half, the ark was abundantly ſufficient for all the animals ſuppoſed to be lodged in it. Snellius computes the ark to have been above half an acre in area. Father Lamy ſhows, that it was 110 feet longer than the church of St. Mary at Paris, and 64 feet narrower: and if ſo, it muſt have been longer than St. Paul's church in London, from weſt to eaſt, and broader than that church is high in the inſide, and 54 feet of our meaſure in height; and Dr. Arbuthnot computes it to have been 81062 tons.

The things contained in it were, beſides eight perſons of Noah's family, one pair of every ſpecies of unclean animals, and ſeven pair of every ſpecies of clean animals, with proviſions for them all during the whole year. The former appears, at firſt view, almoſt infinite; but if we come to a calculation, the number of ſpecies of animals will be found much leſs than is generally imagined; out of which in this caſe, are excepted ſuch animals as can live in the water; and biſhop Wilkins ſhows that only 72 of the quadruped kind needed a place in the ark. By the deſcription Moſes gives of the ark, it appears to have been divided into three ſtories, each ten cubits or fifteen feet high; and it is agreed on, as moſt probable, that the loweſt ſtory was for the beaſts, and the middle for the food, and the upper for the birds, with Noah and his family; each ſtory being ſubdivided into different apartments, ſtalls, &c. though Joſephus, Philo, and other commentators, add a kind of fourth ſtory under all the reſt; being, as it were, the hold of the veſſel, to contain the ballaſt and receive the filth and faeces of ſo many animals: but F. Calmet thinks, that what is here reckoned a ſtory, was no more than what is called the *keel* of ſhips, and ſerved only for a conſervatory of freſh water. Drexelius makes 300 apartments; F. Fournier, 333; the anonymous author of the Queſtions on Geneſis, 400; Buteo, Temporarius, Arias Montanus, Hoſtus, Wilkins, Lamy, and others, ſuppoſe as many partitions as there were different ſorts of animals. Peletier makes only 72; viz. 36 for the birds, and as many for the beaſts. His reaſon is, that if we ſuppoſe a greater number, as 333 or 400 each of the eight perſons in the ark muſt have had 37, 41, or 50 ſtalls to attend and cleanſe daily, which he thinks impoſſible to have been done. But it is to be obſerved, that there is not much in this: to diminiſh the number of ſtalls without a diminution of animals is vain; it being perhaps more difficult to take care of 300 animals in ſeventy-two ſtalls than in 300. As to the number of animals contained in the ark, Buteo cumputes that it could not be equal to 500 horſes; he even reduces the whole to the dimenſions of 56 pair of oxen. F. Lamy enlarges it to 64 pair of oxen, or 128 oxen; ſo that, ſuppoſing one ox equal to two horſes, if the ark had room for 256 horſes, there muſt have been room for all the animals. But the ſame author demonſtrates, that one floor of it would ſuffice for 500 horſes, allowing nine ſquare feet to a horſe.

As to the food in the ſecond ſtory, it is obſerved by Buteo from Columella, that 30 or 40 pounds of hay ordinarily ſuffices for an ox a day; and that a ſolid cubit of hay, as uſually preſſed down in our hay-ricks, weighs about 40 pounds; ſo that a ſquare cubit of hay is more than enough for one ox in one day. Now, it appears, that the ſecond ſtory contained 150,000 ſolid cubits; which divided between 206 oxen, will afford each more hay, by two-thirds, than he can eat in a year. Biſhop Wilkins computes all the carnivorous animals equivalent, as to the bulk of their bodies, and their food, to 27 wolves; and all the reſt to 280 beeves. For the former, he allows 1825 ſheep; and for the latter, 109,500 cubits of hay: all which will be eaſily contained in the two firſt ſtories, and a deal of room to ſpare. As to the third ſtory, no body doubts of its being ſufficient for the fowls; with Noah, his ſons, and daughters. Upon the whole, the learned biſhop remarks, that of the two, it appears much more difficult to aſſign a number and bulk of neceſſary things to anſwer the capacity of the ark, than to find ſufficient room for the ſeveral ſpecies of animals already known to have been there. This he attributes to the imperfection of our liſt of animals, eſpecially thoſe of the unknown parts of the earth; adding, that the moſt expert mathematician at this day could not aſſign the proportion of a veſſel better accommodated to the purpoſe than is here done: and hence he finally concludes, that the capacity of the ark, which had been made an objection againſt ſcripture, ought to be eſteemed a confirmation of its divine authority; ſince, in thoſe ruder ages, men, being leſs verſed in arts and philoſophy, were more obnoxious to vulgar prejudices than now; ſo that, had it been a human invention, it would have been contrived according to thoſe wild apprehenſions which ariſe from a confuſed and general view of things as much too big as it had been repreſented too little. But it muſt be obſerved, that, beſides the places requiſite for the beaſts and birds, and their proviſions, there was room required for Noah to lock up houſehold utenſils, the inſtruments of huſbandry, grains, and ſeeds to ſow the earth with after the deluge; for which purpoſe it is thought that he might ſpare room in the third ſtory for 36 cabins, beſides a kitchen, a hall, four chambers, and a ſpace about 48 cubits in length to walk in.

ARK *of the Covenant*, in ſcripture, was a kind of cheſt wherein, by God's command, Exodus xxv. 16, were kept the two tables of ſtone, whereon God had engraven the ten commandments given to Moſes on the Mount, and held in high veneration among the Hebrews. It was depoſited in the holieſt place of the tabernacle. It was taken by the Philiſtines, and detained twenty, ſome ſay forty years, at Kirjath Jearim; but the people being afflicted with emrods on account of it, returned it with divers preſents. Afterwards, when Solomon's temple was built, it was placed therein.

On the *ark* was the *propitiatory*, or mercy-ſeat; over which were two figures placed, called *Cherubims*, with expanded wings of a peculiar form. The high prieſt appeared before this mercy-ſeat once every year, on the great day of expiation; and the Jews, wherever they worſhipped, turned their faces towards the place where the *ark* ſtood. In the ſecond temple there was alſo an *ark*, made of the ſame ſhape and dimenſions with the firſt, and put in the ſame place, but without any of its contents and peculiar honours. It was uſed as a repreſentative of the former, on the day of expiation, and a repoſitory of the original copy of the holy ſcriptures, collected by Ezra and the men of the great ſynagogue, after the captivity. And in imitation of this, the Jews, to this day, have a kind of *ark* in their ſynagogues, wherein their ſacred books are depoſited. This they called *aron*. Leo of Modena gives a deſcription thereof, in his account of the Cuſtoms and Ceremonies of thoſe of his Nation: "The Jews, ſays he, in the eaſtern ſide of their ſyna-"gogues, have an *ark*, or armory, called *aron*; in memory of "the *ark* of the covenant. In this are preſerved the five books "of Moſes, written on vellum, with ink made on purpoſe" &c. Some have ſuppoſed that the figure of this *ark* is ſtill remaining on the triumphal arch of Titus at Rome; though Villalpandus and others, with greater reaſon, are of opinion, that it is the table of ſhew-bread. Prideaux's Conn. vol. i. p. 209. A cheſt or coffer, very near reſembling the Jewiſh *ark*, and called the *houſe of the god*, was found in Huaheine, one of the iſlands in the Southern ſea. Mr. Banks could obtain no other information concerning it, than what the name imports. Hawkeſworth's Account, &c. vol. ii. p. 252.

ARM, a part of the human body, terminating at one end in the ſhoulder, and at the other in the hand. Among anatomiſts, arm only includes that part between the ſhoulder and the elbow; the reſt from the elbow to the wriſt, being taken into the greater hand; by others called the *fore-arm*. The *arm*, in this latter acceptation, has only one large bone, called the humerus, or ſhoulder-bone. For a particular deſcription of the bones and muſcles of this part of the human body, ſee the Syſtem of ANATOMY, Part I. Art. 2. and Part II. Art. 22. For repreſentation, ſee the Plates annexed to the reſpective parts of bones and muſcles.

ARM is uſed figuratively for *power*. The ſecular *arm* is the lay or temporal authority of a ſecular judge; to which recourſe is had for the execution of the ſentences paſſed by eccleſiaſtical judges. The church ſheds no blood; even the judges of inquiſition, after they have found the perſon guilty, ſurrender him to the ſecular *arm*. The council of Antioch, held in 341, decrees, that recourſe be had to the ſecular *arm* to repreſs thoſe who refuſe obedience to the church: for ſecular *arm*, they here uſe exterior power.

ARM, in Sea-Language. A ſhip is ſaid to be *armed*, when fitted out, and provided, in all reſpects, for war. *Armed* ſhip more

more peculiarly denotes a veſſel that is occaſionally taken into the ſervice of government in time of war, and employed to guard ſome particular coaſt, or attend on a fleet. All ſhips of this ſort are commanded by an officer of the navy, and are upon the ſame eſtabliſhment with the king's ſloops. Alſo a croſs-bar ſhot is ſaid to be *armed*, when ſome rope-yarn, or the like, is rolled round about one end of the iron bar which runs through the ſhot, both that the ſhot may be the better rammed down into the gun, and leſt the ſharp end of the bar ſhould catch into any honeycombs within the cylinder of the piece.

ARM, in reſpect of the Magnet. A load-ſtone is ſaid to be *armed*, when it is capped, caſed, or ſet in iron or ſteel; in order to make it take up the greater weight; and alſo to diſtinguiſh readily its poles. For the attracting power of the magnet, and the principles of magnetiſm, ſee the Articles MAGNET and MAGNETISM. The armour of a ſpherical loadſtone conſiſts of two ſteel ſhells faſtened to one another by a joint, and covering a good part of the convexity of the ſtone. This alſo is to be filed away till the effect is found the greateſt. Kircher, in his book *de Magnete*, tells us, that the beſt way to *arm* a load-ſtone, is, to drill a hole through the ſtone from pole to pole, and in that, to place a ſteel rod of a moderate length; which rod, adds he, will take up more weight at the end, than the ſtone itſelf *armed* the common way can do.

ARMADA, a Spaniſh term, ſignifying a fleet of men of war. The Armada which attempted to invade England in the time of queen Elizabeth, is famous in hiſtory; it was partly ſcattered by the wind, and partly ſubdued by the Engliſh fleet. On which occaſion a medal was ſtruck with this motto, *Affavit Deus, et diſſipantur*.

ARMADILLO, in the ſyſtem of Mammalia, the name of the genus daſypus. For deſcription of the genus, ſee the Article DASYPUS. For claſſification, ſee the SYSTEM. For repreſentation, ſee Plate II. Genus 10.

ARMENIAN *ſtone*, *lapis armenus*, a mineral ſtone, or earth, of a blue colour, ſometimes, ſpotted with green, black, and yellow. It is a very ſcarce foſſil, anciently brought only from Armenia, but is now found very pure, though in ſmall quantities, in the mines at Goſſelaer, in Saxony. The Armenian ſtone, in its harder ſtate, bears a near reſemblance to lapis lazuli, from which it ſeems only to differ in degree of maturity: they are diſtinguiſhed by this, that the lapis armenus is ſofter, and inſtead of ſparks of gold, is often ſpeckled with green. Boerhaave ranks it among ſemi-metals; and ſuppoſes it compoſed of a metal and earth. Woodward ſays, it owes its colour to an admixture of copper. It chiefs uſe is in Moſaic work, though it has ſome place alſo in phyſic. It is a very valuable ſubſtance in painting, being a bright and florid blue. It was in ſo high eſteem as a paint, among the ancients, that counterfeits were continually attempted to ſerve in its place. Both this and the lapis lazuli are ores of copper.

ARMENIANS, in reſpect of religion, a diviſion among the eaſtern Chriſtians; thus called from Armenia, the country anciently inhabited by them. Some have ſuppoſed, that Chriſtianity was eſtabliſhed in Armenia by the apoſtle St. Bartholomew: but this is certain, that in the beginning of the fourth century, the Armenian Chriſtians were in a very flouriſhing ſtate. The Armenian church, in the ſixteenth century, was governed by three patriarchs, the chief of whom reſided in a monaſtery at Echmiazin. There were other biſhops among them, who aſſumed the title of patriarchs, without prerogatives annexed to it; though by authority derived from the chief patriarch, they were allowed to conſecrate biſhops, and every third year to make and diſtribute the holy chriſm, or ointment, which is the privilege of the patriarchs alone. The Armenians, ſince the conqueſt of their country by Sha Abbas, king of Perſia, have had no fixed place of habitation, but are diſperſed in divers parts of Perſia, Turky, and Tartary, and even ſome parts of Europe, particularly Poland. Their chief employment is merchandize, in which they excel. The cardinal de Richelieu, we are told, had a deſign to make an eſtabliſhment of them in France, for promoting the commerce of that country. And the chancellor Seguier, granted them a printing houſe at Marſeilles. With regard to religion, there are two kinds of Armenians; the one catholics, and ſubject to the pope, having a patriarch in Perſia, and another in Poland. The other makes a peculiar ſect, having two patriarchs in Natolia. The Armenians are generally accuſed of being Monophyſites, and only allowing of one nature in Jeſus Chriſt. As to the euchariſt, they agree with the Greeks, except in this, that they mix no water with their wine, and uſe unleavened bread, after the manner of the Latins. The Armenian clergy conſiſt of patriarchs, archbiſhops, doctors, ſecular prieſts, and monks. The ſecular prieſts are not allowed to marry a ſecond time; and therefore they take care to chooſe young healthy wives; they maintain themſelves and families by following ſome occupation, inſomuch that they have hardly time to perform their eccleſiaſtical functions: they lie in the churches on the vigils of thoſe days they are obliged to officiate. The Armenian monks are of the order of St. Baſil; and every Wedneſday and Friday they eat neither fiſh, nor egge, nor oil, nor any thing made of milk, and during Lent they live upon nothing but roots: they are allowed wine only on the Saturday in the Holy Week, and meat on the Eaſter Sunday. Beſides the great Lent, they have four others of eight days each, which are inſtituted to prepare for the four great feſtivals of the Nativity, the Aſcenſion, the Annunciation, and of St. George; in which times they muſt not ſo much as ſpeak of eggs, fiſh, oil, or butter. The Armenians ſeem to place the chief part of their religion in faſtings and abſtinences; and among the clergy, the higher the degree the lower they muſt live; inſomuch that it is ſaid, the archbiſhops live on nothing but pulſe. They conſecrate holy water but once a year; at which time every one fills a pot and carries it home, which brings in a conſiderable revenue to the church.

ARMILLARY, in Aſtronomy, an epithet given to an artificial ſphere, compoſed of a number of metalline circles, repreſentative of the ſeveral circles of the mundane ſphere, put together in their natural order. The word is formed of the Latin armilla, a bracelet. Armillary ſpheres eaſe and aſſiſt the imagination to conceive the conſtitutions of the heavens, and the motions of the heavenly bodies. For deſcription of theſe ſpheres, ſee the Treatiſe on the GLOBES. For repreſentation, ſee the Plate annexed, Fig. 1 and 2.

ARMINIANISM, the doctrine of Arminius and his followers. See the following article.

ARMINIANS, the followers of Arminius, a celebrated miniſter of Amſterdam, and afterwards profeſſor of theology in the univerſity of Leyden. Arminius, though educated at Geneva, and having imbibed the doctrines concerning predeſtination and grace, maintained by Calvin, Beza, Zanchius, &c. began to expreſs his doubts concerning them in the year 1591; and upon further enquiry, adopted ſentiments more nearly reſembling thoſe of the Lutherans, than of the Calviniſts. After his appointment to the theological chair at Leyden, he thought it his duty to avow and vindicate the principles which he had embraced; and the freedom with which he publiſhed and defended them, expoſed him to the reſentment of thoſe that adhered to the theological ſyſtem of Geneva, which then prevailed in Holland; but his principal opponent was Gomar, his colleague. The controverſy which was thus begun, became more general after the death of Arminius, in the year 1609, and threatened to involve the United Provinces in civil diſcord. The Arminian tenets gained ground under the mild and favourable treatment of the magiſtrates of Holland, and were adopted by ſeveral perſons of merit and diſtinction. The Calviniſts, or Gomariſts, as they were then called, appealed to a national ſynod; accordingly the ſynod of Dort was convened, by order of the States General, in 1618, and was compoſed of eccleſiaſtical deputies from the United Provinces, as well as from the reformed churches of England, Heſſia, Bremen, Switzerland, and the Palatinate. The principal advocate in favour of the Arminians was Epiſcopius, who at that time was profeſſor of divinity at Leyden. It was firſt propoſed to diſcuſs the principal ſubjects in diſpute, and that the Arminians ſhould be allowed to ſtate and vindicate the grounds on which their opinions were founded: but ſome difference ariſing as to the proper mode of conducting the debate, the Arminians were excluded from the aſſembly; their caſe was tried in their abſence; and they were pronounced guilty of peſtilential errors, and condemned as corruptors of the true religion. In conſequence of this deciſion, they were treated with great ſeverity; they were deprived of all their poſts and employments; their miniſters were ſilenced, and their congregations were ſuppreſſed. However, after the death of prince Maurice, who had been a violent partizan in favour of the Gomariſts, in the year 1625, the Arminian exiles were reſtored to their former reputation and tranquility; and under the toleration of the ſtate, they erected churches, and founded a college at Amſterdam, appointing Epiſcopius to be the firſt theological profeſſor. The Arminian ſyſtem has very much prevailed in England ſince the time of archbiſhop Laud, and its votaries in other countries are very numerous.

The diſtinguiſhing tenets of the Arminians may be comprized in the following five articles: relating to predeſtination, univerſal redemption, the corruption of man, converſion, and perſeverance. With reſpect to the firſt, they maintained, "That God, from all eternity, determined to beſtow ſalvation on thoſe who, he foreſaw, would perſevere unto the end in their faith in Chriſt Jeſus; and to inflict everlaſting puniſhment on thoſe who ſhould continue in their unbelief, and reſiſt, unto the end, his divine ſuccours: ſo that election was conditional, and reprobation in like manner the reſult of foreſeen infidelity, and perſevering wickedneſs." On the ſecond, the Arminians taught "That Jeſus Chriſt, by his ſufferings and death, made an atonement for the ſins of all mankind in general, and of every individual in particular; that, however, none but thoſe who believe in him, can be partakers of their divine benefit." On the third article, they held, "That true faith cannot proceed from the exerciſe of our natural faculties and powers, nor from the force and operation of free will; ſince man, in conſequence of his natural corruption, is incapable either of thinking or doing any good thing; and that therefore it is neceſſary, in order to his converſion and ſalvation, that he be regenerated and

and renewed by the operation of the Holy Ghoſt, which is the gift of God through Jeſus Chriſt." Fourthly, "That this divine grace or energy of the Holy Ghoſt, begins and perfects every thing that can be called good in man, and conſequently all good works are to be attributed to God alone; that, nevertheleſs, this grace is offered to all, and does not force men to act againſt their inclination, but may be reſiſted, and rendered ineffectual, by the perverſe will of the impenitent ſinner." Some modern Arminians interpret this and the laſt article with a greater latitude. Fifthly, "That God gives to the truly faithful, who are regenerated by his grace, the means of preſerving themſelves in this ſtate;" and though the firſt Arminians made ſome doubt with reſpect to the cloſing part of this article, their followers uniformly maintain, "that the regenerate may loſe true juſtifying faith, forfeit their ſtate of grace, and die in their ſins."

The modern ſyſtem of Arminianiſm likewiſe (founded on a comprehenſive plan projected by Arminius himſelf, as appears from a paſſage in his laſt will,) extends the limits of the Chriſtian church, and relaxes the bonds of fraternal communion in ſuch a manner, that Chriſtians of all ſects and denominations, whatever there ſentiments and opinions may be, papiſts excepted, may be formed into one religious body, and live together in brotherly love and concord. But in order to avoid the reproach of being altogether unconnected by any common principles, Epiſcopius drew up a confeſſion of faith, expreſſed for the moſt part in words and phraſes of Holy Scripture, which the Arminians have generally adopted, though not enjoined upon them by any authoritative obligation.

The Arminians are alſo called Remonſtrants, from an humble petition, intitled their Remonſtrance, which, in the year 1610, they addreſſed to the States of Holland. Their principal writers are, Arminius, Epiſcopius, Vorſtius, Grotius, Curcellæus, Limborch, Le Clerc, and Wetſtein; not to mention many others, of more modern date. Brandt's Hiſt. of the Reformation in the Netherlands; and Moſheim's Eccleſ. Hiſt. by Dr. Maclean, vol. v.

ARMS, in a general ſenſe, includes all kinds of weapons, whether for defence, or offence.

Arms of ſtone, and even of braſs, appear to have been uſed before they came to iron and ſteel. Joſephus aſſures us, that the patriarch Joſeph firſt taught the uſe of iron arms in Egypt, arming the troops of Pharaoh with a caſque and buckler. What contributed moſt to render the Romans maſters of the world, was, that having ſucceſſively warred againſt all nations, they conſtantly renounced their own methods, arms, &c. whenever they met with better. Thus Romulus, during his war with the Sabines, a bold and warlike nation, adopted their broad buckler, in lieu of the ſmall Argian buckler, which he had uſed till that time. Monteſq. Conſid. ſur les Cauſ. de la Grand. des Rom. chap i. p. 2. ſeq.

The principal arms of the ancient Britons were hatchets, ſcythes, lances, ſwords, and bucklers: the Saxons, &c. brought in the halberd, bow, arrows, arbalets, &c. By the ancient laws of England, every man was obliged to bear arms, except the judges and clergy. Under Henry VIII. it was expreſly enjoined on all perſons to be regularly inſtructed, even from their tender years, in the exerciſe of the arms then in uſe; viz. the long bow and arrows; and to be provided with a certain number of them. 33 H. 8.

ARMS *of Offence* in uſe among us at preſent, are, the ſword, piſtol, muſquet, bayonet, pike, &c. The arms of the Highlanders are, the broad ſword, target, poniard, and whinyar or dirk, &c. There are ſeveral acts of parliament for diſarming the Highlanders; ſee 1 Geo. 1. c. 54. 11 Geo. 1. c. 26. 19 Geo. 2. c. 39. 21 Geo. 2. c. 34. 26 Geo. 2. c. 22. and 29.

A ſtand of ARMS. A ſtand of arms ſignifies a muſquet, a bayonet, a ſword, belt, and cartridge box.

ARMS, or ARMORIES, are uſed, in Heraldry, for marks of dignity and honour, regularly compoſed of certain figures and colours, given or authoriſed by ſovereigns, and borne in banners, ſhields, coats, &c. for the diſtinction of perſons, families, and ſtates; and paſſing by deſcent to poſterity. They are called arms, in regard they are borne principally on the buckler, cuiraſs, banners, and other apparatus of war. They are alſo called coats of arms, coat-armor, &c. becauſe anciently embroidered on the coats, &c. Some will have the name to have been firſt occaſioned by the ancient knights, who in their juſts and tournaments bore certain marks (which were frequently their miſtreſs's favours) in their armour, i. e. their helms or ſhield, to diſtinguiſh them from each other. There has been a great diſpute, among the learned, about the origin of arms. But it is certain that, from time immemorial, there have been ſymbolical marks in uſe among men, to diſtinguiſh them in armies, and to ſerve as ornaments for ſhield and enſigns; but theſe marks were uſed arbitrarily, as devices, emblems, hieroglyphics, &c. and were not regular armories, like ours, which are hereditary marks of the nobility of a houſe, regulated according to the rules of heraldry, and authoriſed by princes.—The ſame diverſity has been obſerved with regard to the French and Engliſh; on which account authors are divided when they ſpeak of the ancient arms of thoſe countries. In effect, it appears, from all the beſt authors, that the armories of houſes, as well as the double names of families, were not known before the year 1000. And ſeveral have endeavoured to prove, that the uſe of arms did not begin till the time of the firſt croiſades of the Chriſtians in the Eaſt. The truth is, it appears to have been the ancient tournaments that occaſioned the fixing of armories. Henry the Fowler, who regulated the tournaments in Germany, was the firſt who introduced theſe marks of honour, which appear to be of an older ſtanding in Germany than any other part of Europe.—It was then that coats of arms were firſt inſtituted; which were a kind of livery, compoſed of ſeveral bars, fillets, and colours; whence came the feſs, bend, pale, chevron, and lozenge, which were ſome of the firſt elements of armories. Thoſe who had never been concerned in any tournament, had no arms, though they were gentlemen. Such of the nobility and gentry as croſſed the ſea, in the expeditions to the Holy Land, alſo aſſumed theſe tokens of honour to diſtinguiſh themſelves. Before theſe times, we find nothing upon ancient tombs but croſſes, with Gothic inſcriptions, and repreſentations of the perſons deceaſed. The tomb of pope Clement IV. who died in 1268, is the firſt whereon we find any arms; nor do they appear on any coins ſtruck before the year 1336. We meet with figures, it is true, much more ancient, both in ſtandards, and on medals; but neither cities nor princes ever had arms in form: nor does any authors make mention of blaſoning before that time. Originally, none but the nobility had a right of bearing arms: but king Charles V. having ennobled the Pariſians, by his charter, in 1371, he permitted them to bear arms: from whoſe example, the more eminent citizens of other places did the like. Camden refers the original of hereditary arms in England, to the time of the firſt Norman kings. He ſays, their uſe was not eſtabliſhed till the reign of king Henry III. and inſtances ſeveral of the moſt conſiderable families in England, wherein, till that time, the ſon always bore different arms from the father. About the ſame time it became the cuſtom here in England, for private gentlemen to bear arms; borrowing them from the lords of whom they held in fee, or to whom they were the moſt devoted.

ARMS, at preſent, follow the nature of titles, which being made hereditary, theſe are alſo become ſo, being the ſeveral marks for diſtinguiſhing of families and kindreds, as names are of perſons and individuals. Arms make the object of the art of heraldry, and are variouſly diſtinguiſhed by the Heralds. For a full diſplay of which, or the knowledge of what relates to the bearing of arms, and the laws and regulations thereof, ſee the Syſtem of HERALDRY throughout. For repreſentation of lines, ſhields, bearings, colours, tinctures, &c. together with the ordinaries, diminutives, crown, coronets, &c. ſee the Plates annexed to the SYSTEM. For repreſentation of the arms of the Peers of England, Scotland, and Ireland, ſee the Plates annexed to the Syſtem of PEERAGE.

ARMY, a large body of ſoldiers, conſiſting of horſe and foot, under the command of a general, with ſeveral ranks of ſubordinate officers under him. An army conſiſts of ſquadrons and battalions, and is uſually divided into three corps; which are ranged in three lines. The firſt line is called the van-guard; the ſecond, the main-body; and the third, the rear-guard, or body of reſerve. The middle of each line is poſſeſſed by foot; the cavalry forms the wings on the right and left; and ſometimes they alſo place ſquadrons of horſe in the intervals between the battalions.

When the army is ranged in order of battle, there are five feet diſtance between the horſes, and three between the foot. But in the ſhock the file contracts, and its front leſſens almoſt to one half. In each line the battalions are diſtant from each other about 180 feet, a diſtance about equal to the extent of their front; and the ſame holds of the ſquadrons, which are about 300 feet diſtant, the extent of their own front. Theſe intervals are left for the ſquadrons and battalions of the ſecond line, to range themſelves againſt the intervals of the firſt line; and thoſe of the third line, againſt the intervals of the ſecond; that both the one and the other may march more readily through theſe ſpaces to the enemy. There are uſually 300 feet left between the firſt line and the ſecond, and 600 between the ſecond line and the third; that there may be room to rally when the ſquadrons and battalions are broken. For a copious account of military arrangements and inſtitutions, ſee the Treatiſe on MILITARY AFFAIRS, Sect. III.

Long experience has ſhewn, that in Europe, a prince with a million of ſubjects cannot keep up an army of above ten thouſand men, without ruining himſelf. It was otherwiſe in the ancient republics: the proportion of ſoldiers to the reſt of the people, which is now as about one to an hundred, might then be as about one to eight. The reaſon ſeems owing to that equal partition of lands, which the ancient founders of commonwealths made among their ſubjects; ſo that every man had a conſiderable property to defend, and had means to defend it with. Whereas, among us, the lands and riches of a nation being ſhared among a few, the reſt have no way of ſubſiſting, but by trades, arts, and the like: and have neither any free property to defend, nor means to enable them to go to war in defence of it, without ſtarving their families. A large part of

our

our people are either artiſans or ſervants, and ſo only miniſter to the luxury and effeminacy of the great. While the equality of lands ſubſiſted, Rome, though only a little ſtate, being refuſed the ſuccours which the Latins were obliged to furniſh after the taking of the city in the conſulate of Camillus, preſently raiſed ten legions within their own walls, which was more, Livy aſſures us, than they were able to do in his time, though maſters of the greateſt part of the world. A full proof, adds the hiſtorian, that we are not grown ſtronger; and that what ſwells our city is only luxury, and the means and effects of it. Vid. Liv. Dec. 1. lib. vii. and Conſid. ſur les Cauſ. de la Grand. des Rom. chap. iii. p. 24.

Our armies anciently were a ſort of militia, compoſed chiefly of the vaſſals and tenants of the lords. When each company had ſerved the number of days or months enjoined by their tenure, or the cuſtoms of the fees they held, they returned home. The armies of the empire conſiſt of divers bodies of troops, furniſhed by the ſeveral circles. The groſs of the French armies, under the Merovingian race, conſiſted of infantry. Under Pepin and Charlemagne, the armies conſiſted almoſt equally of cavalry and foot; but ſince the declenſion of the Carlovingian line, the fees being become hereditary, the national armies, ſays Le Gendre, are chiefly cavalry. A well-regulated ſtanding army is greatly ſuperior to a militia; although a militia, it is to be obſerved, after ſerving two or three campaigns, may become equal to a ſtanding army, and in every reſpect a match for veteran troops. As it is only by means of a well-regulated ſtanding army that a civilized country can be defended, ſo it is only by means of it that a barbarous country can be ſuddenly and tolerably civilized. A ſtanding army eſtabliſhes, with an irreſiſtible force, the law of the ſovereign through the remoteſt provinces of the empire, and maintains ſome degree of regular government in countries which could not otherwiſe admit of any. Whoever examined with attention the improvements which Peter the Great introduced into the Ruſſian empire, will find that they almoſt all reſolve themſelves into the eſtabliſhment of a well-regulated ſtanding army. It is the inſtrument which executes and maintains all his other regulations. That degree of order, and internal peace which that empire has ever ſince enjoyed, is altogether owing to the influence of that army. The ſoldiers of a ſtanding army, though they may never have ſeen an enemy, yet have frequently appeared to poſſeſs all the courage of veteran troops, and the very moment that they took the field, to have been fit to face the hardieſt and moſt experienced veterans. In a long peace the generals perhaps may ſometimes forget their ſkill; but where a well regulated ſtanding army has been kept up, the ſoldiers ſeem never to forget their valour.

Men of republican princip'es have been jealous of a ſtanding army as dangerous to the cauſe of liberty by giving vigour to the exertions of deſpotic power. It certainly is ſo, wherever the intereſt of the general and that of the principal officers are not neceſſarily connected with the ſupport of the conſtitution of the ſtate. The ſtanding army of Cæſar deſtroyed the Roman republic; the ſtanding army of Cromwell turned the long parliament out of doors. But where the ſovereign is himſelf the general, and the principal nobility and gentry of the country the chief officers of the army; where the military force is placed under the command of thoſe who have the greateſt intereſt in the ſupport of the civil authority, becauſe they have themſelves the greateſt ſhare of that authority; a ſtanding army can never be dangerous to liberty: on the contrary, it may, in ſome caſes, be favourable to liberty. The ſecurity which it gives to the ſovereign renders unneceſſary that troubleſome jealouſy which in ſome modern republics ſeems to watch over the minuteſt actions, and to be at all times ready to diſturb the peace of every citizen. Where the ſecurity of the magiſtrate, though ſupported by the principal people of the country, is endangered by every popular diſcontent; where a ſmall tumult is capable of bringing about in a few hours a great revolution; the whole authority of government muſt be employed to ſuppreſs and puniſh every murmur and complaint againſt it. To a ſovereign, on the contrary, who feels himſelf ſupported not only by the natural ariſtocracy of the country, but by a well-regulated ſtanding army, the rudeſt, the moſt groundleſs, and the moſt licentious remonſtrances, can give little diſturbance. He can ſafely pardon or neglect them, and his conſciouſneſs of his own ſuperiority naturally diſpoſes him ſo to do. That degree of liberty which approaches to licentiouſneſs can be tolerated only in countries where the ſovereign is ſecured by a well-regulated ſtanding army. It is in ſuch countries only that the public ſafety does not require that the ſovereign ſhould be truſted with any diſcretionary power for ſuppreſſing even the impertinent wantonneſs of this licentious liberty.

A Naval or *Sea*-ARMY is a number of ſhips of war, equipped and manned with ſailors and mariners, under the command of an admiral, with other inferior officers under him. For a full explanation of every particular which relates to the naval armament, or maritime ſtate of Great Britain, ſee the Treatiſe on NAVAL AFFAIRS, Part I. throughout.

ARNOTTA, in Botany, a name given by the peaſants of Burgundy and many other places, to certain roots which they frequently turn up, from five or ſix inches depth, in plowing the ground. They carefully collect theſe, and eat them, after roaſting in the aſhes, or otherwiſe; by which ſort of cooking they acquire the taſte of a cheſnut, and are found to be a very wholeſome and nouriſhing food. They are blackiſh on the outſide, and white within, and are of the ſize of a ſmall walnut. They are common in the north of Scotland, and called arnots.

AROMATIC, is underſtood of a drug, plant, or the like, which yields a briſk, fragrant ſmell, and a warm ſpicy taſte. The word is formed of ἀρωμα, which is compounded of ἀρ, *very*, and ὀδμη, or ὀσμη, *ſmell*.

AROMATICS, or AROMATIC *medicines*, are either ſimple or compound. To this claſs belong moſt cardiac, cephalic, and carminative remedies, with many ſtomachic ones. Of this kind are frankincenſe, ſtoras, benjoin, cinnamon, mace, cloves, nutmeg, pepper, &c. Such alſo are lavender, marjoram, ſage, thyme, roſemary, &c. The peculiar qualities of aromatics reſide in their eſſential oils, and reſinous parts. The more eſſential oil any vegetable affords, the weaker the oil is, and *vice verſa*. The taſte and pungency of ſome of them reſide in the oil, and of others of them in a fixed gummy reſinous matter.

Powders which have aromatic, or other acrid particles in them, not only abſorb liquors, but give more or leſs ſtimulus; and as the effect of all irritation is ſome degree of inflammation, which in ſores is principally removed by a ſubſequent increaſed ſuppuration, theſe powders may aſſiſt to ſeparate corrupted from ſound parts. Such of them as have balſamic particles in their compoſition, encourage the ſuppuration moſt. Several of them reſiſt the putrefaction of animal ſubſtances, and therefore may preſerve a carious bone, or the matter coming from it, from ſuch a high degree of putrefaction as they might otherwiſe attain. Beſide theſe effects on the ſore, regard muſt always be had to their operation, if any of their particles are abſorbed by the blood veſſels, for ſome of them produce a fever in a greater or leſs degree, others become purgatives, &c. Med. Eſſ. Edinb. vol. v. art. 24. Aromatics are of particular ſervice in cold cachectic habits, where the load of tumours has been forced away by ſtrong detergents and cathartics; as they tend to ſtrengthen the fibres, and prevent a relapſe. Hence alſo they become of neceſſary uſe after purging, and carrying off the waters of a dropſy or in the intervals, to fortify the ſprings, and prevent a filling again.

AROMATICUM *roſarum*, is a compound officinal powder, made of red roſes, liquorice, aloes-wood, yellow ſanders, cinnamon, cloves, mace, gum, tragacanth, nutmegs, cardamoms, galangals, ſpikenard, ambergriſe, and muſk, all mixed together. It is chiefly preſcribed in cordial and cephalic boluſes and electuaries, to ſtrengthen the ſtomach and head, which all aromatics have a tendency to do.

ARRAIGNMENT, in Law, the arraigning or ſetting a thing in order, as a perſon is ſaid to arraign a writ of novel diſſeiſin, who prepares and fits it for trial.

ARRAIGNMENTS is moſt properly uſed to call a perſon to anſwer in form of law upon an indictment, &c. When brought to the bar, the criminal is called upon by name to hold up his hand; which, though it may ſeem a trifling circumſtance, yet is of this importance, that by the holding up of his hand *conſtat de perſona*, and he owns himſelf to be of that name by which he is called. However, it is not an indiſpenſable ceremony; for, being calculated merely for the purpoſe of identifying the perſon, any other acknowledgment will anſwer the purpoſe as well: therefore, if the priſoner obſtinately and contemptuouſly refuſes to hold up his hand, but confeſſes he is the perſon named, it is fully ſufficient. Then the indictment is to be read to him diſtinctly in the Engliſh tongue (which was law, even while all other proceedings were in Latin) that he may fully underſtand his charge. After which it is to be demanded of him whether he be guilty of the crime whereof he ſtands indicted, or not guilty? When a criminal is arraigned, he either ſtands mute, or confeſſes the fact, or elſe he pleads to the indictment. If he ſays nothing, the court ought *ex officio* to impannel a jury to inquire whether he ſtands obſtinately mute, or whether he be dumb *ex viſitatione Dei*. If the latter appears to be the caſe, the judges of the court (who are to be of counſel for the priſoner, and to ſee that he hath law and juſtice) ſhall proceed to the trial, and examine all points as if he had pleaded not guilty. But whether judgment of death can be given againſt ſuch a priſoner, who hath never pleaded, and can, ſay nothing in arreſt of judgment, is a point yet undetermined. If he be found to be obſtinately mute (which a priſoner hath been held to be that hath cut his tongue), then, if it be on an indictment of high treaſon, it hath long been clearly ſettled, that ſtanding mute is equivalent to a conviction, and he ſhall receive the ſame judgment and execution. The Engliſh judgment of penance for ſtanding mute was as follows: That the priſoner be remanded to the priſon from whence he came, and put into a low, dark chamber; and there be laid on his back, on the bare floor, naked, unleſs where decency forbids; that there may be placed upon his body as great a weight of

of iron as he could bear, and more; that he have no ſuſtenance, ſave only, on the firſt day, three morſels of the worſt bread; and on the ſecond day, three draughts of ſtanding-water that ſhould be neareſt to the priſon-door; and in this ſituation this ſhould be alternately his daily diet, *till he died*, or, as anciently the judgment ran, *till he anſwered*.

If the priſoner make a ſimple and plain confeſſion, the court hath nothing to do but to award judgment; but it is uſually very backward in receiving and recording ſuch confeſſion, out of tenderneſs to the life of the ſubject; and will generally adviſe the priſoner to retract it.

ARRANGEMENT, a diſpoſition of the parts of a whole, in a certain order. The modern philoſophy ſhews us that the diverſity of the colours of bodies depend entirely on the ſituation and *arrangement* of the parts, which reflect the light differently; the diverſity of taſtes and ſmells, on the different *arrangements* of the pores, which render them differently ſenſible; and the general diverſity of bodies, on the different *arrangement* of their parts. The happy *arrangement* of words makes one of the greateſt beauties of diſcourſe.

Philoſophical ARRANGEMENTS. This title is given by the ingenious J. Harris, Eſq. to a moſt excellent commentary on the CATEGORIES of Ariſtotle; it is juſt as happy a ſimplification of *Logic*, as his *Hermes* is of *Grammar*. Both theſe valuable books, ſo well calculated to convey ſenſible and preciſe notions of logic and grammar, might be very uſefully and compendiouſly exhibited in the form of a *logical* and *grammatical* tree, after the manner of genealogical tables. We have conſulted this learned and ingenious author in the compoſition of our Syſtems of GRAMMAR and LOGIC.

ARREST, in Engliſh law (from the French word *arreſter*, to *ſtop* or *ſtay*) is the reſtraint of a man's perſon, obliging him to be obedient to the law; and is defined to be the execution of the command of ſome court of record or office of juſtice. An arreſt is the beginning of impriſonment; where a man is firſt taken, and reſtrained of his liberty, by power or colour of a lawful warrant.

Arreſts are either in *civil* or *criminal* caſes.

1. An arreſt in a *civil cauſe* is defined to be the apprehending or reſtraining one's perſon by proceſs in execution of the command of ſome court.

An arreſt muſt be by corporally ſeizing or touching the defendant's body; after which the bailiff may juſtify breaking open the houſe in which he is, to take him: otherwiſe he has no ſuch power; but muſt watch his opportunity to arreſt him. For every man's houſe is looked upon by the law to be his caſtle of defence and aſylum wherein he ſhould ſuffer no violence. Which principle is carried ſo far in the civil law, that, for the moſt part, not ſo much as a common citation or ſummons, much leſs an arreſt, can be executed upon a man within his own walls. Peers of the realm and members of parliament are privileged from arreſt; and of courſe from outlawries. And againſt them the proceſs to enforce an appearance muſt be by ſummons and diſtreſs *infinite*, inſtead of a *capias*. Alſo, clerks, attornies, and all other perſons attending the courts of juſtice (for attornies, being officers of the court, are always ſuppoſed to be there attending) are not liable to be arreſted by the ordinary proceſs of the court, but muſt be uſed by bill (called uſually a *bill of privilege*) as being perſonally preſent in court. Clergymen performing divine ſervice, and not merely ſtaying in the church with a fraudulent deſign, are for the time privileged from arreſts, by ſtatute 50 Edw. III. c. 5; and 1 Rich. II. c. 16; as likewiſe members of convocation actually attending thereon, by ſtatute 8 Hen. VI. c. 1. Suitors, witneſſes, and other perſons, neceſſarily attending any courts of record upon buſineſs, are not to be arreſted during their actual attendance, which includes the neceſſary coming and returning. Seamen in the king's ſervice are privileged from arreſts for debts under 20l. (1 Geo. II. c. 14; and 14 Geo. II. c. 38) and ſoldiers or marines are not liable to arreſt for a debt of leſs than 10l. (29 Geo. II. c. 6, 11) and no arreſt can be made in the king's preſence, nor within the verge of his royal palace, nor in any place where the king's juſtices are actually ſitting. The king hath moreover a ſpecial prerogative (which indeed is very ſeldom exerted) that he may by his *writ of protection* privilege a defendant from all perſonal, and many real, ſuits, for one year at a time, and no longer; in reſpect of his being engaged in his ſervice out of the realm. And the king alſo by the common law might take his creditor into his protection, ſo that no one might ſue or arreſt him till the king's debt was paid; but by the ſtatute 25 Edw. III. c. 19, notwithſtanding ſuch protection, another creditor may proceed to judgment againſt him, with a ſtay of execution, till the king's debt be paid; unleſs ſuch creditor will undertake for the king's debt, and then he ſhall have execution for both. And, laſtly, by ſtatute 29 Car. II. c. 7, no arreſt can be made, nor proceſs ſerved, upon a Sunday, except for treaſon, felony, or breach of the peace.

2. An arreſt in a *criminal cauſe* is the apprehending or reſtraining one's perſon, in order to be forthcoming to anſwer an alleged crime. To this arreſt all perſons whatſoever are, without diſtinction, equally liable; and doors may be broken open to arreſt the offender: but no man is to be arreſted, unleſs charged with ſuch a crime as will at leaſt juſtify holding him to bail when taken. There is this difference alſo between arreſts in civil and criminal caſes, that none ſhall be arreſted for debt, treſpaſs, or other cauſe of action, but by virtue of a precept or commandment out of ſome court; but for treaſon, felony, or breach of the peace, any man may arreſt, with or without warrant or precept. But the king cannot command any one by word of mouth to be arreſted; for he muſt do it by writ, or order of his courts, according to law: nor may the king arreſt any man for ſuſpicion of treaſon, or felony, as his ſubjects may; becauſe, if he doth wrong, the party cannot have an action againſt him.

By the vagrant act 17 Geo. II. c. 5, every perſon may apprehend beggars and vagrants; and every private perſon is bound to aſſiſt an officer requiring him to apprehend a felon. In ſome caſes likewiſe arreſts by private perſons are rewarded by law. By the 4 and 5 William and Mary, c. 8, perſons apprehending highwaymen, and proſecuting them to a conviction, are intitled to a reward of 40l. and if they are killed in the attempt, their executors, &c. are intitled to the like reward. By the 6 and 7 William III. c. 17, perſons apprehending counterfeiters and clippers of the coin, and proſecuting them to conviction, are intitled to 40l. By 5 Ann, c. 31, perſons who ſhall take any one guilty of burglary, or the felonious breaking and entering any houſe in the day-time, and proſecute them to conviction, ſhall receive the ſum of 40l. within one month after ſuch conviction.

With regard to arreſts by public officers, watchmen, conſtables, &c. they are either made by their own authority, which differs but very little from the power of a private perſon; or they are made by a warrant from a juſtice of peace. See WARRANT.

Arreſt of Judgment, in law, the aſſigning juſt reaſon why judgment ſhould not paſs: as, want of notice of the trial; a material defect in the pleading; when the record differs from the deed impleaded: when perſons are miſnamed; where more is given by the verdict than is laid in the declaration, &c. This may be done either in criminal or civil caſes.

ARROW, in fortification, is a work placed at the ſaliant angles of the glacis, and conſiſts of two parapets, each forty toiſes long. This work has a communication with the covert-way, of about twenty or thirty feet broad, called *caponier*; and a ditch before it, of five or ſix toiſes. See the Syſtem, and Plate I. Fig 9, Letter A.

ARROW, in ſurveying, is uſed for ſmall ſtraight ſticks about two feet long, ſhod with iron ferrils. Their uſe is to ſtick into the ground, at the end of the *chain*. See the Syſtem, Sect. I.

ARSENIC, in mineralogy and chymiſtry, a heavy opaque ſubſtance, uſually ſold in white maſſes, which, when broken, diſcover a ſemi-tranſparency, ſomewhat reſembling that of ſal-ammoniac, but by expoſure to the air become white and opaque like the outſide of the original maſs. By various chymical proceſſes it may be made to aſſume the appearance either of an acid ſalt or metal, at the pleaſure of the operator; and therefore has been conſidered both as a ſaline ſubſtance and as a ſemimetal. Avicenna, who lived in the 11th century, is the firſt who expreſsly mentions white arſenic, as well as its ſublimate. It is not known by whom arſenic was firſt reduced to a metallic form. Paracelſus aſſerts that arſenic, ſublimed with egg-ſhell lime becomes like ſilver; and, in 1675, M. Lemeri, makes mention of a method of ſubliming arſenic with fixed alkali and ſoap.

The true nature of arſenic being ſo little known, it is no wonder to find chymiſts differing as to the claſs of natural bodies in which it ought to be placed. Avicenna, and a great number of others, claſs it with the ſulphurs; Albertus Magnus, and his followers, among the ſalts. Becher conſiders it as a kind of ſoap, or ſaline ſulphureous body. Later experiments, however, have made it evident that white arſenic conſiſts of an acid united to phlogiſton; and that by diminiſhing the latter, the acid becomes more and more apparent; while, on the contrary, by augmenting the quantity of phlogiſtic matter, the arſenic aſſumes the metallic form. With reſpect to the ſulphureous nature of arſenic, it appears indeed that the regulus itſelf, as well as orpiment and realgar, are inflammable ſubſtances; but it is not ſo with white arſenic. This inflammability, therefore, which arſenic in a certain ſtate has in common with zinc and ſeveral other ſubſtances, will not denominate it ſulphureous, any more than thoſe of other bodies which poſſeſs the common property of inflammability can be denominated *ſulphurs*.

It is commonly ſaid that arſenic mineraliſes metals; and therefore, ſays Mr. Bergman, it is conſidered as a ſulphur by ſome, who yet extend the idea of mineraliſation ſo far as under it to comprehend all mixtures of which metals make a part. But if we examine the ſignification a little more accurately, we ſhall ſee that it is extended too far; for if this be admitted, we muſt at the ſame time allow that no native metal is to be found. Thus the gold called *native*, is ſeldom, if ever, found pure, but more or leſs mixed with copper or ſilver; and ſo with other metals. If, therefore, arſenic, which, unleſs in its reguline ſtate, never diſſolves other metals, be conſidered as a mineraliſing ſubſtance, what hinders us from ſaying that gold is mineraliſed by ſilver or

copper, and in general every metal mineralized by ſome other? It is much more natural to ſuppoſe that thoſe metals are mineralized which are actually diſſolved and concealed by a menſtruum. Sulphur is the chief agent employed by nature for this purpoſe; and though the acids of vitriol, phoſphorus, nitre, and ſometimes even the aërial acid, occaſion the metals to put on an appearance foreign from their nature, yet the number of theſe is ſo ſmall that, compared with the ſulphurated minerals, they almoſt vaniſh.

This mineral, ſo troubleſome to the mineralogiſt, occaſioned the alchemiſts to ſuſpect the exiſtence of a certain arſenical principle indiſpenſibly neceſſary to the perfection of every metal. Even as late as 1773 a queſtion to this purpoſe was propoſed by the Royal Academy of Sciences at Berlin: the prize was adjudged to M. Monnet, who in his anſwer conſidered arſenic as a ſemimetal of a peculiar kind, which is ſo far from conſtituting any eſſential part of metals, that its preſence is always attended with inconveniences, either by carrying off the metal as it flies away, or ſpoiling the maſs in which it remains. Theſe conſiderations, however, do not hinder us from aſſerting that the acid of arſenic, like others, is a mineralizing ſubſtance, if at any time it happens to meet with metals in the bowels of the earth, and to unite with it in that form.

Poiſonous Qualities of Arſenic and its Acid.

Arſenic in its pure ſtate is well known to be a moſt deſtructive and deadly poiſon, for which the art of medicine has ſcarcely as yet afforded a cure. Mr. Bergman is of opinion that it acts as an highly corroſive acid, even when applied externally. He alſo tells us that the dry acid is more deſtructive than white arſenic; the regulus and realgar leſs ſo. From an experiment of Mr. Scheele, however, in which eight grains of arſenical acid were given to a cat, it does not appear that it acts more violently than white arſenic. The extreme danger attending this ſubſtance when taken into the human body, ariſes from its inſolubility, and the difficulty of decompounding it: for there can but little danger ariſe from a liquid, unleſs, like corroſive acids, it ſhould at once burn the ſubſtance of the ſtomach, like fire; or like laurel-water, ſuſpend the action of the nervous ſyſtem. Corroſive ſublimate, ſolutions of mercury in the aquafortis, &c. will as certainly poiſon as arſenic; but they are much leſs difficult to cure, becauſe the alkaline ſubſtance will certainly decompound them, and deſtroy their deleterious efficacy. Arſenic, on the contrary, cannot be decompounded, nor united with any known ſubſtance, at leaſt in ſuch a ſhort time as the exigence of the caſe we ſpeak of would require, without a conſiderable degree of heat. It therefore remains in the ſtomach, continually exerting its miſchievous qualities, unleſs it can be diſcharged by vomiting.

Symptoms attending the ſwallowing of Arſenic.

The ſymptoms attending arſenic when ſwallowed are, nauſea, ſickneſs, and retching to vomit, about half an hour after it is taken. Theſe are followed by violent vomitings, hiccoughs, and pains in the ſtomach and bowels. Convulſions and palſies of the limbs preſently ſucceed, with intenſe heats, cold ſweats, palpitations of the heart, extreme anxiety, proſtration of ſtrength, thirſt and dryneſs of the mouth and thorax, loſs of reaſon, and at laſt death. If the quantity taken was conſiderable, the patient dies in ſeven or eight hours after taking it; and the ſtomach and inteſtines are found, upon diſſection, to be corroded and perforated. When this is not the caſe, violent putrefactive ſymptoms ſoon enſue after arſenic is ſwallowed; for the bodies of thoſe who are poiſoned by it generally have abundance of red or purple ſpots even before death. It remarkably inflames the coats of the ſtomach, and the putrefaction is ſaid particularly to take place in the genitals of men. Mr. Bergman relates, that in the body of a man who was poiſoned with arſenic, and diſſected in the anatomical theatre at Upſal, the putrefaction had been ſo ſtrong that the mineral was deprived of part of its phlogiſton, and emitted the garlic ſmell, that peculiar characteriſtic of arſenic when in this ſituation.

Antidotes ineffectually propoſed.

Many antidotes have been propoſed againſt this dreadful poiſon by authors of the higheſt reputation; but it is feared without that ſucceſs which the confidence of thoſe who propoſed them ſeemed to enſure. Indeed, previous to any great hope of ſucceſs in this reſpect, it ought to be ſhewn that theſe antidotes are able to effect ſome conſiderable change on arſenic when out of the body; and that not in ſolution, but when in a powder not very fine, as is the caſe with arſenic when it is uſually taken. Mr. Bergman recommends alkalies in diſeaſes occaſioned by arſenic; nay, he tells us, that "ſince phlogiſton and alkalies are the moſt powerful correctors of acid acrimony, it will *readily occur* how it may be mitigated, and its deleterious effects obviated." But the many fatal accidents conſequent on taking this mineral ſhow that none of thoſe are to be depended upon. Bergman himſelf indeed cautions us againſt truſting to phlogiſton correctors alone: and perhaps the ſolution of hepar ſulphuris, which contains the united powers of both the alkaline and phlogiſtic antidotes united, might prove more efficacious than either of them ſingly. Oils, fat, milk, warm fat broths, freſh butter, &c. have all been recommended; and no doubt, in ſuch deplorable caſes, are thoſe remedies to which we can moſt readily have recourſe; but even here it is evident that their efficacy muſt be exceedingly dubious whatever their intrinſic virtues may be; and for this plain reaſon, that the arſenic is already in contact with the ſtomach, and though the remedies might have prevented its action had they been *firſt* ſwallowed, their operation muſt be much leſs powerful after the poiſon has had acceſs to the ſtomach and begun to exert its pernicious effects.

Arſenic recommended as a Medicine both internally and externally

Notwithſtanding the dreadful effects of arſenic, when taken in large quantity, attempts have not been wanting to introduce it into the materia medica. The diſeaſe, indeed in which it has been recommended (the cancer) is of a very incurable nature, at leaſt by ordinary medicines. M. Le Febure, a French phyſician, ſome time ago publiſhed a treatiſe, in which he recommended pure white arſenic as a ſpecific in that diſtemper. The doſe was four grains, equal to three and a half Engliſh, diſſolved in a French pint (32 troy ounces) of diſtilled water. A table-ſpoonful of this ſolution is to be taken with an equal quantity of milk, and half an ounce of ſyrup of poppies, every morning faſting, and taking care to taſte nothing for an hour after. This courſe muſt be continued eight days; after which a doſe is to be taken twice every day in the ſame manner, one in the morning, and another about eight at night. At the end of a fortnight three doſes may be exhibited daily, the third being taken at mid-day. Thus people of a weakly conſtitution may continue till the cure is completed; but ſuch as are more robuſt may gradually augment the doſe till two table-ſpoonfuls are taken at each time, with as much milk, and half an ounce of ſyrup of poppies. Children muſt on no account take more than three teaſpoonfuls a day, with a proportional quantity of ſyrup of poppies. For adults, the ſtrength of the ſolution, as well as the quantity, is to be augmented; ſix grains being put into the ſecond bottle, and eight into the third; and a purgative, compoſed of manna, rhubarb, and ſal-ſeignette, is to be given every eight or twelve days. An iſſue he conſiders as uſeful in every caſe. The tumor, if not ulcerated, ought to be waſhed with a ſolution of arſenic in the proportion of eight grains to a pint; and he adviſes the following cataplaſm: "Take of carrot-juice one pound, of ſugar-of-lead half an ounce, of liquid laudanum a drachm and a half; form the whole into a maſs with as much powder of hemlock as is ſufficient for the purpoſe. The tumor is to be covered to a moderate thickneſs with this cataplaſm, which is to be kept on by a diachylon plaſter." When the cancer is of the ulcerated kind, he directs the ichorous ſeroſity to be taken away by means of a dry *charpée* at each dreſſing, and the ſore to be fomented with the arſenical ſolution with the chill taken off it, and having about a third part of red-wine added to it. When the ſore is of a very bad kind, he propoſes the arſenic to be diſſolved in decoction of bark for the purpoſe of fomentation; after which the cataplaſm and plaſter are to be applied and this is to be renewed every twelve hours.

M. Le Febure aſſerts that the arſenic, when taken with the precautions juſt mentioned, is not attended with any bad conſequences, nor has it a diſagreeable taſte. Its action is ſcarcely perceived on any of the ſecretions or excretions; though ſome diſcharge their urine more freely than uſual, and with ſome the belly is more looſe. In ſome the perſpiration is more copious; but theſe effects are neither regular nor conſtant. He does not conſider it as an infallible cure for the diſtemper in every poſſible ſtage; but thinks that the diſeaſe is incurable when, in its progreſs, it has eroded a blood-veſſel, and occaſioned a conſiderable hemorrhagy; alſo, when the patient is of a hectic or phthyſical habit of body. With reſpect to regimen, he directs whey, with twelve grains of nitre to the bottle, or a weak decoction of althea with an equal quantity of nitre; and to abſtain from wine and fermented liquors. Broth made of beef, veal, or chicken, is alſo proper.

Mr. Bergman informs us, that "it can hardly be doubted but arſenic may be applied to valuable purpoſes in medicine, and experiments have long ago put that out of doubt; but with reſpect both to its doſe and preparation, the utmoſt caution is neceſſary."

Dr. Black, however, has ſeen the internal exhibition of arſenic, in thoſe caſes where it is recommended by foreign phyſicians, attended with very dangerous conſequences, ſuch as hectics, &c. He has likewiſe known obſtinate ulcers healed by it. Yet, though the external uſe of arſenic has proved ſucceſsful in ſome caſes, it has often, even in this way, produced very terrible conſequences: ſo that the Doctor, far from recommending the internal uſe of it, reprobates it even in external applications.

The firſt ſymptoms which enſue on the taking of arſenic ſhow that it is of a highly inflammatory, cauſtic, and corroſive nature with regard to the ſyſtem in general, and the inteſtines in particular; the pulſe becomes extremely weak and irritable, and this is attended with a kind of paralytic affection of the limbs,

limbs, marasmus, &c. Milk and oil have been recommended as antidotes; but the milk may curdle, and the oil will not mix with the fluids in the intestines. It is therefore advisable, when a physician is called to a patient who has swallowed arsenic, to make use of mucilages. A friend of Dr. Black's, who had no mucilage at hand, thought of the whites of eggs, and succeeded. After the violence of the first attack is over, a milk diet, opiates, &c. are proper; and some time after electricity has been found of great service. Some have advised to exhibit hepar sulphuris, as already noticed: but this is founded, not on experience, but theory; and it cannot be supposed that such a quantity can enter the system as will be sufficient for neutralising the arsenic, and converting it into orpiment, which is the design of exhibiting it.

The following account of the use of arsenic in medicine is given by Dr. Duncan: "Notwithstanding, however, the very violent effects of arsenic, it has been employed in the cure of diseases, both as applied externally and as taken internally. Externally, white arsenic has been chiefly employed in cases of cancer; and is used in this way, it is supposed that its good effects depend on its acting as a peculiar corrosive: and it is imagined, that arsenic is the basis of a remedy long celebrated in cancers, which, however, is still kept a secret by a family of the name of *Plunket*, in Ireland. According to the best conjectures, their application consists of the powder of some vegetables, particularly the ranunculus flammeus and cotula foetida, with a considerable proportion of arsenic and flower of sulphur intimately mixed together. This powder, made into a paste with the white of an egg, is applied to the carcerous part which it is intended to corrode; and being covered with a piece of thin bladder, smeared also with the white of an egg, it is suffered to lie on from 24 to 48 hours; and afterwards the ulcer is to be treated with softening digestives, as in other cases.

"Arsenic, in substance, to the extent of the eighth of a grain for a dose, combined with a little of the flower of sulphur, has been said to be employed internally in some very obstinate cases of cutaneous diseases, and with the best effect. But of this we have no experience.

"Of all the diseases in which white arsenic has been used internally, there is no one in which it has been so frequently and so successfully employed as in the cure of intermittent fevers. It has long been used in Lincolnshire, and some other of the fenny countries, under the name of the *arsenic drop*, prepared in different ways: and it is conjectured, that an article, which has had a very extensive sale, under the title of the *tasteless ague-drop*, the form of preparing which, however, is still kept a secret, is nothing else but a solution of arsenic. But whether this be the case or not, we have now the most satisfactory information concerning this article in the 'Medical Reports of the effects of arsenic in the cure of agues, remitting fevers, and periodic head-aches,' by Dr. Fowler, of Stafford. He directs, that 64 grains of arsenic, reduced to a very fine powder, and mixed with as much fixed vegetable alkaline salt, should be added to a half a pound of distilled water, in a Florence flask; that it should be then placed in a sand-heat, and gently boiled till the arsenic be completely dissolved; that after the solution is cold, half an ounce of compound spirit of lavender be added to it, and as much distilled water as to make the whole solution amount to a pound. This solution is taken in doses, regulated according to the age, strength, and other circumstances of the patient, from two to twelve drops, once, twice, or oftener in the course of the day. And in the diseases mentioned above, particularly in intermittents, it has been found to be a safe and very efficacious remedy, both by Dr. Fowler and by other practitioners: but in some instances, even when given in very small doses, we have found it excite violent vomiting. But besides this, it has also been alleged by some, that those cured of intermittents by arsenic are very liable to become phthisical. If arsenic shall ever be extensively employed internally, it will probably be most certain and most safe in its operation when brought to the state of a salt readily soluble in water.

"Wines naturally acid, or grown so by age, still continue to be edulcorated by lead, notwithstanding the punishments attending the detection of this fraud: it is therefore of great consequence to be in possession of an easy method of discovering such a sophistication. For this purpose a probatory liquor has been recommended, composed of caustic fixed alkali and orpiment; which instantly throws down a black or dark-brown precipitate in consequence of the union of the sulphur of the orpiment with the metal. The same effect will take place on the addition of common hepar sulphuris; but methods have been contrived of eluding this proof. If a small quantity of chalk be contained in the wine, the saline hepar does not produce the intended effect; for the falling of the white calcareous earth diminishes the blackness. The other probatory liquor is also rendered ineffectual by a large quantity of tartar; because the tartareous acid, uniting with the lime, forms a kind of selenite, which in like manner diminishes the blackness.

"Arsenic sometimes enters metallic compositions, especially copper and tin; but it were much to be wished that such compositions were banished, at least from the kitchen. Shot made of lead is sometimes hardened by orpiment.

"Regulus of arsenic enters into the composition of Meuder's phosphorus. The power of the calx in vitrification was long ago know to Geber; and it is frequently employed in glass-houses, either for facilitating fusion, for acquiring a certain degree of opacity, or finally for carrying off phlogiston. The method in which mountain crystals, placed over orpiment, white arsenic, crude antimony, and sal ammoniac mixed in a crucible, are tinged by means of heat, is described by Neri, and upon trial is found to be true. I have thus obtained these crystals beautifully marked with red, yellow, and opal spots; but at the same time cracked.

"In painting too the artists sometimes employ arsenic. Painters in oil frequently use both orpiment and realgar; and it is probable that wood covered with a pigment mixed with white arsenic would not be spoiled by worms. A most beautiful green pigment may be precipitated from blue vitriol by means of white arsenic dissolved in water, together with vegetable alkali. This prepared either with water or oil, affords a colour which suffers no change in many years. The playthings of children, however, should not be painted with this or any other preparation of arsenic, on account of their custom of putting every thing into their mouths.

Arsenic is also used in dying, and the yellow combination of it with sulphur has the property of readily dissolving indigo; for which purpose it is used in cloth-painting. It lets it fall again, however, on exposure to the air; and therefore can be employed only in pencil-colours, where a large quantity is laid on at once. The neutral arsenical salt is used in some manufactures in France; but for what purposes is not known.

The smallest quantity of crystaline arsenic being mixed with any metal, renders it friable, and absolutely destroys its malleability. Hence, the refiners dread nothing so much as arsenic in their metals; nor could any thing be so advantageous to them, were such a thing to be had, as a menstruum that would absorb, or act on arsenic alone; for then their metals would be readily purified, without flying off, or evaporating.

A single grain of arsenic will turn a pound of copper into a beautiful white metal, called *alchemy*, looking like silver. This hint many persons have endeavoured to improve on, for making silver, but in vain, as the mixture could never be brought to sustain the hammer: some have been hanged for coining species of this spurious silver.

The chymists furnish several preparations of arsenic, which all turn on repeated ablutions and sublimations, to blunt its corrosive salts, and change it into a safe medicine, after the manner of sublimate. Such are ruby of arsenic, &c. For a further account of the properties and uses of arsenic, see the System of CHYMISTRY, Part III. Chap. I. Sect. I.

ART is defined by Lord Bacon, a proper disposal of the things of nature by human thought and experience, so as to answer the several purposes of mankind; in which sense *art* stands opposed to *nature*. Art is principally used for a system of rules serving to facilitate the performance of certain actions; in which sense it stands opposed to *science*, or a system of speculative principles.

Arts are commonly divided into *useful* or *mechanic*, *liberal* or *polite*. The former are those wherein the *hand* and *body* are more concerned than the mind: of which kind are most of those which furnish us with the *necessaries* of life, and are popularly known by the name of *trades*; as baking, brewing, carpentry, smithery, weaving, &c. The latter are such as depend more on the labour of the mind than that of the hand; they are the produce of the *imagination*, their essence consists in *expression*, and their end is *pleasure*. Of this kind are poetry, painting, music, &c.

Progress of the ARTS. Some useful arts must be nearly coeval with the human race; for food, clothing, and habitation, even in their original simplicity, require some art. Many other arts are of such antiquity as to place the inventors beyond the reach of tradition. Several have gradually crept into existence without an inventor. The busy mind, however, accustomed to a beginning in things, cannot rest till it finds or imagines a beginning to every art. The most probable conjectures of this nature, the reader may see in the historical introductions to the different articles.

In all countries where the people are barbarous and illiterate, the progress of arts is extremely slow. It is vouched by an old French poem, that the virtues of the loadstone were known in France before anno 1180. The mariner's compass was exhibited at Venice anno 1260, by Paulus Venetus, as his own invention. John Goya, of Amalphi, was the first who, many years afterward, used it in navigation; and also passed for being the inventor. Though it was used in China for navigation long before it was known in Europe, yet to this day

it is not ſo perfect as in Europe. Inſtead of ſuſpending it, in order to make it act freely, it is placed upon a bed of ſand, by which every motion of the ſhip diſturbs its operation. Hand-mills, termed *querns*, were early uſed for grinding corn; and when corn came to be raiſed in greater quantity, horſe-mills ſucceeded. Watermills for grinding corn are deſcribed by Vitruvius. Windmills were known in Greece and in Arabia as early the ſeventh century; and yet no mention is made of them in Italy till the fourteenth. That they were not known in England in the reign of Henry VIII. appears from a houſehold book of an Earl of Northumberland, cotemporary with that king, ſtating an allowance for three mill-horſes, "two to draw in the mill, and one to carry ſtuff to the mill and fro." Watermills for corn muſt in England have been of a late date. The ancients had mirror-glaſſes, and employed glaſs to imitate vaſes and goblets; yet they never thought of uſing it in windows. In the 13th century, the Venetians were the only people who had the art of making cryſtal-glaſs for mirrors. A clock that ſtrikes the hours was unknown in Europe till the end of the 14th century. And hence the cuſtom of employing men to proclaim the hours during night; which to this day continues in Germany, Flanders, and England. Galileo was the firſt who conceived an idea that a pendulum might be uſeful for meaſuring time; and Huygens was the firſt who put the idea in execution, by making a pendulum clock. Hook, in the year 1660, invented a ſpiral ſpring for a watch, though a watch was far from being a new invention. Paper was made no earlier than the fourteenth century; and the invention of printing was a century later. Silk manufactures were long eſtabliſhed in Greece before ſilk-worms were introduced there. The manufacturers were provided with raw ſilk from Perſia: but that commerce being frequently interrupted by war, two monks, in the reign Juſtinian, brought eggs of the ſilk-worm from Hindoſtan, and taught their countrymen the method of managing them.—The art of reading made a very ſlow progreſs. To encourage that art in England, the capital puniſhment for murder was remitted if the criminal could but read, which in law-language is termed *benefit of clergy*. One would imagine that the art muſt have made a very rapid progreſs when ſo greatly favoured: but there is a ſignal proof of the contrary; for ſo ſmall an edition of the Bible as 600 copies, tranſlated into Engliſh in the reign of Henry VIII. was not wholly ſold off in three years. The people of England muſt have been profoundly ignorant in Queen Elizabeth's time, when a forged clauſe added to the 20th article of the Engliſh creed paſſed unnoticed till about 50 years ago.

The exertion of national ſpirit upon any particular art promotes activity to proſecute other arts. The Romans, by conſtant ſtudy, came to excel in the art of war, which led them naturally to improve upon other arts. Having in the progreſs of ſociety, acquired ſome degree of taſte and poliſh, a talent for writing broke forth. Nevius compoſed in verſe ſeven books of the Punic war; beſides comedies, replete with bitter raillery againſt the nobility. Ennius wrote annals, and an epic poem. Lucius Andronicus was the father of dramatic poetry in Rome. Pacuvius wrote tragedies. Plautus and Terence wrote comedies. Lucilius compoſed ſatires, which Cicero eſteems to be ſlight, and void of erudition. Fabius Pictor, Cincius Alimentus, Piſo Frugi, Valerius Antias, and Cato, were rather annaliſts than hiſtorians, confining themſelves to naked facts, ranged in due order of time. The genius of the Romans for the fine arts was much inflamed by Greek learning, when free intercourſe between the two nations was opened. Many of thoſe who made the greateſt figure in the Roman ſtate commenced authors; Cæſar, Cicero, &c. Sylla compoſed memoirs of his own tranſactions, a work much eſteemed even in the days of Plutarch.

The progreſs of art ſeldom fails to be rapid when a people happen to be rouſed out of a torpid ſtate by ſome fortunate change of circumſtances. Proſperity, contraſted with former abaſement, gives to the mind a ſpring, which is vigorouſly exerted in every new purſuit. The Athenians made but a mean figure under the tyranny of Piſiſtratus: but upon regaining freedom and independence, they were converted into heroes. Miletus, a Greek city of Ionia, being deſtroyed by the king of Perſia, and the inhabitants made ſlaves, the Athenians, deeply affected with the miſery of their brethren, boldly attacked the king in his own dominions, and burnt the city of Sardis. In leſs than ten years after, they gained a ſignal victory at Marathon; and, under Themiſtocles, made head againſt that prodigious army with which Xerxes threatened utter ruin to Greece. Such proſperity produced its uſual effect: arts flouriſhed with arms, and Athens became the chief theatre for ſciences as well as for fine arts. The reign of Auguſtus Cæſar, which put an end to the rancour of civil war, and reſtored peace to Rome, with the comforts of ſociety, proved an auſpicious æra for literature; and produced a crowd of Latin hiſtorians, poets, and philoſophers, to whom the moderns are indebted for their taſte and talents. One who makes a figure rouſes emulation in all; one catches fire from another, and the national ſpirit is every where triumphant: claſſical works are compoſed, and uſeful diſcoveries made in every art and ſcience. With regard to Rome, it is true that the Roman government under Auguſtus was in effect deſpotic: but deſpotiſm, in the ſingle inſtance, made no obſtruction to literature, it having been the policy of that reign to hide power as much as poſſible.

The reſtoration of the royal family in England, which put an end to a cruel and envenomed civil war, promoted improvements of every kind: arts and induſtry made a rapid progreſs among the people, though left to themſelves by a weak and fluctuating adminiſtration. Had the nation, upon that favourable turn of fortune, been bleſſed with a ſucceſſion of able and virtuous princes, to what a height might not arts and ſciences have been carried! In Scotland, a favourable period for improvement was the reign of the firſt Robert, after ſhaking off the Engliſh yoke; but the domineering ſpirit of the feudal ſyſtem rendered abortive every attempt. The reſtoration of the royal family, mentioned above, animated the legiſlature of Scotland to promote manufactures of various kinds: but in vain; for the union of the two crowns had introduced deſpotiſm into Scotland, which ſunk the genius of the people, and rendered them heartleſs and indolent. Liberty, indeed, and many other advantages, were procured to them by the union of the two kingdoms; but the ſalutary effects were long ſuſpended by mutual enmity, ſuch as commonly ſubſiſts between neighbouring nations. Enmity wore out gradually, and the eyes of the Scots were opened to the advantages of their preſent condition; the national ſpirit was rouſed to emulate and to excel; talents were exerted, hitherto latent; and Scotland at preſent makes a figure in arts and ſciences above what it ever made while an independent kingdom.

Another cauſe of activity and animation is the being engaged in ſome important action of doubtful event; a ſtruggle for liberty, the reſiſting a potent invader, or the like. Greece, divided into ſmall ſtates, frequently at war with each other, advanced literature and the fine arts to unrivalled perfection. The Corſicans, while engaged in a perilous war for defence of their liberties, exerted a vigorous national ſpirit; they founded an univerſity for arts and ſciences, a public library, and a public bank. After a long ſtupor during the dark ages of Chriſtianity, arts and literature revived among the turbulent ſtates of Italy. The Royal Society in London, and the Academy of Sciences in Paris, were both of them inſtituted after civil wars that had animated the people and rouſed their activity.

As the progreſs of arts and ſciences towards perfection is greatly promoted by emulation, nothing is more fatal to an art or ſcience than to remove that ſpur, as where ſome extraordinary genius appears who ſoars above rivalſhip. Mathematics ſeem to be declining in Britain: the great Newton, having ſurpaſſed all the ancients, has not left to the moderns even the faineſt hope of equalling him; and what man will enter the liſts who deſpairs of victory?

In a country thinly peopled, where even neceſſary arts want hands, it is common to ſee one perſon exerciſing more arts than one: in ſeveral parts of Scotland, one man ſerves as a phyſician, ſurgeon, and apothecary. In every populous country, even ſimple arts are ſlit into parts, and each part has an artiſt appropriated to it. In the large towns of ancient Egypt, a phyſician was confined to a ſingle diſeaſe. In mechanic arts that method is excellent. As a hand confined to a ſingle operation becomes both expert and expeditious: a mechanic art is perfected by having its different operations diſtributed among the greateſt number of hands: many hands are employed in making a watch, and a ſtill greater number in manufacturing a web of woollen cloth. Various arts or operations carried on by the ſame man, invigorate his mind, becauſe they exerciſe different faculties; and as he cannot be equally expert in every art or operation, he is frequently reduced to ſupply want of ſkill by thought and invention. Conſtant application, on the contrary, to a ſingle operation, confines the mind to a ſingle object, and excludes all thought and invention: in ſuch a train of life, the operator becomes dull and ſtupid, like a beaſt of burden.

The difference is viſible in the manners of the people: in a country where, from want of hands, ſeveral occupations muſt be carried on by the ſame perſon, the people are knowing and converſable: in a populous country, where manufactures flouriſh, they are ignorant and unſociable. The ſame effect is equally viſible in countries where an art or manufacture is confined to a certain claſs of men. It is viſible in Hindoſtan, where the people are divided into caſts, which never mix even by marriage, and where every man follows his father's trade. The Dutch lint-boors are a ſimilar inſtance: the ſame families carry on the trade from generation to generation; and are accordingly ignorant and bruiſh even beyond other Dutch peaſants. The inhabitants of Buckhaven, a ſea-port in the county of Fife, were originally a colony of foreigners, invited hither to teach our people the art of fiſhing. They continue fiſhers to this day, marry among themſelves, have little intercourſe with their neighbours, and are dull and ſtupid to a proverb.

Uſeful arts paved the way to fine arts. Men upon whom the former had beſtowed every convenience, turned their thoughts to the latter. Beauty was ſtudied in objects of ſight; and men of taſte attached themſelves to the fine arts, which multiplied their enjoyments and improved their benevolence. Sculpture and paint-

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ing made an early figure in Greece; which afforded plenty of beautiful originals to be copied in theſe imitative arts. Statuary, a more ſimple imitation than painting, was ſooner brought to perfection: the ſtatue of Jupiter by Phidias, and of Juno by Polycletes, though the admiration of all the world, were executed long before the art of light and ſhade was known. Apollodorus, and Xeuxis his diſciple, who flouriſhed in the 15th Olympiad, were the firſt who figured in that art. Another cauſe concurred to advance ſtatuary before painting in Greece, viz. a great demand for ſtatues of their gods. Architecture, as a fine art, made a ſlower progreſs. Proportions, upon which its elegance chiefly depends, cannot be accurately aſcertained, but by an infinity of trials in great buildings: a model cannot be relied on; for a large and a ſmall building, even of the ſame form, require different proportions.

From the fine arts mentioned, we proceed to literature. It is agreed, among all antiquaries, that the firſt writings were in verſe, and that writing in proſe was of a much later date. The firſt Greek who wrote in proſe was Pherecides Syrus: the firſt Roman was Appius Cæcus, who compoſed a declamation againſt Pyrrhus. The four books of the Chatah Bhade, which is the ſacred book of Hindoſtan, are compoſed in verſe ſtanzas; and the Arabian compoſitions in proſe followed long after thoſe in verſe. To account for that ſingular fact, many learned pens have been employed; but without ſucceſs. By ſome it has been urged that as memory is the only record of events where writing is unknown, hiſtory originally was compoſed in verſe for the ſake of memory.

The ſongs of the bards, being univerſal favourites, were certainly the firſt compoſitions that writing was employed upon: they ſhould be carefully collected by the moſt ſkilful writers, in order to preſerve them in perpetual remembrance. The following part of the progreſs is obvious. People acquainted with no written compoſitions, but what were in verſe, compoſed in verſe their laws, their religious ceremonies, and every memorable tranſaction that was intended to be preſerved in memory by writing. But when ſubjects of writing multiplied, and became more and more involved; when people began to reaſon, to teach, and to harangue; they were obliged to deſcend to humble proſe: for to confine a writer or ſpeaker to verſe in treating ſubjects of that nature, would be a burden unſupportable.

The proſe compoſitions of early hiſtorians are all of them dramatic. A writer deſtitute of art is naturally prompted to relate facts as he ſaw them performed; he introduces his perſonages as ſpeaking and conferring; and he himſelf relates what was acted, and not ſpoke. The hiſtorical books of the Old Teſtament are compoſed in that mode; and ſo addicted to the dramatic are the authors of thoſe books, that they frequently introduce God himſelf into the dialogue. At the ſame time, the ſimplicity of that mode is happily ſuited to the poverty of every language in its early periods. The dramatic mode has a powerful effect in expreſſing ſentiment, and every thing that is ſimple and tender. Read, as an inſtance of a low incident becoming, by that means, not a little intereſting, Ruth, i. 8, to iv. 16. The dramatic mode is far from pleaſing ſo much in relating bare hiſtorical facts. Read, as an example, the ſtory of Adonijah in 1 Kings, i. 11---49. In that paſſage there are frequent repetitions; not however by the ſame perſon, but by different perſons who have occaſion in the courſe of the ſtory to ſay the ſame things; which is natural in the dramatic mode, where things are repreſented preciſely as they were tranſacted. In that view, Homer's repetitions are a beauty, not a blemiſh; for they are confined to the dramatic part, and never occur in the narrative.

But the dramatic mode of compoſition, however pleaſing, is tedious and intolerable in a long hiſtory. In the progreſs of ſociety new appetites and new paſſions ariſe; men come to be involved with each other in various connections: incidents and events multiply, and hiſtory becomes intricate by an endleſs variety of circumſtances. Dialogue accordingly is more ſparingly uſed, and in hiſtory plain narration is mixed with it. Narration is as it were the groundwork; and dialogue is raiſed upon it, like flowers in embroidery. Homer is admitted by all to be the great maſter in that mode of compoſition.

The narrative mode came in time ſo to prevail, that in a long chain of hiſtory, the writer commonly leaves off dialogues altogether. Early writers of that kind appear to have very little judgment in diſtinguiſhing capital facts from minute circumſtances, ſuch as can be ſupplied by the reader without being mentioned. The hiſtory of the Trojan war by Dares Phrygius is a curious inſtance of that cold and creeping manner of compoſition. The Roman hiſtories before the time of Cicero are chronicles merely. Cato, Fabius Pictor, and Piſo, confined themſelves to naked facts. In the Auguſtæ Hiſtoriæ Scriptores we find nothing but a tedious narrative of facts, commonly of very little moment, concerning a degenerate people, without a ſingle incident that can rouſe the imagination or exerciſe the judgment. The monkiſh hiſtories are all of them compoſed in the ſame manner.

The dry narrative manner being very little intereſting or agreeable, a taſte for embelliſhment prompted ſome writers to be copious and verboſe. Saxo-Grammaticus, who in the 12th century compoſed in Latin a hiſtory of Denmark, ſurpriſingly pure at that early period, is extremely verboſe and full of tautologies. Such a ſtyle, at any rate unpleaſant, is intolerable in a modern tongue, before it is enriched with a ſtock of phraſes for expreſſing aptly the great variety of incidents that enter into hiſtory. The perfection of hiſtorical compoſition, which writers at laſt attain to after wandering through various imperfect modes, is a relation of intereſting facts, connected with their motives and conſequences. An hiſtory of that kind is truly a chain of cauſes and effects. The hiſtory of Thucydides, and ſtill more that of Tacitus, are ſhining inſtances of that mode.

Eloquence was of a later date than the art of literary compoſition; for till the latter was improved, there were no models for ſtudying the former. Cicero's orations for Roſcius is compoſed in a ſtyle diffuſe and highly ornamented; which, ſays Plutarch, was univerſally approved, becauſe at that time the ſtyle in Aſia, introduced into Rome with its luxury, was in high vogue. But Cicero, in a journey to Greece, where he leiſurely ſtudied Greek authors, was taught to prune off ſuperfluities, and to purify his ſtyle, which he did to a high degree of refinement. He introduced into his native tongue a ſweetneſs, a grace, a majeſty, that ſurpriſed the world, and even the Romans themſelves. Cicero obſerves, with great regret, that if ambition for powe had not drawn Julius Cæſar from the bar to command legions, he would have become the moſt complete orator in the world. So partial are men to the profeſſion in which they excel. Eloquence triumphs in a popular aſſembly, makes ſome figure in a court of law compoſed of many judges, very little where there is but a ſingle judge, and none at all in a deſpotic government. Eloquence flouriſhed in the republics of Athens and of Rome; and makes ſome figure at preſent in a Britiſh houſe of commons.

The Greek ſtage has been juſtly admired among all polite nations. The tragedies of Sophocles and Euripides in particular are by all critics held to be perfect in their kind, excellent models for imitation, but far above rivalſhip. If the Greek ſtage was ſo early brought to maturity, it is a phenomenon not a little ſingular in the progreſs of arts. The Greek tragedy made a rapid progreſs from Theſpis to Sophocles and Euripides, whoſe compoſitions are wonderful productions of genius, conſidering that the Greeks at that period were but beginning to emerge from roughneſs and barbarity into a taſte for literature. The compoſitions of Eſchylus, Sophocles, and Euripides, muſt have been highly reliſhed among a people who had no idea of any thing more perfect. We judge by compariſon, and every work is held to be perfect that has no rival. It ought at the ſame time to be kept in view, that it was not the dialogue which chiefly enchanted the Athenians, nor variety in the paſſions repreſented, nor perfection in the actors; but machinery and pompous decoration, joined with exquiſite muſic. That theſe particulars were carried to the greateſt height, we may with certainty conclude from the extravagant ſums beſtowed on them: the exhibiting a ſingle tragedy was more expenſive to the Athenians than their fleet or their army in any ſingle campaign.

One would imagine, however, that theſe compoſitions were too ſimple to enchant for ever; as variety in action, ſentiment, and paſſion, is requiſite, without which the ſtage will not continue long a favourite entertainment: and yet we find not a ſingle improvement attempted after the days of Sophocles and Euripides. The manner of performance, indeed, prevented abſolutely any improvement. A fluctuation of paſſion and refined ſentiments would have made no figure on the Grecian ſtage. Imagine the diſcording ſcene between Brutus and Caſſius in Julius Cæſar to be there exhibited, or the handkerchief in the Moor of Venice: how ſlight would be their effect, when pronounced in a maſk, and through a pipe? The workings of nature upon the countenance, and the flections of voice expreſſive of various feelings, ſo deeply affecting in modern repreſentation, would have been entirely loſt. If a great genius had ariſen with talents for compoſing a pathetic tragedy in perfection, he would have made no figure in Greece. An edifice muſt have been erected of a moderate ſize: new actors muſt have been trained to act with a bare face, and to pronounce in their voice. And after all, there remained a greater miracle ſtill to be performed, viz. a total reformation of taſte in the people of Athens. In one word, the ſimplicity of the Greek tragedy was ſuited to the manner of acting; and that manner excluded all improvements.

With reſpect to comedy, it does not appear that the Greek comedy ſurpaſſed the tragedy in its progreſs towards perfection. Horace mentions three ſtages of Greek comedy. The firſt well ſuited to the rough and coarſe manners of the Greeks, when Eupolis, Cratinus, and Ariſtophanes, wrote. Theſe authors were not aſhamed to repreſent on the ſtage real perſons, not even diſguiſing their names; of which we have a ſtriking inſtance in a comedy of Ariſtophanes, called *The Clouds*, where Socrates is introduced, and moſt contemptuouſly treated. This ſort of comedy, ſparing neither gods nor men, was reſtrained by the magiſtrates of Athens, ſo far as to prohibit perſons to be named on the ſtage. This led writers to do what is done at preſent: the characters and

The Binder is deſired to obſerve, that this Sheet (4 O---1) is to be placed before Sheet (4 O---2) it being an additional Sheet introduced to enlarge the Article Art, in this new Edition of the Work.

manners of known perſons were painted ſo much to the life, that there could be no miſtake; and the ſatire was indeed heightened by this regulation, as it was an additional pleaſure to find out the names that were meant in the repreſentation. This was termed the *middle comedy*. But as there ſtill remained too great ſcope for obloquy and licentiouſneſs, a law was made prohibiting real events or incidents to be introduced upon the ſtage. This law happily baniſhed ſatire againſt individuals, and confined it to manners and cuſtoms in general. Obedient to this law are the comedies of Menander, Philemon, and Diphilus, who flouriſhed about 300 years before the Chriſtian æra. And this is termed the *third ſtage* of Greek comedy The comedies of Ariſtophanes which ſtill remain, err not leſs againſt taſte than againſt decency. But the Greek Comedy is ſuppoſed to have been conſiderably refined by Menander and his cotemporaries. Their works, however, were far from perfection, if we can draw any conjecture from their imitator Plautus, who wrote about a century later.

The Roman theatre, from the time of Plautus to that of Terence, made a rapid progreſs. Ariſtotle defines comedy to be "an imitation of light and trivial ſubjects, provoking laughter." The comedies of Plautus correſpond accurately to this definition: thoſe of Terence riſe to a higher tone. Nothing is more evident than the ſuperiority of Terence above Plautus in the art of writing; and, conſidering that Terence is a later writer, nothing would appear more natural, if they did not copy the ſame originals. It may be owing to genius that Terence excelled in purity of language and propriety of dialogue; but how account for his ſuperiority over Plautus in the conſtruction and conduct of a play? It will not certainly be thought that Plautus would imitate the worſt conſtructed plays, leaving the beſt to thoſe who ſhould come after him. This difficulty does not ſeem to have occurred to any of the commentators. Had the works of Menander and of his cotemporaries been preſerved, they probably would have explained the myſtery; which for want of that light will probably remain a myſtery for ever.

Homer has for more than 2000 years been held the prince of poets. Such perfection in an author who flouriſhed when arts were far ſhort of maturity, is truly wonderful. The nations engaged in the Trojan war are deſcribed by him as in a progreſs from the ſhepherd-ſtate to that of agriculture. Frequent mention is made in the Iliad of the moſt eminent men being ſhepherds. Andromache, in particular, mentions ſeven of her brethren who were ſlain by Achilles as they tended their father's flocks and herds. In that ſtate, garments of woollen cloth were uſed; but the ſkins of beaſts, the original clothing, were ſtill worn as an upper garment: every chief in the Iliad appears in that dreſs. Such indeed was the ſimplicity of this early period, that a black ewe was promiſed by each chief to the man who would undertake to be a ſpy. In times of ſuch ſimplicity, literature could not be far advanced; and it is a great doubt whether there was at that time a ſingle poem of the epic kind for Homer to imitate or improve upon. Homer is undoubtedly a wonderful genius, perhaps the greateſt that ever exiſted: his fire, and the boldneſs of his conceptions, are inimitable. But in that early age, it would fall little ſhort of a real miracle, to find ſuch ripeneſs of judgment, and correctneſs of execution, as in modern writers are the fruits of long experience and progreſſive improvements during the courſe of many centuries. Accordingly, that Homer is far from being ſo ripe, or ſo correct, cannot eſcape the obſervation of any reader of taſte and diſcernment.

One ſtriking particular is, his digreſſions without end, which draw our attention from the principal ſubject. Diomedes, for inſtance, meeting with Glacus in the field of battle, and doubting, from his majeſtic air, whether he might not be an immortal, enquires who he was, declaring that he would not fight with a god. Glaucus lays hold of this very ſlight opportunity, in the very heat of action, to give a long hiſtory of his family. In the mean time, the reader's patience is put to trial, and his ardour cools. Again, Agamemnon deſiring advice how to reſiſt the Trojans, Diomedes ſprings forward; but, before he offers advice, gives the hiſtory of all his progenitors, and of their characters, in a long train. And, after all, what was the ſage advice that required ſuch a preface? It was, that Agamemnon ſhould exhort the Greeks to fight bravely. At any rate, was Diomedes ſo little known as to make it proper to ſuſpend the action at ſo critical a juncture, for a genealogical hiſtory? There is a third particular which juſtly merits cenſure; and that is, an endleſs number of minute circumſtances, eſpecially in the deſcription of battles, where they are moſt improper. The capital beauty of an epic poem is, the ſelection of ſuch incidents and circumſtances as make a deep impreſſion, keeping out of view every thing low or familiar. An account of a ſingle battle employs the whole fifth book of the Iliad, and a great part of the ſixth: yet in the whole there is no general action; but unknown warriors, whom we never heard of before, killed at a diſtance with an arrow or a javelin; and every wound deſcribed with an anatomical accuracy. The whole ſeventeenth book is employed in the conteſt about the dead body of Patroclus, ſtuffed with minute circumſtances, below the dignity of an epic poem. In ſuch ſcenes the reader is fatigued with endleſs particulars; and has nothing to ſupport him but the melody of Homer's verſification.

Having traced the progreſs of the fine arts towards maturity, in a ſummary way, the decline of theſe arts comes next in order. An art, in its progreſs towards maturity, is greatly promoted by emulation; and after arriving at maturity, its downfal is not leſs promoted by it. It is difficult to judge of perfection but by compariſon; and an artiſt, ambitious to outſtrip his predeceſſors, cannot ſubmit to be an imitator, but muſt ſtrike out ſomething new, which, in an art advanced to ripeneſs, ſeldoms fails to be a degeneracy. This cauſe of the decline of the fine arts may be illuſtrated by various inſtances. The perfection of vocal muſic is to accompany paſſion, and to enforce ſentiment. In ancient Greece, the province of muſic was well underſtood; which being confined within its proper ſphere, had an enchanting influence.

The Italian opera, in its form, reſembles the Greek tragedy, from which it is evidently copied; but very little in ſubſtance. In the latter, muſic being made ſubſervient to ſentiment, the dialogue is nervous and ſublime: in the former, the whole weight is laid on muſic; and the dialogue, devoid of ſentiment, is weak and ſpiritleſs. Reſtleſs man knows no golden mean, but will be attempting innovations without end.—By the ſame ambition, architecture has viſibly declined from its perfection. The Ionic was the favourite order when architecture was in its height of glory. The Corinthian order came next; which, in attempting greater perfection, has deviated from the true ſimplicity of nature; and the deviation is ſtill greater in the Compoſite order. With reſpect to literary productions, the firſt eſſays of the Romans were very imperfect. We may judge of this from Plautus, whoſe compoſitions are abundantly rude, though much admired by his cotemporaries, being the beſt that exiſted at that time. The exalted ſpirit of the Romans hurried them on to the grand and beautiful; and literary productions of all kinds were in perfection when Auguſtus reigned. In attempting ſtill greater perfection, the Roman compoſitions became a ſtrange jumble of inconſiſtent parts: they were tumid and pompous; and, at the ſame time, full of antitheſes, conceit, and tinſel wit. Every thing new in the fine arts pleaſes, though leſs perfect than what we are accuſtomed to; for that reaſon, ſuch compoſitions were generally reliſhed. We ſee not by what gradual ſteps writers, after the time of Auguſtus, deviated from the patterns that were before them: for no book of any moment after that time is preſerved till we come down to Seneca, in whoſe works nature and ſimplicity give place to artificial thought and baſtard wit. He was a great improver of the Roman taſte; and after him nothing was reliſhed but brilliant ſtrokes of fancy, with very little regard to ſentiment: even Virgil and Cicero made no figure in compariſon. Lucan has a forced elevation of thought and ſtyle, very difficult to be ſupported; and, accordingly, he ſinks often into puerile reflections; witneſs his encomium on the river Po, which, ſays he, would equal the Danube, had it the ſame number of tributary ſtreams. Quintilian, a writer of true and claſſical taſte, who was protected and encouraged by Veſpaſian, attempted to ſtem the tide of falſe writing. His rhetoric is compoſed in an elegant ſtyle; and his obſervations contain every delicacy of the critical art. At the ſame time flouriſhed Tacitus, poſſeſſing a more extenſive knowledge of the nature of man than any other author, ancient or modern, if Shakſpeare be not excepted. His ſtyle is original, conciſe, compact, and comprehenſive; and, in what is properly called his *hiſtory*, perfectly correct and beautiful. He has been imitated by ſeveral, but never equalled by any. Brutus is ſaid to be the laſt of the Romans for love of liberty: Quintilian and Tacitus may be ſaid to be the laſt of the Romans for literary genius. Pliny the Younger is no exception; his ſtyle is affected, turgid, and full of childiſh brilliancy. Seneca and Pliny are proper examples of writers who ſtudy ſhow more than ſubſtance, and who make ſenſe yield to ſound. The difference between theſe authors and thoſe of the Auguſtan age, reſembles the difference between Greek and Italian muſic. Muſic, among the Greeks, limited itſelf to the employment to which it is deſtined by nature, viz. to be the handmaid of ſenſe, to enforce, enliven, or ſweeten a ſentiment. In the Italian opera, the miſtreſs is degraded to be handmaid; and harmony triumphs, with very little regard to ſentiment.

Another great cauſe that precipates the downfal of every fine art is deſpotiſm. The reaſon is obvious; and there is a diſmal example of it in Rome, particularly with regard to eloquence. We learn from a dialogue accounting for the corruption of the Roman eloquence, that in the decline of the art it became faſhionable to ſtuff harangues with impertinent poetical quotations, without any view but ornament merely; and this alſo was long faſhionable in France. It happened unluckily for the Romans, and for the world, that the fine arts were at their height at Rome, and not much upon the decline in Greece, when deſpotiſm put an end to the republic. Auguſtus, it is true, retarded their fall, particularly that of literature; it being the policy of his reign to hide deſpotiſm, and to give his government an air of freedom. His court was a ſchool of urbanity, where people of genius acquired that delicacy of taſte, that elevation of ſentiment, and that purity of expreſſion, which characterize the writers of his time. He honoured men of learning, admitted them to his table, and

and was bountiful to them. It would be painful to follow the decline of the fine arts in Rome to their total extirpation. The tyranny of Tiberius, and of ſubſequent emperors, broke at laſt the elevated and independent ſpirit of the brave Romans, reduced them to abject ſlavery, and left not a ſpark of genius. The ſcience of law is the only exception, as it flouriſhed even in the worſt of times: the Roman lawyers were a reſpectable body, and leſs the object of jealouſy than men of power and extenſive landed property. Among the Greeks alſo, a conquered people, the fine arts decayed; but not ſo rapidly as at Rome; the Greeks, farther removed from the ſeat of government, being leſs within the reach of a Roman tyrant. During their depreſſion, they were guilty of the moſt puerile conceits: witneſs verſes compoſed in the form of an axe, an egg, wings, and ſuch-like. The ſtyle of the Greek authors, in the reign of the emperor Adrian, is unequal, obſcure, ſtiff, and affected. Lucian is the only exception that may be made.

We need ſcarce any other cauſe but deſpotiſm, to account for the decline of ſtatuary and painting in Greece. Theſe arts had arrived at their utmoſt perfection about the time of Alexander the Great; and from that time they declined gradually with the vigour of a free people; for Greece was now enſlaved by the Macedonian power. It may in general be obſerved, that when a nation becomes ſtationary in that degree of power which it acquires from its conſtitution and ſituation, the national ſpirit ſubſides, and men of talents become rare. It is ſtill worſe with a nation that is ſunk below its former power and pre-eminence; and worſt of all when it is reduced to ſlavery. Other cauſes concurred to accelerate the downfal of the arts mentioned. Greece, in the days of Alexander, was filled with ſtatues of excellent workmanſhip, and there being little demand for more, the later ſtatuaries were reduced to heads and buſts. At laſt the Romans put a total end both to ſtatuary and painting in Greece, by plundering it of its fineſt pieces; and the Greeks, expoſed to the avarice of the conquerors, beſtowed no longer any money on the fine arts.

The decline of the fine arts in Rome, is by a writer of taſte and elegance aſcribed to a cauſe different from any above mentioned, a cauſe that overwhelms manhood as well as the fine arts wherever it prevails; and that is opulence, joined with its faithful attendants avarice and luxury. "In ancient times (ſays he) when naked virtue had her admirers, the liberal arts were in their higheſt vigour; and there was a generous conteſt among men, that nothing of real and permanent advantage ſhould long remain undiſcovered. Democritus extracted the juice of every herb and plant; and, leſt the virtue of a ſingle twig ſhould eſcape him, he conſumed a lifetime in experiments. Eudoxus, immerſed in the ſtudy of aſtronomy, ſpent his age upon the top of a mountain. To turn to the imitative arts: Lyſippus, while labouring on the forms of a ſingle ſtatue, periſhed from want. Myron, whoſe powerful hand gave to the braſs almoſt the ſoul of man and animals,—at his death found not an heir. How ſhould we wonder that the art of painting has declined, when, in the eyes of men, there is more beauty in a maſs of gold than in all the works of Phidias and Apelles?"

In England, the fine arts are far from ſuch perfection as to ſuffer by opulence. They are in great progreſs towards maturity.

There is ſtill another cauſe that never fails to undermine a fine art in a country where it is brought to perfection, abſtracted from every one of the cauſes above mentioned. It is remarked a little above, that nothing is more fatal to an art or to a ſcience than a performance ſo much ſuperior to all of the kind as to extinguiſh emulation. This remark is exemplified in the great Newton, who, having ſurpaſſed all the ancients, has not left to his countrymen even the faineſt hope of rivalling him; and to that cauſe is attributed the viſible decline of mathematics in Great Britain. The ſame cauſe would have been fatal to the arts of ſtatuary and painting among the Greeks, even though they had continued a free people. The decay of painting in modern Italy is, probably, owing to the ſame cauſe: Michael Angelo, Raphael, Titian, &c. are lofty oaks that bear down young plants in their neighbourhood, and intercept from them the ſunſhine of emulation. Had the art of painting made a flower progreſs in Italy, it might have there continued in vigour to this day.

The decline of an art or ſcience proceeding from the foregoing cauſe, is the moſt rapid where a ſtrict compariſon can be inſtituted between the works of different maſters. The ſuperiority of Newton above every other mathematician can be aſcertained with preciſion, and hence the ſudden decline of that ſcience in Great Britain. In Italy a talent for painting continued many years in vigour, becauſe no painter appeared with ſuch ſuperiority of genius as to carry perfection in every branch of the art. As one ſurpaſſed in deſigning, one in colouring, one in graceful attitudes, there was ſtill ſcope for emulation. But when at laſt there was not a ſingle perfection but what one or other maſter had excelled in, from that period the art began to languiſh. Architecture continued longer in vigour than painting, becauſe the principles of compariſon in the former are leſs preciſe than in the latter. The artiſt who could not rival his predeceſſors in an eſtabliſhed mode, fought out a new mode for himſelf, which, though perhaps leſs elegant or perfect, was for a time ſupported by novelty.

Uſeful arts will never be neglected in a country where there is any police; for every man finds his account in them. Fine arts are more precarious. They are not reliſhed but by perſons of taſte, who are rare; and ſuch as can ſpare great ſums for ſupporting them are ſtill more rare. For that reaſon, they will never flouriſh in any country, unleſs patronized by the ſovereign, or by men of power and opulence. They merit ſuch patronage, as one of the ſprings of government: and a capital ſpring they make, by multiplying amuſements, and humanizing manners; upon which account they have always been encouraged by good princes, and are particularly ſo by his Britannic Majeſty George III. under whoſe ſignal patronage they have flouriſhed in ſo eminent a degree, as cannot fail to tranſmit his name with honour to poſterity.

General Theory of the Polite Arts. The eſſence of the polite arts, as before obſerved, conſiſts in *expreſſion*. The end of all theſe arts is *pleaſure*; whereas the end of the ſciences is *inſtruction* and *utility*. Under the denomination of Polite Arts, we comprehend, 1. Eloquence; 2. Poetry; 3. Muſic; 4. Painting; 5. Sculpture; 6. Graving; 7. Architecture. Particular deſcriptions of theſe arts are given under their reſpective names. This branch of the preſent article is intended as a general introduction to them; and, as ſuch, will be occaſionally referred to.

There is one very eſſential reflection, which it appears to us proper to make, in the firſt place, on the polite arts in general. All the rules in the world are not ſufficient to make a great poet, an able orator, or an excellent artiſt; becauſe the quality neceſſary to form theſe depends on the natural diſpoſition, the fire of genius, which no human art can confer, but which is the pure gift of heaven. The rules, however, will prevent a man from being a bad artiſt, a dull orator, or a wretched poet; ſeeing they are the reflections of the greateſt maſters in thoſe arts, and that they point out the rocks which the artiſt ſhould ſhun in the exerciſe of his talents. They are of uſe, moreover, in facilitating his labours, and in directing him to arrive by the ſhorteſt and ſureſt road to perfection. They refine, ſtrengthen, and confirm, his taſte. Nature, abandoned to herſelf, has conſtantly ſomething wild and ſavage. Art, founded on juſt and ſagacious rules, gives her elegance, dignity, and politeneſs; and it is impoſſible to ſacrifice properly to the graces, without knowing the incenſe that is pleaſing to them.

Beauty is the object of all the polite arts. It is not, however, ſo eaſy as it may ſeem to give a clear and determinate idea of what we preciſely mean by that term. We may ſay, in general, that beauty reſults from the various perfections of which any object is ſuſceptible, and which it actually poſſeſſes; and that the perfections which produce beauty conſiſt principally in the agreeable and delightful proportions which are found, 1. Between the ſeveral parts of the ſame object; 2. Between each part and the whole together; 3. Between the parts and the end or deſign of the object to which they belong. *Genius*, or invention, is that faculty of the mind by which *beauty* is produced. *Taſte*, diſpoſition, or rather the natural ſenſation of the mind refined by art, ſerves to guide the genius in diſcerning, embracing, and producing, that which is beautiful of every kind. From whence it follows, that the general theory of the polite arts is nothing more than the knowledge of what they contain that is truly beautiful and agreeable; and it is this knowledge, this theory, which modern philoſophers call by the Latin name of *æſthetica*. It ſhould be conſtantly remembered that the eſſence of the polite arts conſiſts in expreſſion. This expreſſion lies ſometimes in the words and ſometimes in the pen; ſometimes in ſounds and their harmony, and at others in corporeal attitudes; ſometimes in the pencil or in the chiſel, and at others in the graver; ſometimes in a proper diſpoſition or judicious employment of the mechanic arts, and at others merely in their manner of acting. From whence ariſe thoſe arts that we have mentioned, and which are deſcribed in their order. The general theory of the polite arts, or *eſthetics*, neceſſarily ſuppoſes, therefore, certain rules; but theſe general rules are of no great number.

The firſt is, That whoever would devote himſelf to the polite arts, ſhould above all things *conſult his genius*; diveſt himſelf of all ſelf-love; and examine if he be a true ſon of Apollo, and cheriſhed by the muſes? for,

> In vain, raſh author, doſt thou ſtrive to climb,
> By lofty verſe, Parnaſſus' height ſublime,
> If heaven does not by ſecret powers inſpire,
> Or if thy natal ſtar darts not poetic fire.

This precept, with regard to poetry in particular, is applicable to all the polite arts in general; for their moſt happy ſucceſs is founded on *imagination*. By this term we underſtand, in general, a faculty of the mind, a particular genius, a lively invention, a certain ſubtile ſpirit, which gives a facility in diſcovering ſomething new. The fine arts, in their imitations of nature, in their expreſſions, can borrow images, figures, compariſons, from thoſe things only that exiſt and are known. As there have been from the beginning of the world to our days, millions of authors in each of the polite arts, almoſt all the poſſible combinations of the various

ſubjects

ſubjects have been produced by their lively imaginations; and when we hear the ignorant part of mankind talk of a work of wit or of art, *that is entirely new*, that offers ideas which were before utterly unknown, that had never entered into the brain of any other man, we ſhould refer ſuch aſſertions to the claſs of popular errors; and reflect on thoſe ſtories we every day hear of certain empirics, who pretend to be alone poſſeſſed of marvellous methods of cure by means of ſimples; as if there were any plant, any ſtalk of graſs, that grows in our world, that can have eſcaped the reſearches of botaniſts. But the novelty, of which we here ſpeak, conſiſts in the ingenious uſe of combinations of all the various objects of nature, that are new, happy, and agreeable, that have not yet been exhauſted, and which appear even to be inexhauſtable; and of the uſe which the artiſt makes of all new diſcoveries, which he turns to his advantage, by a judicious application. Invention therefore ſuppoſes a conſiderable fund of preliminary knowledge, ſuch as is capable of furniſhing ideas and images, to form new combinations. But there is no art by which invention itſelf can be produced; for that, as we have already ſaid, is the gift of heaven; and it is an endowment which we cannot even make uſe of whenever we pleaſe. We would rather ſay therefore, that invention conſiſts in producing in works of genius, *that which is unexpected*; an object, a harmony, a perfection, a thought, an expreſſion, of which we had no idea, that we could not foreſee, nor hope to find, where the artiſt has ſo happily placed it, and where we perceive it with delight. This idea appears applicable to ſuch of the polite arts as affect the mind by the hearing as well as by the ſight; and it is a matter that is highly eſſential.

The ſecond rule is, That every artiſt ought inceſſantly to labour in the improvement of his *taſte*; in acquiring that ſenſible, refined, and clear diſcernment, by which he will be enabled to diſtinguiſh the real beauties in each object, the ornaments that are agreeable to it, and the proportions and relations that ſubſiſt among the ſeveral parts; and by this faculty, he will be regulated in the employment of his natural talents. This labour conſiſts not only in the profound reflections he will make on the properties of objects as they relate to the fine arts, but alſo in a conſtant aſſiduous ſtudy of the grand models of beauty.

The third rule to be obſerved in the practice of the polite arts, is *The imitation of nature*. Every object in the univerſe has its peculiar nature, of which the artiſt ſhould never loſe ſight in his manner of treating it. In vain will he otherwiſe ornament his work with the moſt refined and moſt brilliant ſtrokes: for, if nature be not juſtly imitated, it will for ever remain imperfect. The ſublime Homer has ſometimes ſinned againſt this rule: for, as the gods have a nature peculiar to themſelves, it cannot be a juſt imitation when we attribute to them paſſions that are ſcarce pardonable in mortals, and make them frequently converſe in a language that is at once vulgar and ridiculous. It was not to imitate nature, to put into the mouth of a hero, at the moment of a deciſive battle, an harangue that muſt become tedious by its exceſſive length, and which certainly could not have been heard by the thouſandth part of a numerous army: but we have already touched upon ſome of the faults that are ſtrewed over the poems of that great man; to multiply or dwell upon them would be ungrateful. We muſt, however, obſerve, that this imitation of nature, which appears at firſt view ſo ſimple and ſo eaſy, is of all things the moſt difficult in practice; and that it requires a diſcernment ſo ſagacious, and an expreſſion ſo happy, as is rarely beſtowed by heaven on mortal man.

Perſpicuity forms the fourth rule of expreſſion. In all the fine arts, in general, an obſcure, perplexed, ambiguous, and elaborate expreſſion, is always bad. The true ſtriking beauty muſt be manifeſt and perceptible to the moſt ignorant of mankind, as well as the moſt learned. Thoſe are ever falſe or inferior beauties that have occaſion for a covering, a kind of veil that may make them appear greater than they really are: true beauty wants no veil, but ſhines by its native luſtre. From the union of the true imitation of nature with perſpicuity of expreſſion ariſes that *truth* which is ſo eſſential in the productions of the fine arts.

In all the polite arts, and in all the ſubjects they embrace, there muſt neceſſarily reign an elevation of ſentiment, that expreſſes each object in the greateſt perfection of which it is ſuſceptible; that imitates nature in her moſt exalted beauty. This makes the fifth general rule. The deſign of the fine arts being to excite pleaſure by the expreſſion of that which is beautiful, every artiſt ſhould raiſe himſelf above his ſubject, and, chooſing the moſt favourable light wherein to place it, ſhould there embelliſh it with the greateſt, moſt noble, and beautiful ornaments, that his own genius can ſuggeſt; ſtill, however, obſerving a ſtrict imitation of nature.

From the obſervation of the two laſt rules reſults the *ſublime*, which is the union of the greateſt perſpicuity with the ſtricteſt truth and moſt exalted elevation poſſible. It is neceſſary to remark here, that the moſt ſimple and common ſubjects are ſuſceptible of a ſublime that is agreeable to their nature. An idyl or landſcape may be as ſublime in their kinds as an epic poem or a hiſtory-piece. When Moſes begins the book of Geneſis with theſe words, *In the beginning God created the heaven and the earth*; or when he tells us, that God ſaid, *Let there be light, and there was light*; theſe expreſſions are ſublime in the higheſt degree, becauſe they are perfectly clear, true, and elevated. Every author ſhould therefore endeavour after the ſublime in every ſubject that he undertakes: and this makes the ſixth and laſt general rule in the practice of the polite arts. But if he cannot attain to this, it is, however, indiſpenſibly neceſſary that he conſtantly make uſe of expreſſions that are *noble and refined*. Every thing that is *low*, *indecent*, or *diſagreeable*, is naturally repugnant to the ſublime, and ought to be for ever baniſhed from all the works that proceed from the noble and liberal arts.

ARTERY, in anatomy, a hollow fiſtulous canal, appointed to receive the blood from the ventricles of the heart, and diſtribute it to all parts of the body, for the maintenance of heat and life, and the conveyance of the neceſſary nutriment. For a copious deſcription of this branch of anatomy, ſee the Syſtem, Part V. Sect. I. and III. For repreſentation, ſee Plate VIII. and IX.

ARTHRITIS, in medicine, a diſeaſe better known under the name of the GOUT. The word is formed from ἄρθρον, *articulus*, *joint*; in regard the chief ſeat of that diſtemper is in the joints. For a copious deſcription of the nature, cauſes, and methods of treating this very ſingular diſeaſe, according to its ſeveral ſymptoms and degrees, ſee the Syſtem of MEDICINE, Genus 24.

ARTICHOKE, in botany. We have two ſorts of *artichokes* that are cultivated in the Engliſh gardens, which we ſhall diſtinguiſh here only by the names whereby they are generally known among gardeners.

The beſt ſort is what the gardeners call the globe *artichoke*. This hath large heads with broad brown ſcales, which turn inward; the fleſhy part at the bottom of the ſcales is very thick, and is therefore much preferred to the other, called the French *artichoke*: the ſtalks of which do generally grow taller, with ſmaller heads, formed more conical than thoſe of the globe; the ſcales are narrower, of a greener colour, and frequently turned outward. The fleſhy part, or bottom, is not near ſo thick, and hath a diſagreeable perfumed taſte. This was almoſt totally rooted out of the Engliſh gardens before the hard froſt in 1739-40, when the greateſt part of the roots of the other ſort were deſtroyed; many perſons were ſupplied the following ſpring with plants from Guernſey, where they cultivate only the latter ſort; but ſince the other has been increaſed again, this green ſort has been rooted out of moſt gardens, to make way for the globe *artichoke*.

The *artichoke* is a pleaſant, wholeſome, and very nourihing food; the roots are reckoned to be aperitive, cleanſing, and diuretic; good for the jaundice, and to provoke urine. The French and Germans eat not only the heads, but alſo the young ſtalks boiled, and ſeaſoned with butter and vinegar. The Italians ſeldom boil the heads, but eat them raw, when young, with ſalt, oil, and pepper. *Artichokes* have the reputation of promoting venereal inclinations to a very great degree; the ſtalks, preſerved in honey, are ſaid to be an excellent pectoral; but they ſhould firſt be blanched, like celery. The common leaves, boiled in white-wine whey, are much commended in the jaundice, as is alſo the juice of theſe leaves. For the moſt approved method of cultivating *artichokes*, ſee the Treatiſe on GARDENING, article KITCHEN GARDEN; months, March, April, Auguſt, and November. *Jeruſalem* is the root of a ſpecies of the *helianthus*, or *ſun-flower*, of the perennial kind, which is propagated in many gardens for the uſe of the kitchen; it is a very agreeable taſted root, but watery and windy, and therefore at preſent generally diſregarded.

ARTICLE, is applied to the ſeveral clauſes or conditions of a contract, treaty of peace, or the like. In this ſenſe we ſay, *articles* of marriage; *articles* of capitulation; preliminary *articles*, &c.

ARTICLE *of faith* is by ſome defined a point of Chriſtian doctrine, which we are obliged to believe, as having been revealed by God himſelf, and allowed and eſtabliſhed as ſuch by the church. The thirty-nine *articles* were founded, for the moſt part, upon a body of *articles* compiled and publiſhed in the reign of Edward VI. They were firſt paſſed in the convocation, and confirmed by royal authority in the year 1562. They were afterwards ratified anew in the year 1571, and again by Charles I. The law requires a ſubſcription to theſe *articles* of all perſons ordained to the deacons or prieſts, 13 Ed. cap. 12. of all clergymen inducted to any eccleſiaſtical living, by the ſame ſtatute, and of licenſed lectures and curates, 13 Ed. cap. 12. and 13 and 14 Ch. II. cap. 4. of the heads of colleges, of chancellors, officials, and commiſſaries, and of ſchool-maſters. By 1 Will. III. cap. 18. diſſenting teachers are to ſubſcribe all except the 34th, 35th, and 36th, and part of the 20th (and in the caſe of Anabaptiſts, except alſo part of the 27th;) otherwiſe they are exempted from the benefits of the act of toleration.

ARTICLE, in arithmetic, ſignifies the number 10, or any number juſtly diviſible into ten parts; as 20, 30, 40, &c.—Theſe are ſometimes called *decads*, and ſometimes *round numbers*.

ARTICLE, in grammar, denotes a particle uſed in moſt languages for the declining of nouns, and denoting the ſeveral caſes and genders thereof. The uſe of *articles* ariſes chiefly hence, that in languages which have no different terminations to expreſs the different ſtates and circumſtances of nouns, there is ſomething required to ſupply that office.

The Latins have no *article*; but the Greeks, and moſt of the modern languages, have had recourſe to them, for fixing and aſcertaining the vague ſignification of common and appellative names.

The Greeks have their ὁ, the eaſtern tongues their *he emphaticum*; the Italians their *il*, *lo*, and *la*.—The French their *le*, *la*, and *les*.—The Germans theis *der*, *das*, *dat*.—The Engliſh have alſo two *articles*, *a* and *the*; which being prefixed to ſubſtantives, apply their general ſignification to ſome particular things.

Some grammarians make the *article* a diſtinct part of ſpeech; others will have it a pronoun; and others a noun adjective. See the Syſtem of GRAMMAR, Part I. Chap. III. and Part II. Chap. III. Art. 1.

Articles are of great ſervice in a language, as they contribute to the more neat and preciſe expreſſing of ſeveral properties and relations, which muſt otherwiſe be loſt.

ARTICULATE *Sounds* are thoſe which expreſs the letters, ſyllables, &c. of any alphabet, or language. Brutes cannot form *articulate* ſounds, or they cannot *articulate* the ſounds of their voice; excepting ſome few birds, as the *parrot*, *pye*, *raven*, *ſtarling*, &c.

ARTICULATION, in grammar, a diſtinct pronunciation of words and ſyllables. *Articulation* is that part of grammar which treats firſt of ſounds and letters; then of their combinations, for the compoſing of ſyllables and words. Hence he who pronounces his words clearly and diſtinctly is ſaid to pronounce them *articulately*. See the Syſtem, Part I. article, UNIVERSAL GRAMMAR.

ARTICULATION, in anatomy, the juncture or connection of two bones. The bones cannot ſerve the intended purpoſes, except the ſeveral pieces are fitly adjuſted, and then kept together in different ways. The moſt ancient oſteologiſts (ſpeaking only of the perfect bones of an adult) called the firſt of theſe *articulation*, and the other SYMPHISIS.

Articulation thus underſtood is of two kinds, one moveable, by which the bones are allowed a certain degree of motion; the other immoveable, by which they are fixed together without motion. The firſt is commonly called DIARTHROSIS; that is, an *articulation* ſeparated; the other *ſynarthroſis*, or an *articulation* conjoined. There is ſtill another ſpecies of *articulation*, which cannot well be reduced to either of the two former, as partaking of both: this, therefore, may be eſtabliſhed as a third kind, by the name of AMPHIARTHROSIS, which agrees better to this ſort than the other *articulations*, to which it has ſometimes been applied. For a copious deſcription of the bones in general, with an explanation of their appendages, ſee the Syſtem of ANATOMY, Part I. Sect. 1. throughout.

ARTIFICERS, thoſe who work with the hands, and fell things faſhioned by them into other forms.

Artificers amount to the ſame with what we otherwiſe call *handicrafts* and *mechanics*; ſuch are ſmiths, carpenters, taylors, ſhoemakers, weavers, and the like.

By means of the *arts*, the minds of men are engaged in inventions beneficial to the whole community; and thus prove the grand preſervative againſt the barbariſm and brutality which ever attend on an indolent and inactive ſtupidity.

By the Engliſh laws, *artificers* in wool, iron, ſteel, braſs, or other metal, going out of the kingdom into any foreign country without licence, are to be impriſoned three months, and fined in a ſum not exceeding one hundred pounds. And ſuch as going abroad, and not returning on warning given by our ambaſſadors, &c. ſhall be diſabled from holding lands by deſcent or deviſe, from receiving any legacy, &c. and be deemed aliens. Stat. 5 Geo. I. cap. 27. By 23 Geo. II. cap. 13, ſect. 1, penalty is alſo inflicted on ſeducing *artificers* to go abroad.

Ramazini has a treatiſe on the diſeaſes of *artificers*.

ARTILLERY, in its general ſenſe, denotes the offenſive apparatus of war, particularly of the miſſile kind. Among the French the term was anciently appropriated to ARCHERY. See that article. In its modern acceptation it ſignifies fire-arms, mounted on their carriages and ready for action, with their balls, their bombs, their grenades, &c. If we take the term in a more extenſive meaning, it includes the powder, the matches, inſtruments for fire-works, the utenſils of ordnance, the machines which facilitate their motion, and tranſport them, the vehicles over which they traverſe rivers, every thing neceſſary to them, and all that enters into the form of a train of artillery. The ſame word, ſtill farther extended in its meaning, likewiſe comprehends the men deſtined for the ſervice of the *artillery*; the people who provide the artillery with materials and implements when engaged, the cannoniers, the bombardiers, the officers of every rank, and engineers of every kind.

By *artillery* is likewiſe underſtood the ſcience which the officers of artillery ought to poſſeſs. This ſcience teaches to know the nature of all the materials and ingredients which enter into the compoſition and the ſtructure of every thing relative to the artillery, ſuch as, nitre, ſulphur, charcoal; the properties of air and fire; the compoſition and preparation of gunpowder; the materials for fire-works; the conſtruction, proportions, &c. of the different warlike machines; the arrangement, movement, and whole management, of cannon, &c. in the field or in ſieges, in ſuch a manner, that each of them, according to the length of its tube and the diameter of its bore, may be ſituated in the beſt place and at the propereſt diſtance for execution, and that the whole train, taken together, may reciprocally aſſiſt and ſupport each other with the greateſt advantage.

Artillery has undergone many changes from its origin to the preſent time. The artillery of the ancients were the catapulta, the baliſtæ, the different kinds of ſlings, &c. In latter ages, the Franks uſed the hatchet as a miſſile weapon, throwing it in the ſame manner as the Americans do their's, called the *tomahawk*. The Gaſcons and Genoeſe were excellent croſs-bowmen. The Swiſs owed their victories to their ſtrength and ſkill in the uſe of the pike, halberd, and eſpadon or two-handed ſword; and the victories of Creſſy, Poictiers, and Agincourt, will occaſion the valour and ſkill of the Engliſh archers to be tranſmitted down to lateſt poſterity. See ARCHERY.

Cannon is one of the moſt ſingular diſcoveries which hav been made amongſt men; and by little and little it has changed the whole art of war, and of conſequence influenced the whole ſyſtem of policy, in Europe. The æra of artillery is dated from the battle of Creſſy in 1346, becauſe it is only from that day that cannons were mentioned in battle. Edward III. of England ſucceſsfully employed ſome pieces of artillery placed in the front of his army. The invention of artillery was then known in France as well as in England; but probably Philip VI. marched with ſo much hurry and precipitation to attack his enemy, that he left his cannon as uſeleſs incumbrances behind him. The ignorance of that age in mechanical arts conſiderably retarded the progreſs of artillery; and that of which they were then poſſeſſed was ſo unwieldy and imperfect, that they could not poſſibly diſcern its importance and efficacy in practice.

After the invention of gunpowder, the Spaniards were the firſt who armed part of their foot with muſkets and harquebuſſes, and mixed them with pikes. In this they were ſoon imitated by moſt other nations; though the Engliſh had not entirely laid aſide their favourite weapon, the long-bow, and generally taken to the uſe of fire-arms, during the reign of queen Elizabeth. The firſt muſkets were very heavy, and could not be fired without a reſt: they had matchlocks and barrels of a wide bore, that carried a large ball and charge of powder, and did execution at a great diſtance. The muſketeers on a march carried only their reſts and ammunition, and had boys to bear their muſkets after them, for which they were allowed great additional pay. They were very ſlow in loading, not only by reaſon of the unwieldineſs of the pieces, and becauſe they carried the power and balls ſeparate, but from the time it took to prepare and adjuſt the match; ſo that their fire was not near ſo briſk as our's is now. Afterwards, a lighter kind of matchlock-muſket came into uſe; and they carried their ammunition in bandeliers, which were broad belts that came over the ſhoulder, to which were hung ſeveral little caſes of wood covered with leather, each containing a charge of powder; the balls they carried looſe in a pouch, and they had alſo a priming-horn hanging by their ſide. Matchlocks were, about the beginning of this century, univerſally diffuſed in Europe, and the troops were armed with firelocks; to which, much about the ſame time, the bayonet being added, pikes alſo were laid aſide.

The old Engliſh writers call thoſe large muſkets *calivers*; the harquebuſs was a lighter piece, that could be fired without a reſt. The matchlock was fired by a match, fixed by a kind of tongs in the ſerpentine or cock, which by pulling the trigger was brought down with great quickneſs upon the priming in the pan, over which there was a ſliding cover, which was drawn back by hand, juſt at the time of firing. There was a great deal of nicety and care required to fit the match properly to the cock, ſo as to come down exactly true on the priming, to blow the aſhes from the coal, and to guard the pan from the ſparks that fell from it: a great deal of time was alſo loſt in taking it out of the cock, and returning it between the fingers of the left-hand, every time that the piece was fired; and wet weather often rendered the matches uſeleſs. However, moſt writers allow that they were very ſure, and leſs apt to miſs fire than the firelock.

The firelock is ſo called, from producing fire of itſelf, by the action of the flint and ſteel. The moſt ancient invention of this ſort is the wheel-lock, which we find mentioned in Luigi Collado's Treatiſe of Artillery, printed at Venice, 1586, as then lately invented in Germany. This ſort of lock was uſed till within theſe hundred years, eſpecially for piſtols and carbines. It was compoſed of a ſolid ſteel wheel, with an axis, to which was faſtened a chain, which, by being round it, drew up a very ſtrong ſpring; on pulling the trigger, the ſpring acting, whirled the wheel about with great velocity, and the friction of the edge of it (which was a little notched) againſt the ſtone produced the fire: the cock was made ſo as to bring the ſtone upon the edge of the wheel, part of which was in the pan, and touched the priming; they uſed any common hard pebble for that purpoſe, which ſerved as well as flint. Theſe locks were inconvenient, took time to wind up (or

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ſpan as they termed it) and ſometimes would not go off; an inſtance of which may be ſeen in Ludlow's Memoirs.

When the firelock, ſuch as we now uſe, was invented, we cannot aſcertain: it is called, by writers of about the middle of the laſt century, a *ſnaphane* or *ſnaphance*; which being the Dutch word for a *firelock*, ſeems to indicate that it is a Dutch invention, and that we took it from them. But Ward, in his Animadverſions of War, printed in 1639, p. 502, after deſcribing the exerciſe of the firelock, piſtol, and carbine (by which he means the wheel-lock) ſays, that as moſt of our pieces go with Engliſh locks, which differ from firelocks, he ſhall add the method of handling them; and then gives the exerciſe of the ſnaphane carbine; by which it appears, that there was little or no difference between that and the pieces now in uſe. The more modern writers call it *fuſee*, from the French word *fuſil*; whence the name of fuſileers is ſtill continued to ſeveral of our regiments, which were the firſt that were armed with them on the diſuſe of matchlocks. They uſed the muſket and reſt in England ſo late as the beginning of the civil wars, as may be ſeen in Col. Bariffe's Young Artillery Man, printed at London, 1643.

Figuerra, in his embaſſy in 1518, relates that the Perſians would neither make uſe of infantry nor of artillery, becauſe by them the impetuoſity of attack and the facility of retreat were equally incumbered and retarded: in theſe expedients alone their addreſs and their glory conſiſted. This method of advancing and recalling is widely different from the preſent conduct of war, as the artillery in armies is now prodigiouſly multiplied, and muſt be tranſported to every place where any body of troops whatever is deſtined to operate.

The length and diameter of cannon have been much diminiſhed, which muſt likewiſe proportionably diminiſh their weight. It is by long practice and experience that they have diſcovered how much might be deduced from their magnitude in both theſe reſpects with propriety, without hurting the grand effect, which, on ſome occaſions, it is neceſſary they ſhould produce, by rendering them more eaſy to be wielded, which was the advantage purſued by leſſening their ſize. For a copious explanation of this branch of artillery, relative to theory and practice, ſee the Treatiſe on PROJECTILES, throughout. See further the articles CANNON, GUNNERY, and PROJECTILES.

Improvements, however, are ſtill making, and will probably long continue to be made, in theſe ignivomous machines that mock the thunder, which, though they ſeem to be invented for the deſtruction the human race and the ſubverſion of empires, have yet by their effects rendered war leſs ſavage, and leſs ſanguinary; political alliances have been more ſucceſsfully conciliated among all nations, conqueſts are become leſs frequent and leſs rapid, and ſucceſſes in war have been more eaſily reduced to calculation.

In modern war the great expence of fire-arms gives an evident advantage to the nation that can beſt afford that expence; and conſequently to an opulent and civilized, over a poor and barbarous nation. In ancient times, the opulent and civilized found it difficult to defend themſelves againſt the poor and barbarous nations. In modern times, the poor and barbarous find it difficult to defend themſelves againſt the opulent and civilized. The invention of fire-arms, an invention which at firſt ſight appears to be ſo pernicious, is certainly favourable both to the permanency and to the extenſion of civilization.

In the battles of the Greeks and Romans, the extraordinary diſproportion between the numbers ſlain on the ſide of the victors and the vanquiſhed has been obſerved as another remarkable circumſtance. But this neceſſarily reſulted from the nature of their arms. Their principal weapons being not miſſile, but manual, armies could not begin to act till they had approached ſo nearly to each other, that the conquered found themſelves cut off from all poſſibility of retreat. In modern times, ſuch conſequences ſeldom take place. The uſe of fire-arms (which often renders the action itſelf more bloody) furniſhes the defeated party with various means of retreating with conſiderable ſafety. The ſphere of military action is ſo widely extended in modern times, that before the victors can run over the ſpace which ſeparates them from the vanquiſhed, the latter may fall back, and proceed with little loſs beyond their reach; and ſhould any village, hedge, ravine, &c. be found in their way, may often check the ardour of the purſuers. Upon theſe conſiderations, the invention of gunpowder and modern artillery may be ſaid to have ſaved the effuſion of human blood. For the nature and effects of *gunpowder*, ſee that article.

ARTIST, in a general ſenſe, a perſon ſkilled in ſome art; or, according to Mr. Harris's definition, a perſon poſſeſſing an habitual power of becoming the cauſe of ſome effect, according to a ſyſtem of various and well-approved precepts. In this ſenſe, we ſay, an excellent, a curious *artiſt*. The pre-eminence is diſputed between ancient and modern *artiſts*, eſpecially as to what relates to ſculpture, painting, and the like. At Vicenza, we are told of a privilege granted to *artiſts*, like that of clergy in England; in virtue of this, criminals adjudged to death ſave their lives, if they can prove themſelves the moſt excellent and conſummate workmen in any uſeful art. This benefit is allowed them *in favorem artis*, for the firſt offence, except in ſome particular crimes, of which coining is one. The exception is juſt; ſince here the greater the *artiſt*, the more dangerous the perſon. Evelyn's Diſc. of Medals, ch. vii. p. 237, &c.

ARTOCARPUS (from ἀρτος, *bread*, and καρπος, *fruit*) the BREAD-FRUIT TREE: a genus of the monandria order, belonging to the monœcia claſs of plants. It has a cylindric amentum or catkin, which thickens gradually, and is covered with flowers; the male and female in a different amentum. In the *male*, the calyx is two-valved, and the corolla is wanting. In the *female*, there is no calyx nor corolla; the ſtylus is one, and the drupa is many-celled.

Though this tree has been mentioned by many voyagers, particularly by Dampier, by Rumphius, and by Lord Anſon, yet very little notice ſeems to have been taken of it till the return of Captain Wallis from the South Sea, and ſince that time by others who have touched at Otaheite, and ſome countries in the Eaſt Indies. Captain Dampier relates, that in Guam, one of the Ladrone iſlands, "there is a certain fruit called the *bread-fruit*, growing on a tree as big as our large apple-trees, with dark leaves. The fruit is round, and grows on the boughs like apples, of the bigneſs of a good penny loaf; when ripe, it turns yellow, ſoft, and ſweet; but the natives take it green, and bake it in an oven till the rind is black: this they ſcrape off, and eat the inſide, which is ſoft and white, like the inſide of new-baked bread, having neither ſeed nor ſtone; but if it is kept above twenty-four hours it is harſh. As this fruit is in ſeaſon eight months in the year, the natives feed upon no other ſort of bread during that time. They told us that all the Ladrone iſlands had plenty of it. I never heard of it in any other place."

Rumphius, after deſcribing the tree, obſerves, that "the fruit is ſhaped like a heart, and increaſes to the ſize of a child's head. Its ſurface or rind is thick, green, and covered every where with warts, of a quadragonal or hexagonal figure, like cut diamonds, but without points. The more flat and ſmooth theſe warts are, the fewer ſeeds are contained in the fruit, and the greater is the quantity of pith, and that of a more glutinous nature. The internal part of the rind, or peel, conſiſts of a fleſhy ſubſtance, full of twiſted fibres, which have the appearance of fine wool; theſe adhere to, and in ſome meaſure form it. The fleſhy part of this fruit becomes ſofter towards the middle, where there is a ſmall cavity formed without any nuts or ſeeds, except in one ſpecies, which has but a ſmall number, and this ſort is not good unleſs it is baked, or prepared ſome other way: but if the outward rind be taken off, and the fibrous fleſh dried, and afterwards boiled with meat as we do cabbage, it has then the taſte of artichoke bottoms. The inhabitants of Amboyna dreſs it in the liquor of cocoa-nuts: but they prefer it roaſted on coals, till the outward part or peel is burnt. They afterwards cut it into pieces, and eat it with the milk of the cocoa-nut. Some people make fritters of it, or fry it in oil; and others, as the Sumatrians, dry the internal ſoft part, and keep it to uſe inſtead of bread with other food. It affords a great deal of nouriſhment, and is very ſatisfying, therefore proper for hard-working people; and being of a gentle aſtringent quality, is good for perſons of a laxative habit of body. It is more nouriſhing boiled in our manner with fat meat than roaſted on coals. The milky juice which diſtils from the trunk, boiled with the cocoa-nut oil, makes a very ſtrong bird-lime. This tree is to be found on the eaſtern parts of Sumatra, and in the Malay language is called the *ſoccus* and *ſoccum capas*. It grows likewiſe about the town of Bantam in Java, and in the Belega and Madura, and is known there by the name of *ſocum*."

In Anſon's Voyage we are informed, "that the rima, or bread-fruit tree, is common in all the Ladrone iſlands and ſome of the Philippines. It is ſomewhat larger than our apple-tree, and bears a broad dark-coloured leaf, with five indentures on each ſide. The fruit hangs on boughs like apples; and is of the ſize of a penny loaf, with a thick tough rind, which when full ripe turns yellow. The natives gather it before it is quite ripe, and bake it till the cruſt is pretty black; then they raſp it, and there remains a pretty loaf, with a tender yellow cruſt, and the crumb of it is as ſoft and ſweet as a new-baked roll: it is without any ſeeds or ſtones. This fruit the inhabitants enjoy for about ſeven months; during which they never eat any other kind of bread: but they are obliged to bake it every day; for when it grows a little ſtale, it becomes harſh and huſky, ſomething like the potato-bread made in the weſt of England. There is, however, a remedy for this; which is cutting the loaf into ſlices when it is new, and drying it in the ſun, by which it is changed into the pleaſanteſt ruſk that can be eaten."

Captain Cook, in his voyage, obſerves, that this fruit not only ſerves as a ſubſtitute for bread among the inhabitants of Otaheite and the neighbouring iſlands, but alſo, variouſly dreſſed, compoſes the principal part of their food. It grows on a tree that is about the ſize of a middling oak: its leaves are frequently a foot and a half long, of an oblong ſhape, deeply ſinuated like thoſe of the fig-tree, which they reſemble in colour and conſiſtence, and in the exuding of a milky juice upon being broken. The fruit is about the ſize and ſhape of a new-born child's head; and the ſurface is reticulated, not much unlike a truffle; it is covered with a thin ſkin, and has a core about as big as the handle of a ſmall knife. The eatable part lies between the ſkin and the core; it is as white-

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as ſnow, and ſomewhat of the conſiſtence of new bread; it muſt be roaſted before it is eaten, being firſt divided into three or four parts; its taſte is inſipid, with a ſlight ſweetneſs, ſomewhat reſembling that of the crumb of wheaten bread mixed with a Jeruſalem artichoke. This fruit is alſo cooked in a kind of oven, which renders it ſoft, and ſomething like a boiled potato; not quite ſo farinaceous as a good one, but more ſo than thoſe of the middling ſort. Of the bread-fruit they alſo make three diſhes, by putting either water or the milk of the cocoa-nut to it, then beating it to a paſte with a ſtone peſtle, and afterwards mixing it with ripe plantains, bananas, or the ſour paſte which they call *mahie*. See Bankes's Geography.

The mahie, which is likewiſe made to ſerve as a ſucceedaneum for ripe bread-fruit before the ſeaſon comes on, is thus made: The fruit of the bread-tree is gathered juſt before it is perfectly ripe; and being laid in heaps, is cloſely covered with leaves: in this ſtate it undergoes a fermentation, and becomes diſagreeably ſweet; the core is then taken out entire, which is done by gently pulling out the ſtalk, and the reſt of the fruit is thrown into a hole which is dug for that purpoſe, generally in the houſes, and neatly lined in the bottom and ſides with graſs: the whole is then covered with leaves, and heavy ſtones laid upon them; in this ſtate it undergoes a ſecond fermentation, and becomes ſour, after which it will ſuffer no change for many months. It is taken out of the hole as it is wanted for uſe; and being made into balls, it is wrapped up in leaves and baked: after it is dreſſed, it will keep five or ſix weeks. It is eaten both cold and hot; and the natives ſeldom make a meal without it, though to Europeans the taſte is as diſagreeable as that of a pickled olive generally is the firſt time it is eaten. The fruit itſelf is in ſeaſon eight months in the year, and the mahie ſupplies the inhabitants during the other four.

To procure this principal article of their food (the bread-fruit) coſts theſe happy people no trouble or labour, except climbing up a tree: the tree which produces it does not indeed grow ſpontaneouſly; but if a man plant ten of them in his life-time, which he may do in about an hour, he will as completely fulfil his duty to his own and future generations, as the native of our leſs temperate climate can do by ploughing in the cold of winter, and reaping in the ſummer's heat, as often as theſe ſeaſons return; even if, after he has procured bread for his preſent houſehold, he ſhould convert a ſurplus into money, and lay it up for his children.

There are two ſpecies of artocarpus, viz. the inciſus, with gaſhed leaves; and the integrifolia, with entire leaves. There is alſo ſaid to be another diſtinction, into that which bears fruit with ſtones or ſeeds, and that in which the fruit has none. The parts of fructification of that tree which bears the fruit without ſtones are defective. The amentum, or catkin, which contains the male parts, never expands. The ſtyli, or female part of the fruit, are likewiſe deficient. From which it follows that there can be no ſtones or ſeeds, and therefore that this tree can be propagated only by ſuckers or layers; although it is abundantly evident that it muſt originally have proceeded from the ſeed-bearing bread-fruit tree. Inſtances of this kind we ſometimes find in European fruits; ſuch as the barberry, and the Corinthian grape from Zant, commonly called currants, which can therefore be increaſed only by layers and cuttings. Dr. Solander was aſſured by the oldeſt inhabitants of Otaheite and the adjoining iſlands, that they well remembered there was formerly plenty of the ſeed-bearing bread-fruit; but they had been neglected upon account of the preference given to the bread-fruit without ſeeds, which they propagate by ſuckers. For repreſentation of the bread-fruit tree, ſee Plate I. of Miſcellaneous Subjects, Fig. 28.

ARYTÆNOIDEUS, in anatomy, one of the muſcles ſerving to cloſe the LARYNX; otherwiſe called little *arytænoideus*, and *aryartænoideus*, as deriving its origin from the poſterior and inferior part of the *arytænoides*. The *arytænoides* has its head on one *arytanoid* cartilage, and its tail in the other; and ſerves to bring them together, and ſhut the *rima* or *glottis*. See the Syſtem, Part II. Table of MUSCLES, Article 13, and Plate IV. Fig. 9, &c.

ASCARIS, in vermeology, a genus of inſects belonging to the order *Vermes Inteſtina*. The body of the aſcaris is cylindrical, filiform, and tapers at both ends. The ſpecies are two viz. 1. The vermicularis, with faint annular rugæ, and the mouth tranſverſe, is about a quarter of an inch long, and thicker at one end than the other. It is found in boggy places, in the roots of putrid plants, and very frequently in the rectum of children and horſes. It emaciates children greatly, and is ſometimes vomited up. 2. The lumbricoides is about the ſame length with the lumbricus terreſtris, or common earth-worm; but it wants the protuberant ring towards the middle of the body, the only mark by which they can properly be diſtinguiſhed. The body of the lumbricoides is cylindrical, and ſubulated at each extremity; but the tail is ſomewhat triangular. The lumbricoides is the worm which is moſt commonly found in the human inteſtines. It is viviparous, and produces vaſt numbers.

The *aſcarides* are found in the *inteſtinum rectum*, chiefly of children, are frequently voided with their *fæces;* ſometimes alſo adhering to the fundament, or even pendent from it. They are thus called from ασκαριζω, *I leap*, on account of their continual troubleſome motion, cauſing a moſt intolerable itching.

The *aſcarides* are worms not ſo dangerous as ſome others, but more difficult to be expelled, and that for ſeveral reaſons. The firſt is, becauſe thoſe creatures are remote from the ſtomach; ſo that remedies loſe their virtue before they can come where the worms are; the ſecond is, becauſe the *aſcarides* are wrapt up in viſcous humours, which hinder the operation of medicines; the third is, becauſe theſe worms aſcend ſometimes into the *cæcum*. Now that gut being like the bottom of a ſack, the *aſcarides* keep themſelves as it were intrenched in that place. However it be, it is better to attack them below.

The beſt known remedy for them is Harrowgate water, at the ſpring; the flower of brimſtone taken with treacle, in ſuch a quantity as to purge the patient gently every day, is perhaps the next moſt efficacious remedy. The fumes of tobacco, injected in form of a clyſter, have been ſucceſsfully uſed for expelling *aſcarides*. Med. Obſ. and Inq. vol. ii. p. 307. For a further deſcription of theſe worms, and the method of treating the diſorders with which they infeſt the human ſyſtem, ſee the Syſtem of MEDICINE, Genus 43.

ASCENDING, in anatomy, is applied to ſuch veſſels as carry the blood upward, or from lower to higher parts of the body. The *aſcending aorta*, *aorta aſcendens*, is the ſuperior trunk of the artery which furniſhes the head.

The *aſcending cava*, *vena cava aſcendens*, is a large vein, formed by a meeting or union of the iliacs of one ſide, with thoſe of the other. For a copious explanation of this branch of the ſcience, ſee the Syſtem, Part V. Sect. 1. Plate VIII.

Many of the ancient anatomiſts called this the *deſcending cava*; as imagining that the blood deſcended from the liver by this vein, to ſupply the parts below the diaphragm. But the moderns have ſhewn that it has a quite contrary uſe, and ſerves for the conveyance of the blood from the lower parts to the heart; whence its appellation *aſcendant*.

ASCENSION, in aſtronomy, is either *right* or *oblique*.

Right-ASCENSION of the ſun, or of a ſtar, is that degree of the equinoctial, accounted from the beginning of Aries, which riſes with the ſun or ſtar in a right ſphere.

Or, right-*aſcenſion* is that degree and minute of the equinoctial, counted as before, which comes to the meridian with the ſun, or other point of the heavens. The reaſon of thus referring it to the meridian is, becauſe that it is at right-angles to the equinoctial, whereas the horizon is only ſo in a right or direct ſphere. The right-*aſcenſion* ſtands oppoſite to the right-*deſcenſion*. For a table pointing out the right-aſcenſion of the principal fixed ſtars, ſee the Syſtem, cloſe of Sect. 8.

Oblique-ASCENSION, is an arch of the equator intercepted between the firſt point of Aries, and that point of the equator which riſes together with a ſtar, &c. in an oblique ſphere. The oblique-*aſcenſion* is numbered from weſt to eaſt; and is more or leſs, according to the different obliquity of the ſphere. To find the right and oblique aſcenſion of the ſun, ſtars. &c. See the Problems under the head of *The Uſe of the Terreſtrial Globe*, in the Treatiſe on the GLOBES.

ASCENT, ASCENSUS, the motion of a body tending from below upwards; or the continual receſs of a body from the earth. In this ſenſe the word ſtands oppoſite to *deſcent*. For a full illuſtration of this ſubject, ſee the Syſtem of MECHANICS, and the article MOTION.

The moderns deny any ſuch thing as ſpontaneous levity, and ſhew that whatever *aſcends* does it in virtue of ſome external impulſe, or extruſion. Thus it is that ſmoke, and other rare bodies, *aſcend* in the atmoſphere; and oil, light woods, &c. in water: not by any external principle of levity, but by the ſuperior gravity, or tendency downwards of the parts of the medium wherein they are.

The *aſcent* of light bodies in heavy mediums is produced after the ſame manner as the *aſcent* of the lighter ſcale of a balance. It is not that ſuch ſcale has an internal principle, whereby it immediately tends upwards; but it is impelled upwards by the preponderancy of the other ſcale; the exceſs of the weight of the one having the ſame effect by augmenting its impetus downwards as ſo much real levity in the other: becauſe the tendencies mutually oppoſe each other, and that action and reaction are always equal. See this farther illuſtrated under the article SPECIFIC *Gravity*, and FLUID.

ASCENT *of fluids* is particularly underſtood of their riſing above their own level, between the ſurfaces of nearly contiguous bodies, or in ſlender capillary glaſs tubes, or in veſſels filled with ſand, aſhes, or the like porous ſubſtances. For a copious explanation of this article, as an elementary principle appertaining to the doctrine of fluids, ſee the ſyſtem of HYDROSTATICS. &c. Part I. Sect. 1. For the practical methods relating to the ſame, ſee Part II. For illuſtration, ſee the plates annexed to the Syſtem.

ASCENT *of vapour*. For a copious deſcription and illuſtration of this article, ſee EVAPORATION.

ASCIDA, in vermeology, a genus of animals belonging to the order *Vermes Moluſca*. The body is cylindrical, and fixed to a ſhell, rock, &c. It has two apertures; one on the ſummit, the other lower, forming a ſheath. There are ſix ſpecies of the animal, viz. the papilloſum, gelatinoſum, inteſtinalis, quadridentata, ruſtica, and echinata; only one of which, viz. the ruſtica, is found in the Britiſh ſeas. Animals of this genus have the faculty

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of ſquirting out the water they take in. The expanſion and contraction of their bodies occaſion their aſſuming various forms. For a further account, ſee the Syſtem of VERMEOLOGY.

ASCII, in geography, are thoſe inhabitants of the globe, who at certain times of the year have no ſhadow. The word is formed of the privative *α*, and *σκια*, *umbra*, *ſhadow*. Such are the inhabitants of the torrid zone; becauſe the ſun is ſometimes vertical to them.

ASCITES, in medicine, a ſpecies of *dropſy*, affecting chiefly the *abdomen*, or lower belly. The word is borrowed from *ασκος*, *uter*, *bag*, or *bladder*. The *aſcites* is the ordinary WATER-DROPSY. For a copious deſcription of this diſorder, its cauſes, prognoſis, and methods of treatment, ſee the Syſtem, Genus 57.

ASH-*tree*, in botany, the Engliſh name of the genus *Fraxinus*. For deſcription of the genus, method of cultivation, uſes, &c. ſee the article FRAXINUS.

ASHES, *cineres*, the terrene and earthy part of wood and other combuſtible bodies, remaining after they are burnt or conſumed with fire. This name is generally applied to the ſubſtance remaining of bodies containing an inflammable matter, after they have been deprived of it by burning, or calcination in open air. Pewterers, for example, give the name of *tin-aſhes* to the earth of this metal, which in fuſion has been deprived of its phlogiſton and metallic properties.

Aſhes are properly the earth and fixed ſalts of the fuel, which the fire cannot raiſe; all the other principles being gone off in the ſmoke. The chemiſts frequently call the *aſhes* of a body its *calx*. See the Syſtem of CHYMISTRY, under the ſeveral ſubſtances, Mineral, Vegetable, and Animal.

Aſhes, if well burnt, are uſually pure white, becauſe the oil to which they owe their blackneſs when in a coal, is ſuppoſed quite evaporated. The *aſhes* of kali, fern, or the like, are a principal matter in the compoſition of glaſs.

The *aſhes* of all vegetables are found to contain iron, inſomuch, that M. Geoffroy makes it a chemical problem, which he propoſes to the public, *to find aſhes without any particles of iron therein*. ---Whether the metal exiſted in the plants themſelves, or is produced in them by the operation of calcination, is a point very ingeniouſly controverted between Meſſ. Geoffroy, and Lemery the Younger, in the Memoirs of the Royal Academy.

Aſhes are of conſiderable uſe in making lixiviums, or leys, for the purpoſes of medicine, for bleaching, and for ſugar-works, &c. For a particular account of the effects of aſhes, eſpecially wood-coal and ſoap aſhes, as conducive to vegetation, ſee the Syſtem of AGRICULTURE, Sect. 2.

If the aſhes are produced from vegetable bodies, they contain a conſiderable quantity of fixed ſalt, blended with the terrene particles: and from theſe aſhes the fixed alkaline ſalts called *pot-aſh*, *pearl aſh*, &c. are extracted.

ASH-WEDNESDAY, the firſt day of Lent, ſuppoſed to have been ſo called from a cuſtom in the church of ſprinkling aſhes that day on the heads of penitents then admitted to penance.

ASILUS, or HORNET-FLY, in entomology, a genus of inſects belonging to the order inſecta diptera. Many of them wound in a very painful manner, and are particularly troubleſome to cattle in low meadows; others of them are quite harmleſs. For deſcription and claſſification, ſee the Syſtem, Order 6.

ASINUS, the aſs, a ſpecies of the genus equus, in the ſyſtem of mammalia. For particular deſcription, ſee the article EQUUS. For claſſification, ſee the Syſtem MAMMALIA, Order 6. For repreſentation, ſee Plate X. Genus 33. Species 2.

Aſs's Milk is very nouriſhing and abſtergent, and is therefore eſteemed good in a conſumption, in diſorders of the ſtomach, abſceſſes of the kidneys, the ſtone in the bladder, and arthritic pains. It is eſteemed gently cathartic, and was frequently directed by Hippocrates as a purge in large quantities. As a topic, it makes the gums firm, eaſes arthritic pains, and gives the face an agreeable whiteneſs if waſhed with it. See MILK.

ASP, in natural hiſtory, a ſmall poiſonous kind of ſerpent, whoſe bite gives a ſpeedy but eaſy death. It is ſaid to be thus denominated from the Greek *ασπις*, *ſhield*, in regard to the manner of its lying convolved in a circle, in the centre of which is the head, which it exerts, or raiſes, like the umbo or umbilicus of a buckler. This ſpecies of ſerpent is very frequently mentioned by authors; but ſo careleſsly deſcribed, that it is not eaſy to determine which, if any, of the ſpecies known at preſent, may properly be called by this name. It is ſaid to be common in Africa, and about the banks of the Nile; and Bellonius mentions a ſmall ſpecies of ſerpent which he had met with in Italy, and which had a ſort of callous excreſcence on the forehead, which he takes to have been the aſpis of the ancients. It is with the aſp that Cleopatra is ſaid to have diſpatched herſelf, and prevented the deſigns of Auguſtus, who intended to have carried her captive to adorn his triumphal entry into Rome. But the fact is conteſted: Brown places it among his vulgar errors. The indications of that queen's having uſed the miniſtry of the aſp, were only two almoſt inſenſible pricks found in her arm: and Plutarch ſays, it is unknown what ſhe died of. At the ſame time it muſt be obſerved, that the ſlightneſs of the pricks found in her arm furniſhes no preſumption againſt the fact; for no more than the prick of a needle-point dipt in the poiſon was neceſſary for the purpoſe.

ASPARAGUS, SPARAGUS, SPEERAGE, or SPARROWGRASS: a genus of monogynia order, belonging to the hexandria claſs of plants: and in the natural method ranking under the 11th order, *Sarmentaceæ*. The calyx is quinquepartite, and erect; the three inferior petals are bent outwards; the berry has three cells, and contains two ſeeds. The ſpecies are ten; but the only one cultivated in the garden is that with an upright herbaceous ſtalk, briſtly leaves, and equal ſtipula, or the common aſparagus. The other ſpecies are kept only in the gardens of the curious, for the ſake of variety.

Medicinal Uſes. The roots have a bitteriſh mucilaginous taſte, inclining to ſweetneſs; the fruit has much the ſame kind of taſte, the young ſhoots are more agreeable than either. Aſparagus promotes appetite, but affords little nouriſhment. It gives a ſtrong ill ſmell to the urine in a little time after eating it, and for this reaſon chiefly is ſuppoſed to be diuretic; it is likewiſe eſteemed aperient and deobſtruent; the root is one of the five called *opening roots*; its top, or head, taken in the way of food, readily diſcovers itſelf in the ſmell of the urine; but its root is ſtill more ſtrongly endued with that quality, as containing more of the ſalt from which it is derived. Hence it becomes among us, an ingredient in all compoſitions, intended to cleanſe the *viſcera*, and guard againſt jaundices, dropſies, &c. Aſparagus appears from experience to contribute very little either to the exciting of urine when ſuppreſſed, or increaſing its diſcharge; and in caſes where aperient medicines generally do ſervice, this has little or no effect. It is alſo of ſome uſe as a pectoral; and makes a chief ingredient in the ſyrup of marſhmallows, againſt the ſtone. Though foreign phyſicians ſpeak more ſparingly of the uſe and virtues of this medicine. For a copious account of the moſt approved methods of forcing aſparagus, dreſſing the beds, cutting them, &c. ſee the Treatiſe on GARDENING, article KITCHEN GARDEN, months, February, March, May, June, and October.

ASPECT, in aſtronomy, denotes the ſituation of the planets and ſtars with reſpect to each other.

There are five different aſpects. 1. Sextile aſpect is when the planets or ſtars are 60° diſtant, and marked thus ⚹. 2. The quartile, or quadrate, when they are 90° diſtant, marked □. 3. Trine, when 120° diſtant, marked △. 4. Oppoſition, when 180° diſtant, marked ☍. And 5. Conjunction, when both in the ſame degree, marked ☌.

Kepler, who added eight new ones, defines aſpect to be the angle formed by the rays of two ſtars meeting on the earth, whereby their good or bad influence is meaſured: for it is to be obſerved, that theſe aſpects being firſt introduced by aſtrologers, were diſtinguiſhed into benign, malignant, and indifferent; the quartile and oppoſition being accounted malign; the trine and ſextile, benign or friendly; and the conjunction indifferent.

ASPERA *Arteria*, in anatomy, the *wind-pipe*; otherwiſe called the *trachea*. The *aſpera arteria* is a canal ſituate in the middle and fore-part of the neck, before the *aſophagus*: its upper end is called the *larynx*; from whence it deſcends to the fourth *vertebra* of the back, where it divides, and enters the lungs. For a copious deſcription, ſee the Syſtem, Part IV. Sect. 5, throughout.

Tranſverſe ſections of the *aſpera arteria* have been commonly reputed mortal. Yet in the modern practice we find many inſtances to the contrary. In ſome dangerous caſes of quinſies, &c. they are even obliged to cut open this part. This operation is called *bronchotomy*. See that article.

In the Philoſoph. Tranſact. is a letter recommending the more frequent uſe of bronchotomy, or opening the wind-pipe, upon preſſing occaſions; which it is urged from a remarkable caſe of a perſon who had the *trachea*, or wind-pipe, cut quite through beneath the *pomum Adami*, cured by ſtitching the wound, and uſing proper medicines. For curious obſervations on the peculiar advantages in the ſtructure of the aſpera arteria, or wind-pipe of ſeveral birds, ſee the ſyſtem of COMPARATIVE ANATOMY, Chap. II. Sect. 2. and Plate II. For ſome remarks on the ſtructure of the Water Tortoiſe, ſee Chap. 3, and Plate 5.

ASPERITY, implies the inequality or roughneſs of the ſurface of any body; whereby ſome parts of it do ſo ſtick out beyond the reſt, as to hinder the hand, &c. from paſſing over it eaſily and freely.

Aſperity, or roughneſs, ſtands oppoſed to ſmoothneſs, evenneſs, politure, &c.---From the *aſperity* of the ſurfaces of contiguous bodies ariſes friction.

According to the relations of Vermauſen, the blind man ſo famous for diſtinguiſhing colours by the touch, it ſhould appear, that every colour hath its particular degree and kind of *aſperity*. He makes black the rougheſt, as it is the darkeſt of colours; but the others are not ſmoother in proportion as they are lighter; i. e. the rougheſt do not always reflect the leaſt light: for, according to him, yellow is two degrees rougher than blue, and as much ſmoother than green. See the article BLIND.

ASPHALTUM, BITUMEN JUDAICUM, or JEWS' PITCH, is a light, ſolid bitumen, of a duſky colour on the outſide, and a deep ſhining black within; of very little taſte; and having ſcarcely any

ſmell

ſmell, unleſs heated, when it emits a ſtrong pitchy one. It is found in a ſoft or liquid ſtate on the ſurface of the Dead-Sea, and by age grows dry and hard. The ſame kind of bitumen is met with likewiſe in the earth, in other parts of the world, in China, America, and in ſome places of Europe, as the Carpathian hills, France, Neufchatel, &c. There are ſeveral kinds of Jews' pitch in the ſhops: but none of them are the genuine ſort, and have little other title to the name than their being artificially compounded by Jews; and as they are a medley of we know not what ingredients, their medicinal uſe begins to be deſervedly laid aſide, notwithſtanding the diſcutient, reſolvent, pectoral, and other virtues, attributed to this bitumn by the ancients. The true aſphaltum was formerly uſed in embalming the bodies of the dead. The thick and ſolid aſphalta are at preſent employed in Egypt, Arabia, and Perſia, as pitch for ſhips; as the fluid ones, for burning in lamps, and for varniſhes. Some writers relate that the walls of Babylon, and the temple of Jeruſalem, were cemented with bitumen inſtead of mortar. Thus much is certain, that a true natural bitumen, that, for inſtance, which is found in the diſtrict of Neufchatel, proves an excellent cement for walls, pavements, and other purpoſes, uncommonly firm, very durable in the air, and not penetrable by water. The watch and clock makers uſe a compoſition of aſphaltum, fine lamp-black, and oil of ſpike or turpentine, for drawing the black figures on dial-plates: this compoſition is prepared chiefly by certain perſons at Augſburg and Nuremberg.

ASPIRATE, *Aſpiratio*, in grammar, a character uſed to denote an aſpiration.

The aſpirate, by the Greeks called *ſpiritus aſper*, and marked over their vowels, ſeems to be of a very different nature from the letters; but is nevertheleſs a true letter, as well as the reſt, and a real conſonant.—By letters we do not mean the characters of the alphabet, which are changeable according to the languages and the people, and among the ſame people, according to time and cuſtom; and even according to the fancy of particular perſons.—Thus ſome, for inſtance, write the aſpirates, or letters *aſpirated*, which, by others, are omitted; though both the one and the other pronounce alike; as in *huomo*, *huomini*, an Italian word, frequently written *uomo*, *uomini*. But, by letters, we mean articulate ſounds, marked by them, and formed by the organs of ſpeech, viz. the throat, mouth, tongue, palate, teeth, &c.

Theſe ſounds are of two kinds, the one *ſimple*, and the other *compound*, or modified.—*Simple* are thoſe pronounced by a ſingle motion of the organ; ſuch are the vowels. *Compound* ſounds are thoſe ſame ſimple ſounds modified by a motion of the organ, ſuperadded to the motion neceſſary to pronounce the ſimple ſound; of which kind are the conſonants. The aſpirate is frequently changed into a conſonant, and expreſſed by a conſonant. Thus, of ξ is made *ſex*; of *ſεπ|α*, *ſeptem*; of ἑσπερος, *veſperus*, &c. of the Hebrew ע, עין, and thence *vinum*, &c. Nay even in the ſame language, Heſiod, ſpeaking of Hercules's buckler, uſes, Ἡρσην for Θηρσην; making no difference between a Θ and an aſpirate. Hence it follows, that aſpirates are real conſonants; and that we ought not to exclude the *h*, in our language, out of the number of letters. Other grammarians contend that the *h* is ſounded only by a ſtrong emiſſion of the breath, without any conformation of the organs of ſpeech, and conſequently is no letter. See H.

ASPIRATION, the act of aſpirating, i. e. of pronouncing any ſyllable, or word, ſtrongly, with a good deal of breath, and vehemence. This we do, for inſtance, in thoſe words which have the letter *h* before them, as *harangue*, *hook*, *Holland*, *hero*, &c. whereas the like ſyllables are ſounded much ſofter and eaſier without the *h*, as in the *ear*, *eat*, &c. See H.

ASS, the Engliſh name of the *Aſinus*, a ſpecies of the genus *Equus* in the ſyſtem of mammalia. For deſcription of the genus and the ſpecies appertaining to it, ſee the article EQUUS, ſee alſo the article ASINUS.

ASSA-*fœtida*, a gum, or reſin, brought from the Eaſt-Indies, of a browniſh colour, a ſharp taſte, and a very ſtrong offenſive ſmell; whence it is alſo called *ſtercus diaboli*, or devil's dung. The goodneſs of aſſa-fœtida is known by its colour and ſmell: a tolerable ſcent, and a clear colour, are the ſigns of its good quality; as a black colour, and a great ſtench, are proofs of the contrary. The ſtrong ſcent of this gum is much like that of garlic. The Engliſh and Dutch import it from Surat.

Geoffroy gives the following account of aſſa-fœtida: *Aſſa-fœtida*, ſays he, is a gum reſin, brought to us in lumps of different colours; white, yelloviſh, blue, or brown; which laſt is the worſt colour of all. It has a very ſtrong fœtid ſmell; and we are obliged to Kæmpfer for an exact hiſtory of the tree which produces it, and of the manner of gathering it, &c. In general, this tree, or large plant, is of the umbelliferous kind, growing plentifully in the province of Lahir, in the dominions of the Great Mogul; and in that of Chorazen, in Perſia. In the months of July and Auguſt, the country people make inciſions in the roots of theſe trees, through which the juice drains. It is whitiſh and thin at firſt, but by drying ſoon becomes thicker, and of a brown colour; in which form it is gathered, and preſerved for uſe. The root of the plant reſembles a large parſnep, and is externally black.

Aſſa-fœtida is an excellent remedy in all hyſteric diſorders, whether only ſmelled to, or mixed in what is taken internally. It is alſo eſteemed a good ſudorific, and ſtrengthens the ſtomach. The doſe is from twelve grains to half a drachm: but with a view to the ſtomach only, it muſt be given in ſmall doſes. Externally, it is a good diſſolvent, and in that intention is an ingredient in the *ceratum de galbano*, and is ſometimes tied to the bits of horſe's bridles. For a further account of the nature and properties of this gum, ſee the Syſtem of CHYMISTRY, Part IV. Chap. I. Sect. 4.

The *aſſa-fœtida* plant is recommended by Mr. Lawrence to be cultivated in our fields, for the food of cattle, inſtead of clover, ſaintfoin, or other ſuch herbs as we ſow among corn, and make into hay in the ſucceeding ſummers, and uſe as food for cattle at other ſeaſons.

This gentleman is of opinion that the ſheep fed on this plant would afford mutton of a much finer flavour than any that we are at preſent acquainted with. But it ſeems ſtrange that this ſhould be the effect of theſe creatures feeding on a plant of ſo ſtrong a ſcent, as the ſame author obſerves, that one drachm of the freſh root ſmells more than a hundred weight of the drug, as kept by the druggiſts, and that the whole air is ſtrongly and very diſagreeably ſcented with it, wherever it grows. Upon the whole, it ſeems probable that though this plant, or the *cytiſus*, or ſeveral others, might be cultivated in England for the food of cattle, yet not any one would be ſo eaſily raiſed, or make ſo great an advantage to the farmer, as the SAINTFOIN.

ASSAULT, in the art of war, an attack made upon a camp, fortreſs, or poſt, in order to carry or become maſter thereof. An aſſault is properly a general furious attack, wherein the aſſailants do not ſcreen themſelves by any works. We ſay, to give an aſſault, to be commanded to the aſſault, to ſtand an aſſault, to repulſe an aſſault, to carry by aſſault, &c. While an aſſault laſts, and both parties are mixed, the fire of the batteries ceaſes; and there is no uſe of cannon on either ſide; for they are afraid of deſtroying their own men thereby. And, it is almoſt impoſſible to carry a place by aſſault or ſtorm, when the breach may be defended by the fires of works not yet deſtroyed. In reality, it ſhould be defended by no other fires but thoſe which are oppoſed to it in front, or from the breach itſelf. Feuq. Mem. chap. xcix. Such obſtinacy in defending places to the laſt extremity is no longer found, except among the Turks; with whom it is a point of religion not to ſurrender to the Chriſtians, by capitulation, any place where they have once had a moſque.—Though of late they have ſometimes departed from this maxim.

ASSAULT, in law, an offer, or attempt, to hurt the perſon of another. Or, it is a violent injury offered to a man's perſon, of a larger extent than battery, becauſe it may be committed by only offering to give a blow; or even, according to ſome, by a threatening ſpeech, by preſenting a piſtol, or the like. Though ſome, it is obſerved, deny that words can amount to an aſſault.

To rebuke a collector with foul words, ſo that he depart for fear, without doing his office, has been adjudged an aſſault; and to ſtrike at a man, though he be not hurt or ſometimes not even hit with the blow, is reputed the ſame. For, in treſpaſs for aſſault and battery, a man may be found guilty of the aſſault, and excuſed of the battery, 25 Ed. III. c. 4: but every battery includes an aſſault.

The aſſaulting a perſon with offenſive weapons, with a deſign to rob (though no robbery enſues) is puniſhed with tranſportation for ſeven years. 7 Geo. II. c. 21. Aſſaulting in the ſtreet or highway, with intent to ſpoil peoples' clothes, and ſo ſpoiling them, is felony and tranſportation, by 6 Geo. I. c. 23. Sect. 11. And aſſaulting a privy-councellor in the execution of his office, is felony without benefit of clergy, by 9 Ann. c. 16.

ASSAY, *Eſſay*, or *Say*, in metallurgy, the proof or trial of the goodneſs, purity, value, &c. of metals, and metalline ſubſtances.

In ancient ſtatutes, this is called *touch*; and thoſe who had the care of it, *keepers of the touch*.—Under Henry VI. divers cities were appointed to have touch for wrought ſilver-plate. 2 Ann. VI. c. 14.—By this, one might imagine they had no better method of aſſaying than the ſimple one, by the touch-ſtone; but the caſe is far otherwiſe. In the time of king Henry II. the biſhop of Saliſbury, then treaſurer, conſidering that though the money paid into the king's exchequer for his crown-rents, did anſwer *numero & pondere*, it might nevertheleſs be mixed with copper or braſs: wherefore a conſtitution was made, called *the trial by combuſtion*; which differs little or nothing from the preſent method of aſſaying ſilver. See a deſcription of it in the Black Book in the Exchequer, written by Gervaſe of Tilbury, c. xxi.—The trial is alſo there called *eſſaium*, and the officer who made it is named *fuſor*. Vide Lownd. Eſſ. Amend. Silv. Coin. p. 5, & 155.

The method ſtill in uſe of aſſaying gold and ſilver, was firſt eſtabliſhed by an act of the Engliſh parliament, in 1354. Anderſon's Com. vol. p. 187.

ASSAYING, *Ars docimaſtica*, in its extent, comprehends particular manners of examining every ore, or mixed metal, according to its nature, with the beſt adapted fluxes; ſo as to diſcover, not only what metals, and what proportions of metal, are contained in ores; but likewiſe how much ſulphur, vitriol, alum, arſenic, ſmalt, &c. may be obtained from every one reſpectively.

Aſſaying is more particularly uſed by moneyers and goldſmiths

for the making a proof or trial by the cuppel, or teſt of the fineneſs or purity of the gold and ſilver to be uſed in the coining of money, and manufacture of plate, &c. or that have been already uſed therein. There are two kinds of aſſaying; the one before metals are melted, in order to bring them to their proper fineneſs; the other after they are ſtruck, to ſee that the ſpecies be ſtandard. For the firſt aſſay, the aſſayers uſed to take fourteen or fifteen grains of gold, and half a dram of ſilver, if it be for money; and eighteen grains of one, and a dram of the other, if for other occaſions.

As to the ſecond aſſay, it is made of one of the pieces of money already coined, which they cut into four parts. The quantity of gold for an aſſay among us, is ſix grains; in France, nearly the ſame; and in Germany, about three times as much.

In order to the due ſeparation of metals from metals, or of a confuſed mixture of metals, ſuch as thoſe commonly called *electrums*, or ſuch as the Corinthian braſs was ſuppoſed to be, we muſt obſerve, that experience has taught us a certain effect of lead, which could not be well conceived *à priori*.

ASSAY-MASTER, an officer, under certain corporations, entruſted with the care of making true touch, or aſſay, of the gold and ſilver brought to him; and giving a juſt report of the goodneſs or badneſs thereof.

Such is the aſſay-maſter of the mint in the Tower, called alſo *aſſayer of the king*.

The aſſay-maſter of the goldſmith's company is a ſort of aſſiſtant-warden, called alſo a *touch-warden*, appointed to ſurvey, aſſay, and mark all the ſilver-work, &c. committed to him.—There are alſo aſſay-maſters appointed by ſtatute at York, Exeter, Briſtol, Cheſter, Norwich, Newcaſtle, and Birmingham, for aſſaying wrought plate. The aſſay-maſter is to retain eight grains of every pound Troy of ſilver brought to him; four whereof are to be put in the *pix*, or box of deal, to be re-aſſayed the next year, and the other four to be allowed him for his waſte and ſpillings. 12 and 13 W. III. c. 4. 1 An. c. 9.

ASSAY-*balance*. The flat pieces of glaſs often placed under the ſcales of an aſſay-balance, ſeem by their power of electricity, capable of attracting, and thereby making the lighter ſcale preponderate, where the whole matter weighed is ſo very ſmall. See Phil. Tranſ. N° 480. p. 245.

ASSIGNEES, under a commiſſion of bankruptcy, are perſons to whom the bankrupt's eſtate is aſſigned, for the benefit of the creditors: they are choſen at one of the three meetings appointed by the commiſſioners, and publiſhed in the Gazette, by the major part, in value, of the creditors, who ſhall then have proved debts; but they may be originally appointed by the commiſſioners, and afterwards approved or rejected by the creditors; and no creditor ſhall be admitted to vote in the choice of aſſignees, whoſe debt does not amount to ten pounds. The aſſignees may purſue any legal method of recovering the property veſted in them, by their own authority; but cannot commence a ſuit in equity, nor compound any debts owing to the bankrupt, nor refer any matters to arbitration, without the conſent of the creditors, or a major part of them in value, obtained at a Gazette meeting. The aſſignees muſt, within twelve months after the commiſſion iſſued, give one and twenty days notice to the creditors of a meeting for a dividend; and within eighteen months, a ſecond and final dividend ſhall be made, unleſs all the effects were exhauſted by the firſt.

ASSIMILATION, the act of aſſimilating; an act whereby a thing is rendered ſimilar, and like to another. The word is compounded of *ad*, *to*, and *ſimilis*, *like*.

ASSIMILATION, *Aſſimilatio*, in phyſics, is properly a motion whereby bodies convert other duly diſpoſed bodies into a nature like, or homogeneous to, their own.

Inſtances of this aſſimilation we ſee in flame, which converts the oily or other particles of fuel into its own fiery and luminous nature. The like alſo appears in air, ſmoke, and ſpirits of all kinds.

The like we ſee in vegetables, where the watery juices imbibed from the earth, being farther prepared and digeſted in the veſſels of the plant, become of a vegetable nature, and augment the wood, leaves, fruit, &c.

So alſo, in animal bodies, we ſee the food aſſimilated, or changed into an animal ſubſtance, by digeſtion, chylification, and the other operations neceſſary to nutrition.

ASSISE, in old Engliſh law-books, is defined to be an aſſembly of knights, and other ſubſtantial men, together with a juſtice, in a certain place, and at a certain time: but the word, in its preſent acceptation, implies a court, place, or time, when and where the writs and proceſſes, whether civil or criminal, are decided by judge and jury,

All the counties of England are divided into ſix circuits; and two judges are aſſigned by the king's commiſſion, who hold their aſſizes twice a-year in every county (except London and Middleſex, where courts of *niſi prius* are holden in and after every term, before the chief or other judge of the ſeveral ſuperior courts; and except the four northern counties, where the aſſizes are taken only once a-year) to try by a jury of the reſpective counties the truth of ſuch matters of fact as are then under diſpute in the court of Weſtminſter-hall. The judges of aſſize came into uſe in the room of the ancient juſtices in eyre, *juſticiarii in itinere*; who were regularly eſtabliſhed, if not firſt appointed, by the parliament of Northampton. A. D. 1176, 22 Hen. II. with a delegated power from the king's great court or *aula regia*, being looked upon as members thereof: and they afterwards made their circuit round the kingdom once in ſeven years for the purpoſe of trying cauſes. They were afterwards directed by *magna charta*, c. 12. to be ſent into every county once a-year to take or try certain actions then called *recognitions* or *aſſiſes*; the moſt difficult of which they are directed to adjourn into the court of common pleas to be there determined. The itinerant juſtices were ſometimes mere juſtices of aſſiſe, or of dower, or of gaol delivery, and the like; and they had ſometimes a more general commiſſion, to determine all manner of cauſes, *juſticiarii ad omnia placita*: but the preſent juſtices of aſſiſe and *niſi prius* are more immediately derived from the ſtatute Weſtm. 2, 13 Edw. I. c. 30. explained by ſeveral other acts, particularly the ſtatute 14 Edw. III. c. 16. and muſt be two of the king's juſtices of the one bench or the other, or the chief baron of the exchequer, or the king's ſerjeants ſworn. They uſually make their circuits in the reſpective vacations after Hilary and Trinity terms; aſſiſes being allowed to be taken in the holy time of Lent by conſent of the biſhops at the king's requeſt, as expreſſed in ſtatute Weſtm. 1. 3 Edw. I. c. 51. And it was alſo uſual during the time of Popery, for the prelates to grant annual licenſes to the juſtices of aſſiſe to adminiſter oaths in holy times: for oaths being of a ſacred nature, the logic of thoſe deluded ages concluded that they muſt be of eccleſiaſtical cognizance. The prudent jealouſy of our anceſtors ordained that no man of law ſhould be judge of aſſiſe in his own country: and a ſimilar prohibition is found in the civil law, which has carried this principle ſo far, that it is equivalent to the crime of ſacrilege, for a man to be governor of the province in which he was born, or has any civil connection.

The judges upon their circuits now ſit by virtue of five ſeveral authorities. 1. The commiſſion of the *peace* in every county of the circuits; and all juſtices of the peace of the county are bound to be preſent at the aſſiſes; and ſheriffs are alſo to give their attendance on the judges, or they ſhall be fined. 2. A commiſſion of *oyer* and *terminer*, directed to them and many other gentlemen of the county, by which they are empowered to try treaſons, felonies, &c. and this is the largeſt commiſſion they have. 3. A commiſſion of general *gaol-delivery*, directed to the judges and the clerk of aſſiſe aſſociate, which gives them power to try every priſoner in the gaol committed for any offence whatſoever, but none but priſoners in the gaol; ſo that one way or other they rid the gaol of all the priſoners in it. 4. A commiſſion of *aſſiſe*, directed to the judges and clerk of aſſiſe, to take aſſiſes; that is, to take the verdict of a peculiar ſpecies of jury called *an aſſiſe*, and ſummoned for the trial of *landed* diſputes. The other authority is, 5. That of *niſi prius*, which is a conſequence of the commiſſion of *aſſiſe*, being annexed to the office of thoſe juſtices by the ſtatute of Weſtm. 2. 13 Edw. I. c. 30. And it empowers them to try all queſtions of fact iſſuing out of the courts of Weſtminſter, that are then ripe for trial by jury. The original of the name is this: all cauſes commenced in the courts of Weſtminſter-hall are, by the courſe of the courts, appointed to be there tried, on a day fixed in ſome Eaſter or Michaelmas term, by a jury returned from the county wherein the cauſe of action ariſes; but with this proviſo, *niſi prius juſticiarii ad aſſiſas capiendas venerint*; *unleſs before* the day prefixed the judges of aſſiſe come into the county in queſtion. This they are ſure to do in the vacations preceding each Eaſter and Michaelmas term, and there diſpoſe of the cauſe; which ſaves much expence and trouble, both to the parties, the jury, and the witneſſes.

The word *aſſiſe* (from the French *aſſis*, ſeated, ſettled, or eſtabliſhed, and formed of the Latin verb *aſſideo*, I ſit by) is uſed in ſeveral different ſenſes. It is ſometimes taken for the ſittings of a court; ſometimes for its regulations or ordinances, eſpecially thoſe that fix the ſtandard of weights and meaſures; and ſometimes it ſignifies a jury, either becauſe juries conſiſted of a fixed determinate number, or becauſe they continued ſitting till they pronounced their verdict. In Scots law, an aſſiſe or jury conſiſts of fifteen ſworn men (*juratores*) picked out by the court from a greater number, not exceeding 45, who have been ſummoned for that purpoſe by the ſheriff, and given in a liſt to the defender, at ſerving him with a copy of his libel.

ASSIZE is uſed, according to Lyttleton, for an ordinance, or ſtatute, regulating the weight, ſize, or dimenſions of certain commodities.—Thus the ancient ſtate of bread and ale, anno 51 Hen. III. is termed the *aſſiſe of bread and ale*, *aſſiſa panis & cereviſiæ*.

ASSOCIATON, the act of aſſociating, or conſtituting a ſociety, or partnerſhip, in order to carry on ſome ſcheme or affair with more advantage.—The word is Latin, *aſſociatio*; and compounded of *ad*, to, and *ſocio*, to join.

ASSOCIATION *of Ideas*, is where two or more ideas conſtantly and immediately follow or ſucceed one another in the mind, ſo that one ſhall almoſt infallibly produce the other, whether there be any natural relation between them or not.

Where there is a real affinity or connection in ideas, it is the excellency of the mind, to be able to collect, compare, and range them

them in order, in its inquiries: but where there is none, nor any cauſe to be aſſigned for their accompanying each other, but what is owing to mere accident or habit; this unnatural aſſociation becomes a great imperfection, and is, generally ſpeaking, a main cauſe of error, or wrong deductions in reaſoning. Thus the idea of goblins and ſprights, it has been obſerved, has really no more affinity with darkneſs than with light; and yet let a fooliſh maid inculcate theſe ideas often on the mind of a child, and raiſe them there together, it is poſſible he ſhall ever be able to ſeparate them again ſo long as he lives, but darkneſs ſhall ever bring with it thoſe frightful ideas. With regard to this inſtance, however, it muſt at the ſame time be obſerved, that the connection alluded to appears far from being either unnatural or abſurd. See the article APPARITION.

Such wrong combinations of ideas, Mr. Locke ſhows, are a great cauſe of the irreconcileable oppoſition between the different ſects of philoſophy and religion: for we cannot imagine, that all who hold tenets different from, and ſometimes even contradictory to, one another, ſhould wilfully and knowingly impoſe upon themſelves, and refuſe truth offered by plain reaſon: but ſome looſe and independent ideas are by education, cuſtom, and the conſtant din of their party, ſo coupled in their minds, that they always appear there together; theſe they can no more ſeparate in their thoughts, than if they were but one idea, and they operate as if they were ſo. This gives ſenſe to jargon, demonſtration to abſurdities, conſiſtency to nonſenſe, and is the foundation of the greateſt, and almoſt of all, the errors in the world.

ASSOCIATION *of Parliament*. In the reign of king William III. the parliament entered into a ſolemn aſſociation to defend his majeſty's perſon and government againſt all plots and conſpiracies; and all perſons bearing offices civil or military, were enjoined to ſubſcribe the aſſociation to ſtand by king William, on pain of forfeitures and penalties, &c. by ſtat. 7 and 8 W. III. c. 27.

ASSURANCE, in commerce. We have ſeveral offices of aſſurance from fire—as the Royal Exchange aſſurance; the Sun-fire-office; the Hand-in-hand-fire-office; the London aſſurance, &c. ſome for houſes, others for goods, and ſome for both.

We have alſo aſſurances for life, in virtue whereof, when the perſon aſſured dies, a ſum of money becomes payable to the perſon in whoſe behalf the policy of aſſurance was granted.

ASSURANCES on lives.—By ASSURING a life, is meant, obtaining ſecurity for a ſum of money to be received ſhould the life drop, in conſideration of ſuch a payment made to the aſſurer as is a ſufficient compenſation for the loſs and hazard to which he expoſes himſelf.—The ſum at which this compenſation ſhould be valued depends, 1. On the rate of intereſt at which money is improved: and 2. On the probability of the duration of the life to be aſſured. —If intereſt is high, and alſo the probability *high* of the duration of the life, the value of the aſſurance will be proportionably *low*. On the contrary, if the rate of intereſt is *low*, and the probability of living *low*, the value of the aſſurance will be proportionably *high*. In order to explain this: let 100*l.* be ſuppoſed to be aſſured on a life for a year to come; that is, let 100*l.* be ſuppoſed payable a year hence, provided a life of a given age fails in that time. Were the intereſt of money at 5 *per cent.* and the life *ſure* of failing, the value of the aſſurance would be the ſame with the preſent value of 100*l.* payable at the end of the year, reckoning intereſt at 5 *per cent.* that is, it would be that ſum, which being now put out to intereſt at 5 *per cent.* would produce 100*l.* at the end of the year, or 95*l.* 4*s.* 8*d.* For a copious explanation of the doctrine of annuities, with definitions, tables, and problems, illuſtrative of the ſame, whether certain or contingent, ſee the ſyſtem of ANNUITIES throughout.

On the contrary, if it be an equal chance, or the odds are equal, whether the life does or does not fail in the year, the value of the aſſurance will be half the former value, or 47*l.* 12*s.* 4*d.*—If the odds *againſt* its falling are *two to one*, that is, if it is to be expected, that ſome *one* of *three* lives, at the age of the given life, will fail in the year, the value of the aſſurance will be a *third* of the firſt value, reckoning the ſame intereſt, or 31*l.* 15*s.* If the odds are 19 to 1, or if it may be expected, that ſome one out of twenty lives, at the age of the given life, will fail in the year, the value of the aſſurance will be a twentieth part of the firſt value, or 4*l.* 16*s.* If the odds are 49 to 1, or only one out of fifty ſuch lives as the given life can be expected to fail in the year, the value of the aſſurance will be a fiftieth part of the firſt value; that is, it will be 1*l.* 18*s.* Now the odds of 3 to 1 are, according to Dr. Halley's Table of Obſervations, (ſee MORTALITY,) the odds that a life aged 87, will not drop in a year. The odds of 19 to 1 are the odds, according to the ſame table, that a life aged 64, will not drop in a year. And the odds of 49 to 1 are the odds that a life aged 39 will not drop in a year. It follows, therefore, that the value of the aſſurance of 100*l.* for a year, on a life aged 87, is 31*l.* 15*s.* on a life 64, 4*l.* 16*s.* on a life aged 39, 1*l.* 18*s.* reckoning intereſt at 5 *per cent.* If intereſt is reckoned at 3 *per cent.* theſe values will be 31*l.* 7*s.* 4*l.* 17*s.* 1*l.* 18*s* 10*d.*

ASTERIAS, STAR-FISH, or SEA-STAR, in vermeology, a genus of inſects of the order of vermes molluſca. It has a depreſſed body, covered with a coriaceous coat; is compoſed of five or more ſegments, running out from a central part, and furniſhed with numerous tentacula; and has the mouth in the centre. The conformation of the mouth is this: The under part of each lobe runs towards a point with the reſt at the centre of the body; and theſe ſeveral productions of the rays make a ſort of lips, the ends of each of which are armed with a number of ſharp teeth, which ſerve to take and convey the food into the body. From this mouth there goes a ſeparate canal to all or many of the rays, which runs through their whole length, and becomes gradually narrower as it approaches the extremity. The tentacula reſemble the horns of ſnails, but ſerve the animal to walk with. They are capable of being contracted or ſhortened: and it is only at the creature's moving that they are ſeen at the full length; at other times, no part of them is ſeen but the extremity of each, which is formed like a ſort of button, being ſomewhat larger than the reſt of the horn.

Moſt of the ſpecies of aſterias are found in the Britiſh ſeas. 1. The glacialis, with five rays, depreſſed, broad at the baſe, yellow, and having a round ſtriated opereulum on the back, is the moſt common; it feeds on oyſters, and is very deſtructive to the beds. 2. The clathatra, or cancellated ſea-ſtar, with five ſhort thick rays, hirſute beneath, cancellated above, is found with the former, but more rare. 3. The oculata, with five ſmooth rays, dotted or punctured, is of a fine purple colour, and is found about Angleſea. 4. The hiſpida, with five rays, broad, angulated at the top, and rough with ſhort briſtles, is of a brown colour, and likewiſe found about Angleſea. 5. The placenta, with five very broad and membranaceous rays, extremely thin and flat, is found about Weymouth. 6. The ſpherulata, with a pentagonal indented body; a ſmall globular head between the baſe of each ray; the rays ſlender, jointed, taper, and hirſute on their ſides; found off Angleſea. 7. The caput Meduſæ, or aboreſcent ſea-ſtar, with five rays iſſuing from an angular body; the rays dividing into innumerable branches, growing ſlender as they recede from the baſe. Theſe the animal, in ſwimming, ſpreads like a net to their full length; and when he perceives any prey within them, draws them in again, thus catching it with all the dexterity of a fiſherman. It is an inhabitant of every ſea; and is called by ſome the *Magellanic ſtar-fiſh* and *baſket-fiſh*. When it extends its rays fully, it forms a circle of near three feet in diameter. The fragments of theſe rays furniſh the foſſile entochi. If we drown this animal in brandy or ſpirits of wine, and keep the rays flat and expanded in the execution, it is eaſy to extract, by means of a pair of forceps, the ſtomach of the animal whole and entire through the mouth. 8. The decacnemos has ten very ſlender rays, with numbers of long beards on the ſides: the body is ſmall, and ſurrounded beneath with ten ſmall filiform rays. It inhabits the weſtern coaſts of Scotland.—There are ſeveral other ſpecies mentioned by authors; ſome of them of 10, 12, 13, or even 14 rays.

ASTHMA, in medicine, a diſeaſe of the lungs, accompanied with a ſhortneſs and difficulty of reſpiration. An aſthma is a difficulty of breathing, ariſing from a diſorder of the lungs; and uſually attended with violent motions of the diaphragm, abdominal and intercoſtal muſcles, to the very ſcapula, and the pinnæ of the noſtrils; as alſo with a rattling in the throat. If reſpiration be only thick and quick, without the other ſymptoms, it is called a dyſpnœa.—And if it be ſo intenſe as to occaſion a violent motion of the muſcles of the thorax, ſo that the patient cannot be tolerably eaſy, except in an erect poſture, it is called an orthopnœa.

The aſthma is uſually divided into moiſt and dry, or manifeſt and occult, or pneumonic and convulſive: the firſt is attended with an expectoration of purulent matter; the latter is without.

The true or pneumonic aſthma is occaſioned by an abundance of ſeroſities, or of groſs, viſcous, or purulent humours collected in the cavities of the lungs, which ſtop or ſtraighten the paſſages of the air, and compreſs the bronchia. Aſthmas may alſo be owing to empyemas, phthiſes, polypuſes, crudities in the ſtomach, cachexies, &c.

Dr. Mead obſerves, that whatever occaſions the ambient air to enter the lungs with leſs freedom than uſual, brings on this diſeaſe. Hence it may ariſe, 1ſt, From an impediment to the action of the diaphragm, or of the intercoſtal and abdominal muſcles. 2dly, From an obſtruction of the free paſſage of the air into the aſpera arteria, or its ramifications, whether it ariſes from a tumour, or from viſcid humours. 3dly, The air itſelf may be a cauſe, if it be much heavier or lighter than uſual. 4thly, The tenderneſs of the lungs may ſometimes occaſion this diſtemper, as appears from thoſe who are ſubject to a difficulty of breathing upon removing from the thick air of the town into the clear air of the country. 5thly, The difficult paſſage of the air through the lungs may be reckoned among the cauſes of difficult reſpiration. And this may happen either from the weakneſs of the heart, or too great thickneſs of the blood.

That kind called the *convulſive aſthma* is ſuppoſed to be occaſioned by an irregular motion of the animal ſpirits; and happens when the ſpirits do not flow faſt enough, or in ſufficient quantity, into the muſcles of the breaſt, either by reaſon of an obſtruction, or of ſome other obſtacle: the neceſſary conſequence whereof is a violent and painful reſpiration, in which nature's effort ſeems to

be

be the relieving herſelf from the load of a plethora, by a ſpitting of blood, though ſhe fails in the attempt. The convulſive aſthma reſembles the *incubus*, or night-mare, in many particulars; but it never ſeizes any body, unleſs they are awake, whereas the other uſually attacks them when between ſleep and waking; and this is a much more laſting complaint, and more frequent in the return of its fits than the other. The *incubus* alſo prevents reſpiration in ſo violent a degree that the perſon can form no articulate ſound. But the convulſive aſthma ſuffers a ſomewhat more free reſpiration, and the uſe of the voice. The *incubus* is a diſeaſe of a very little danger; the convulſive aſthma, on the contrary, is a very dangerous, and often fatal diſorder. Juncker. Conſp. Med. p. 364.

Signs of the convulſive ASTHMA. Theſe are a terrible ſhortneſs of breath, which differs from that of the ſuffocative catarrh only in this, that it is ſomewhat leſs violent, and is not attended with the ſame ſenſation of a ſtuffing up of the breaſt: a numbneſs of the limbs, and a general laſſitude of the whole body; there is a violent compreſſion felt in the breaſt, and about the ſhoulders, with a great palpitation of the heart. The face is red in ſome parts, and ſeems tumid, and the temporal arteries are diſtended. The bowels are uſually coſtive, and there is a dimneſs often in the eyes, and ſometimes an alienation of the mind. Theſe ſymptoms uſually come on in an evening, and laſt an hour or two. Often, however, the fits are of much longer duration, and ſometimes they obſerve regular periods, at different diſtances of time.

As every ſpecies of this diſeaſe is attended with more or leſs effervеſcence in the blood, the bark will be found uſeful; and there have been inſtances where it has done vaſt ſervice, mixed with the cinnabar of antimony. Mead. Mon. & Pract. Med. cap. 8.

Bliſters on the back give relief during the fit; and by keeping them open as long as poſſible may prevent returns. In general, all ales, and eſpecially that prepared of wheat, are in this diſorder to be avoided. In *aſthmatic* caſes, the moſt proper liquor is old Rheniſh wine, mixed with three or four parts of pure ſpring water, or the Seltzer waters. Beſides infuſions by way of tea, prepared of hyſſop, Paul's botony, garden crowfoot, ground-ivy, liquorice-root, the *tragus* (ſea-grape), and the flowers of the daiſy, are highly beneficial in all aſthmas, from whatever cauſe they may ariſe. Such ſubſtances as are too ſweet, or prepared with ſugar or honey, are in every ſpecies of the aſthma, but more eſpecially thoſe of the ſerous, or hypochondriacal kind, to be carefully abſtained from. For further particulars reſpecting this diſeaſe, ſee the Syſtem of MEDICINE, Genus 41.

ASTRAGAL, in anatomy, a bone of the heel, having a convex head, articulated with the *tibia*, by *ginglymus*. The *aſtragalus*, called alſo *talus*, and popularly *os baliſtæ*, is the firſt bone of the *tarſus*, and the higheſt of all thoſe that belong to the foot. See the Syſtem, Part I. Sect. 4. Art. 7.

ASTRAGAL in architecture, a little round moulding, which in the order ſurrounds the top of the ſhaft or body of the column. It is alſo called the *talon* and *tondino*; it is uſed at the bottoms as well as tops of columns, and on other occaſions; it properly repreſents a ring, on whatever part of a column it is placed; and the original idea of it was that of a circle of iron put round the trunk of a tree, uſed to ſupport an edifice, to prevent its ſplitting. The aſtragal is often cut into beads and berries, and is uſed in the ornamented entablatures to ſeparate the ſeveral faces of the architrave. See the Syſtem, Part II. Sect. 4, and Plate 6. Fig. 2.

ASTRICTION, *Adſtrictio*, in medicine, an operation intended partly to conſtringe the parts and pores of the body, when too looſe, and partly to reſtrain the courſe of the humours, when too fluid. Aſtriction, with regard to the object, is of two ſorts; the firſt employed on the too much relaxed *ſolids*; the ſecond on the *fluids*, chiefly in hæmorrhages; intended to moderate or reſtrain the flux of the blood through the cuſtomary paſſages, as the noſe, *menſes*, *lochia*, and the like; and ſometimes alſo to ſtop extraordinary and unuſual hæmorrhages, ariſing from violent cauſes.

ASTRINGENTS, in medicine, binding remedies; or ſuch as have the power of contracting the parts, and diminiſhing the pores thereof. Aſtringents chiefly act either by the aſperity of their particles, whereby they corrugate the membranes, and make them draw up cloſer; or by thickening the fluids, whereby they cannot run off ſo faſt as before. Hence, aſtringents are of the claſs of ſtrengtheners, or corroborants. Aſtringents naturally ſtand oppoſed to laxatives. They only differ from what are called ſtyptics, in degree of efficacy. Among ſimples, mint, red roſes, nettles, ſanicle, barberries, quinces, pomegranates, ſloes, cinnamon, blood-ſtone, alum, chalk, boles, coral, &c. are the principal aſtringents. Aſtringent medicines are to be avoided in all inflammatory caſes, for they diſturb nature in the effort ſhe is making to relieve herſelf from a congeſtion of blood in the part; and prevent that free paſſage which the blood ought to have, and which alone can make a cure, or break through the obſtruction that is the real diſeaſe.

Mr. Petit concludes, from a great many experiments he made in covering pieces of fleſh with the different ſorts of aſtringents employed in hæmorrhages, that ſome act only as abſorbents, ſuch are earthy ſubſtances, moſt of the aſtringent plants, ſome gums, reſins, and animal ſubſtances. Other aſtringents abſorb, and at the ſame time, their ſaline and ſulphureous particles, inſinuating themſelves into the fleſh, preſerve it from corruption. Vitriol and alum, which are acknowledged to be among the ſtrongeſt aſtringents, appeared, by his experiments, to abſorb moſt humidity. Mem. Acad. Scienc. an. 1732. Aſtringents are beſt adminiſtered in ſmall doſes, with a large quantity of ſome proper liquid. Extracts made from aſtringent vegetables do not keep long. Dr. Percival, in his Medical Eſſays and Experiments, obſerves, that aſtringents, acid and vegetable, neutralize each other; that vegetable acids leſſen their aſtriction externally; but that mineral acids increaſe it both internally and externally. Vegetable aſtringents are the moſt powerful, as medicines; and of theſe one of the ſtrongeſt is galls.

See Neumann's chemical hiſtory of aſtringent vegetables, his account of their antiſeptic nature, of the methods of extracting their aſtringency, of their ſtriking colours with chalybeate vitriol, of their uſe in tanning, of their giving ſome durable dyes, and of their fixing others, in Dr. Lewis's edition of Neumann's Works, with his own additional obſervations, 4to. an. 1759. p. 562, & ſeq. See alſo the Syſtem of CHYMISTRY, Part IV. Ch. I. Sect. 1.

ASTROLOGY, a conjectural ſcience, which teaches to judge of the effects and influences of the ſtars, and to foretel future events by the ſituation and different aſpects of the heavenly bodies.

This ſcience has been divided into two branches, natural and judiciary. To the former belongs the predicting of natural effects; as, the changes of weather, winds, ſtorms, hurricanes, thunder, floods, earthquakes, &c. This art properly belongs to natural philoſophy; and it is only to be deduced, *à poſteriori*, from phenomena and obſervations. Judiciary, or judicial aſtrology, is that which pretends to foretel moral events; i. e. ſuch as have a dependence upon the free-will and agency of man; as if they were directed by the ſtars. This art, which owes its origin to the practices of knavery and credulity, is now univerſally exploded by the intelligent part of mankind.

The profeſſors of this kind of aſtrology maintain, "That the heavens are one great volume or book, wherein God has written the hiſtory of the world; and in which every man may read his own fortune, and the tranſactions of his time. The art, ſay they, had its riſe from the ſame hands as aſtronomy itſelf; while the ancient Aſſyrians, whoſe ſerene unclouded ſky favoured their celeſtial obſervations, were intent on tracing the paths and periods of the heavenly bodies, they diſcovered a conſtant ſettled relation of analogy between them and things below; and hence were led to conclude theſe to be the Parcæ, the Deſtinies ſo much talked of, which preſide at our births, and diſpoſe of our future fate.

"The laws therefore of this relation being aſcertained by a ſeries of obſervations, and the ſhare each planet has therein; by knowing the preciſe time of any perſon's nativity, they were enabled, from their knowledge in aſtronomy, to erect a ſcheme or horoſcope of the ſituation of the planets at that point of time; and hence, by conſidering their degrees of power and influence, and how each was either ſtrengthened or tempered by ſome other, to compute what muſt be the reſult thereof." Thus the aſtrologers.—But the chief province now remaining to the modern profeſſors, is the making of calendars or almanacs.

Judicial aſtrology is commonly ſaid to have been invented in Chaldea, and thence tranſmitted to the Egyptians, Greeks, and Romans; though ſome will have it of Egyptian origin, and aſcribe the invention to Cham. But it is to the Arabs that we owe it. At Rome the people were ſo infatuated with it, that the aſtrologers, or, as they were then called, the *mathematicians*, maintained their ground, in ſpite of all the edicts of the emperors to expel them out of the city.

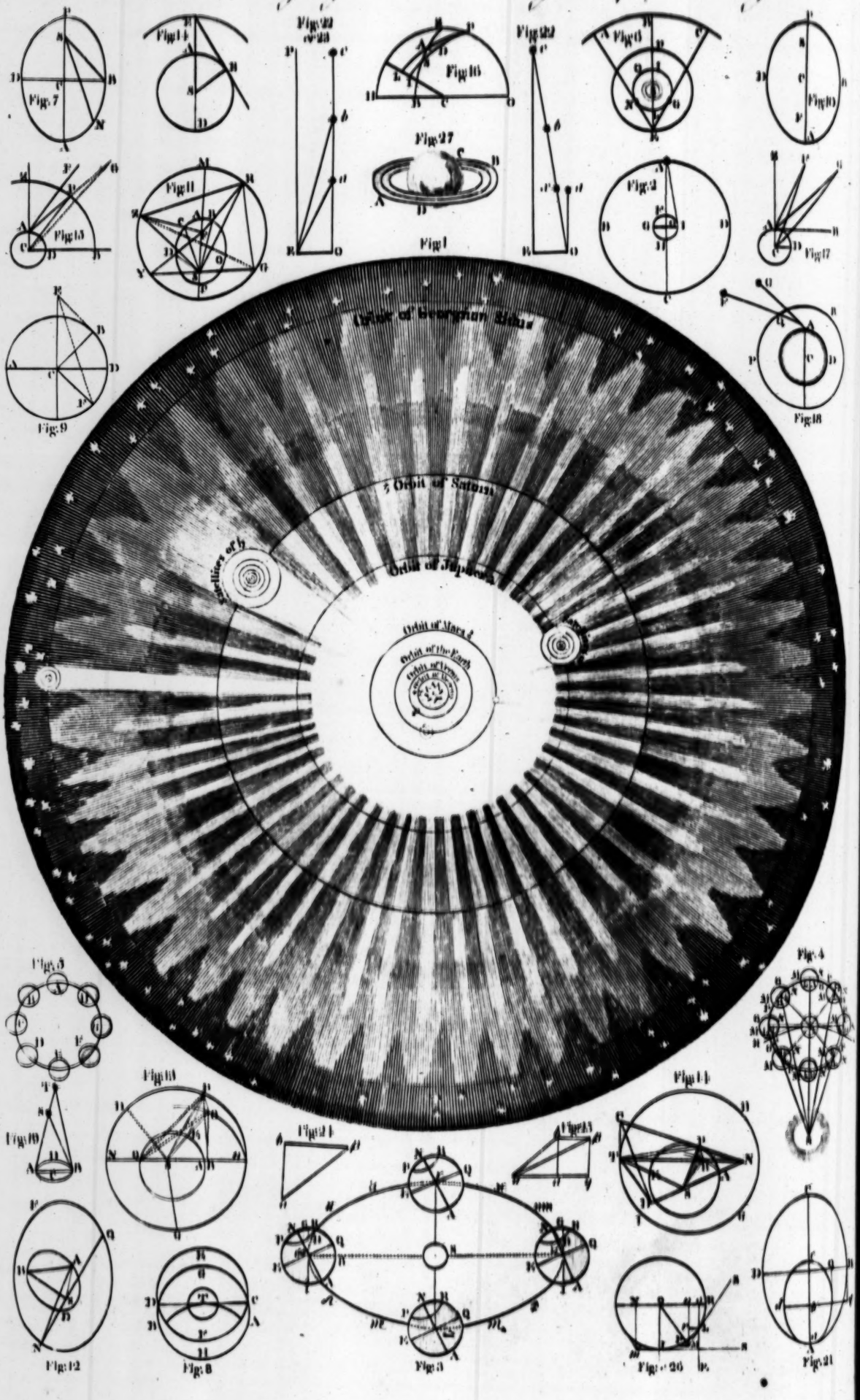
Add, that the Bramins, who introduced and practiſed this art among the Indians, have hereby made themſelves the arbiters of good and evil hours, which gives them great authority: they are conſulted as oracles; and they have taken care never to ſell their anſwers but at good rates. The ſame ſuperſtition has prevailed in more modern ages and nations. The French hiſtorians remark, that in the time of queen Catharine de Medicis, aſtrology was ſo much in vogue, that the moſt inconſiderable thing was not to be done without conſulting the ſtars. And in the reigns of king Henry III. and IV. of France, the predictions of Aſtrologers were the common theme of the court converſation. This predominant humour in that court was well rallied by Barclay, in his Argenis, lib. ii. on occaſion of an aſtrologer who had undertaken to inſtruct king Henry in the event of a war then threatened by the faction of the Guiſes.

ASTRONOMICAL, ſomething relating to ASTRONOMY.

ASTRONOMICAL CALENDAR, an inſtrument engraved on copper-plates, printed on paper, and paſted on a board, with a braſs ſlider, carrying a hair: it ſhews by inſpection the ſun's meridian altitude, right-aſcenſion, declination, riſing, ſetting, amplitude, &c. to a greater degree of exactneſs than the common globes.

Aſtronomy, the knowledge of the heavenly bodies, with regard to their magnitudes, motions, diſtances, &c. whether real or apparent, and of their natural cauſes on which their natural phenomena depend.

Elements of Astronomy, including the Solar System, with the new discovered Planet the Georgium Sidus. See System of Astronomy, Sect. 3.



SYSTEM OF ASTRONOMY.

SECTION I.

HISTORY OF ASTRONOMY.

THAT Aſtronomy was ſtudied in the very firſt ages of the world is beyond a doubt, as it muſt have been a neceſſary reſearch to form ſome judgment of the lapſe of time; for without that there could be no way of communicating ideas of paſt events, much leſs any intelligible records made of them.

And this could only be done by duly obſerving the motions and revolutions of the ſun and moon, which the All-wiſe Creator has appointed as indexes for that purpoſe. From this it ſhould appear that even Adam was not deſtitute of ſome knowledge in Aſtronomy; for, otherwiſe, how could an account of his age, at the birth of Seth, or the number of years that he lived, have been preſerved?

Beſides, it ſeems extremely probable, that he, whom the Almighty had made Lord over the creation, by placing every creature in ſubordination, and to whom he committed the naming of every thing, ſhould know ſomething of the nature of each, and their ſeveral uſes.

Joſephus, however, writes that Seth or his nephews, firſt obſerved the order of the heavens, and the courſes of the ſtars; and ſuppoſes that longevity was beſtowed upon the Antideluvians for the very purpoſe of improving the ſciences of Geometry and Aſtronomy; adding that the latter could not be learned in leſs than 600 years, the extremity of that period being the grand year. It is ſuppoſed Joſephus meant the period in which the ſun and moon came again into the ſame ſituation, with regard to the moon's nodes, apogee, &c. as at the beginning.

If this was a fixed period of the Antideluvians, they muſt have known more of Aſtronomy than was known many ages after the flood.

Among the nations who firſt made any conſiderable figure in hiſtory, the Chaldeans and Egyptians were the moſt remarkable for their Aſtronomical knowledge. They diſputed with each other the honour of having been the firſt cultivators of Aſtronomy. The Chaldeans boaſted of their temple of Belus, and of Zoroaſter, who, as they pretended, flouriſhed 5000 years before the deſtruction of Troy; though, it is pretty certain, that he lived within a thouſand years of that event. The Egyptians, on the other hand, exulted in their ancient colleges of prieſts, where Aſtronomy was taught, and of the monument of Oſymandyas; in which it is ſaid, there was a golden circle of 365 cubits in circumference, and one cubit thick. It is recorded that the upper face was divided into 365 equal parts, correſponding to the days in a year; and that on each diviſion was written the name of the day, the heliacal riſing of the ſeveral ſtars for ſuch day, with prognoſtications, &c.

It is further ſaid, that the Babylonians had obſervations for 700 years engraven upon bricks; and that when Alexander took Babylon, he carried away obſervations for almoſt 2000 years; but as they fell into the hands of ignorant and careleſs people, the greateſt part of them were loſt; which is ſuch a period of time, and fund of obſervations, as we have not to ſhew at this day. So arts and ſciences, as well as the ſtars, have their periods, ſtations, and retrogradations.

However, according to the beſt accounts, the Chaldeans derived the chief of their knowledge in Aſtronomy from the Egyptians, who fled to Babylon when Egypt was invaded by the Ethiopians.

The riſe of Aſtronomy among the Greeks is unknown; though many are of opinion that they, as well as the Phœnicians, derived their knowledge in this ſcience from the Egyptians.

After him, Aſtronomy was carried into Greece; Thales, the Mileſian, went thither for inſtruction. He flouriſhed about 580 years before Chriſt, and delighting himſelf in this ſcience, made conſiderable improvements. He is ſaid to have obſerved the exact time of the ſolſtices, and equinoctial points; to have taught the obliquity of the ecliptic, and to have been the firſt who foretold eclipſes.

He predicted a total eclipſe of the ſun, which happened on the 28th of May, 585 years before Chriſt, and alſo another of the moon.

After him, Thales, Anaximander, Anaximanes, Anaxagoras, and Pythagoras, contributed conſiderably to the advancement of Aſtronomy. Pythagoras made great improvements both in Aſtronomy, and Geometry, and deſcribed the order of the univerſe, agreeable to the preſent Newtonian ſyſtem.

Then followed Philolaus, Hicetas, Meton, Euctemon, Plato, Ariſtotle, Eudoxus, Calippus, &c. all of whom were men of conſiderable renown, and aſſiduous in promoting the progreſs of this and other ſciences; though Plato and Ariſtotle, inſtead of advancing, rather clouded Aſtronomy, by embracing an erroneous ſyſtem, which was afterwards rigidly taught by Ptolemy, and from thence it was called the Ptolemaic ſyſtem.

Ariſtarchus, who lived about 270 years before Chriſt, diligently ſtrove to reſcue Aſtronomy from the obſcurity into which it was brought by Plato and Ariſtotle, ſtrenuouſly aſſerting and defending the Pythagorean ſyſtem.

He gave a method of determining the diſtance of the ſun, by the moon's dichotomy.

The celebrated Archimedes, about 220 years before Chriſt, was no leſs ſkilful in Aſtronomy than Geometry. He invented a planetarium, or orrery, for repreſenting the phœnomena and motions of the heavenly bodies; he alſo determined the diſtance of the moon from the earth, of Mercury from the moon, of Venus from Mercury, of the ſun from Venus, of Mars from the ſun, of Jupiter from Mars, and of Saturn from Jupiter; as likewiſe the diſtance of the fixed ſtars from the orbit of Saturn.

Hipparchus, who flouriſhed about 140 years before Chriſt, was a diligent obſerver of the ſtars. He was the firſt who diſcovered the orbits of the moon and planets to be eccentric, and the anticipation of the moon's nodes. He alſo determined the length of the year with great accuracy; conſtructed tables of the motions of the ſun and moon; and gave a catalogue of the latitudes, longitudes, and apparent magnitudes of 1022 ſtars.

In ſhort, he is reputed to have been the firſt who applied his ſtudy to every part of Aſtronomy; and ſo indefatigable was he in his purſuits, that he is ſaid to have calculated all the eclipſes that were to happen for the ſpace of 600 years after his time.

From the time of Hipparchus to that of Ptolemy, who flouriſhed about A. D. 70, Aſtronomy made but little progreſs, and then it became enveloped in miſt and obſcurity, through Ptolemy's reviving the erroneous notions of Plato and Ariſtotle, as was before obſerved.

From this period, till the 16th century, the Pythagorean Syſtem was entirely laid aſide; when it was reſtored again by Nicholas Copernicus, who wrote a treatiſe, dedicated to Pope Paul III. in the preface of which he attempted to apologize as much as poſſible for the extraordinary doctrines it appeared to contain. He died however, within a few hours of its publication. But although, from the time of Ptolemy to that of Copernicus, the true ſyſtem was exploded, yet there were ſome who, in other reſpects, improved the ſcience.

Among the Arabians, the caliph Al Mamun, who aſcended the throne in A. D. 814, was a great encourager of the ſciences. He made many aſtronomical obſervations himſelf, and determined the obliquity of the ecliptic to be 23° 35′. Alſo Albategnius, about A. D. 880, greatly reformed Aſtronomy; he determined the preceſſion of the equinoxes to be 1 degree in 70 years, and, with Al Mamun, fixed the ſun's greateſt declination, at 23° 35′.

Uleg Beg, grandſon of the famous Tamerlane, was a great proficient in practical Aſtronomy. He compoſed Aſtronomical Tables from his own obſervations, ſo exact as to differ very little from thoſe afterwards conſtructed by Tycho Brache. He alſo gave a catalogue of the fixed ſtars, made from his own obſervations in A. D. 1437; and determined the latitude of Samarcand, his capital, to be 39° 37′ 23″. This ſhews how accurate he was in his obſervations. Likewiſe, previous to the time of Copernicus, John De Sacro Boſco (an Engliſhman) Purbach, John Muller of Monteregio, in Franconia, generally named Regiomontanus, and John Werner, a clergyman at Nuremberg, were great ſtudents in Aſtronomy. The laſt of whom determined the preceſſion of the equinoctial points to be 1 degree and 10 minutes in 100 years; and the obliquity of the ecliptic to be 23° 28′, which numbers nearly agree with modern obſervations.

After the death of Copernicus, which was on the 23d of May, 1543, Aſtronomy was much improved by Schoner, Nonius, Apian, and Gemma Friſius; though Schoner only ſurvived Copernicus four years. Gemma Friſius was the firſt who propoſed a time-keeper for aſcertaining the longitude at ſea.

About A. D. 1561, William the IVth, Landgrave of Heſſe Caſſel, applied himſelf to the ſtudy of this ſcience, and erected an obſervatory on the top of his palace, and afterwards gave a catalogue of the latitudes and longitudes of 400 ſtars from his own obſervations.

Tycho Brache was contemporary with the Landgrave of Heſſe before-mentioned; he made a vaſt number of obſervations, and publiſhed a catalogue of 770 ſtars.

He invented a new ſyſtem of the World, which he vainly endeavoured to eſtabliſh on the ruins of that of Copernicus; but the conſonancy and ſimplicity of the Copernican ſyſtem ſoon prevailed over the unnatural and complicated ſyſtem of Tycho.

But, notwithſtanding his odd notion of the univerſe, his works diſcover him to have been a man of vaſt abilities.

The famous John Kepler, was for ſome time under the tuition of Tycho Brache; but he ſoon diſcovered the error of Tycho's ſyſtem, and alſo found that his predeceſſors had been wrong in ſuppoſing the orbits of the planets to be circular; for, from his own obſervations he found them to be elliptical, and the Sun to be placed in one of the foci; he alſo diſcovered that all the planets deſcribe equal areas in equal times, and that the ſquares of the periodical times round the ſun are as the cubes of their mean diſtances.

He likewiſe diſcovered ſomething of the principle of gravity; for he ſignified that gravity is a mutual power betwixt two bodies; that the moon and earth tend toward each other, and would meet in a point nearer to the earth than the moon in the proportion of the ſuperior magnitude of the former; provided they were not hindered by their projectile motions. He further added, that the tides ariſe from the gravitation of the waters towards the moon.

But though Kepler, from the obſervations he made, went thus far, yet the true theory of the planetary motions, as reſulting

from the principles of mechanics, and the doctrine of centripetal forces, he was an utter ſtranger to; and therefore it is not to be wondered at that he afterwards did not ſteadily adhere to thoſe principles, but in lieu thereof ſubſtituted others as the cauſes of the planetary motions.

The buſineſs of adjuſting and demonſtrating theſe matters; of determining the true figures of the planets' orbits, and ſhewing that the irregular motions of the Satellites, &c. are perfectly conformable to the laws of motion and gravity, was reſerved for the immortal Engliſh philoſopher Sir Iſaac Newton, to whom aſtronomy, philoſophy, and the various branches of the mathematical ſciences, are indebted for almoſt every thing that is truly valuable.

Galileus, an Italian, in the beginning of the 17th century, by the help of teleſcopes, diſcovered the Satellites of Jupiter, and Saturn, the ring of Saturn, &c.

In 1633, Mr. Jeremiah Horrox foretold a tranſit of Venus that would happen on November 24, 1639; he alſo formed a new theory of the moon, ſo ingenious as to attract the notice of Sir Iſaac Newton; but the hopes of Aſtronomers, from the abilities of this excellent young man, were diſappointed, by his death, in January 1640, he being then only about 22 years of age.

Mr. John Flamſtead, the firſt Aſtronomer Royal in this kingdom, made many obſervations on the Sun, Moon, Planets, and Comets; and on the ſtars alſo, publiſhing a catalogue of 3000. He likewiſe publiſhed new ſolar tables, and a theory of the moon, according to Horrox; and it was from his obſervations that Dr. Halley's tables and Sir Iſaac Newton's theory of the moon were conſtructed.

Mr. Flamſtead died A. D. 1719, and was ſucceeded by Dr. Halley, a moſt excellent Aſtronomer and Mathematician, as appears clearly by his writings in the Philoſophical Tranſactions. He was the firſt who diſcovered the acceleration of the Moon; and gave a very ingenious method of finding her parallax by three obſerved phaſes of a Solar Eclipſe. He compoſed a complete ſet of tables of the ſun, moon, and all the planets, except the Georgium Sidus, ſince diſcovered; and, in the courſe of nine years, ſpent at the Obſervatory, he made near 1500 obſervations of the Moon.

Dr. Halley dying, A. D. 1742, was ſucceeded by Dr. Bradley, who was a moſt accurate obſerver, and who diſcovered the aberration of light, and the mutation of the earth's axis. He alſo obſerved the places and computed the elements of the comets which appeared in the years 1723, 1736, 1743, and 1757.

He made new and accurate tables of Jupiter's Satellites, and accompliſhed various other improvements in aſtronomy too tedious to mention.

Dr. Bradley died A. D 1762, and was ſucceeded by Mr. Bliſs, Savilian Profeſſor of Aſtronomy at Oxford, who died ſoon after, and was ſucceeded by Nevile Maſkelyne, D. D. the preſent Aſtronomer Royal.

The moſt remarkable foreign Aſtronomers ſince Mr. Flamſtead's time are M. De la Caille, Clairault, Euler, Mayer, Wargentine, and M. De la Lande, all of whom have ſhewn great genius and induſtry in improving aſtronomical tables.

M. De la Lande's planetary tables, Mayer's lunar tables, as improved by Maſon, and Wargentine's tables of the Satellites are ſuppoſed the moſt correct, and are uſed by our preſent Aſtronomer Royal in calculating the Nautical Ephemeris for the uſe of the navy.

But, perhaps, the greateſt aſtronomer of the preſent time is Dr. Herſchel, who, through his wonderful improvement of teleſcopes, has explored the celeſtial regions far beyond whatever had been done; and has diſcovered the new planet, Georgium Sidus, and an immenſe number of ſtars that were totally unknown before. By his diſcoveries among the fixed ſtars he has greatly enlarged our ideas of the univerſe. In ſhort, if I may venture to judge of his abilities from the ſpecimens which I have ſeen, I think him a man in every reſpect qualified to perfect all that the Great Newton left unfiniſhed.

SECT. II.

ON THE SOLAR SYSTEM.

MANY hypotheſes have been formed for explaining the motions and appearances of the ſun and planets, &c. but none, except the following, could account for all the phœnomena of theſe celeſtial bodies.

This hypotheſis, as has been obſerved, was firſt advanced by Pythagoras; revived ſince by Copernicus and Keplar; and then fully eſtabliſhed and demonſtrated by the immortal Newton.

In this ſyſtem the ſun is placed nearly immovable in the centre of the orbits of all the planets, or more properly ſpeaking in one of the foci of their repective orbits, for the orbits are not circular, but elliptical. And though the ſun always keeps nearly in the ſame place, yet he is obſerved to move round his own axis in about 25 days 15 hours and 16 minutes. The orbits of the planets are not all in one plane, but interſect one another in lines that paſs through the centre of the ſun; and the places of the orbits where they interſect are called the Nodes.

The number of planets (including the Earth) are 7; namely, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and the *new diſcovered planet* GEORGIUM SIDUS. Theſe all move round the ſun in the manner above deſcribed, and in the order they are inſerted, Mercury being ſtationed the neareſt to the ſun, and the Georgium Sidus, at the moſt remote diſtance from him. Alſo ſome of theſe planets have attendants, called Secondary Planets, or Satellites, moving round them. Thus our ſatellite, the MOON, revolves round the earth; alſo four moons or ſatellites revolve round Jupiter; five round Saturn; and two round the Georgium Sidus. Theſe likewiſe revolve from Weſt to Eaſt; but none of them, except the Moon, were obſerved before the invention of teleſcopes. The diſtances, magnitudes, revolutions, &c. of the planets and ſatellites will be ſhewn hereafter.

But beſides the planets and their ſatellites, there is another ſort of bodies revolving round the ſun, called wandering Stars or Comets. Theſe move in eliptical orbits, which extend to almoſt an immenſe diſtance from the ſun, or it may be that the orbits of ſome of them are of the parabolic kind, in which caſe, after they diſappear, they are never more ſeen, as they muſt, according to the laws of gravitation, proceed on to eternity through open ſpace, without returning to perform a revolution.

The comets move round the ſun in all manner of directions, and cut the plane of the earth's orbit in all ſorts of angles, ſome of them proceeding the ſame way as the planets, and others the contrary way.

Plate III. *Fig.* 1. is a repreſentation of the ſolar ſyſtem. The fixed ſtars do not belong to this ſyſtem; but, it is probable, are as ſo many ſuns to other ſyſtems. The diſtance of the neareſt of them is aſtoniſhingly great; for let the earth be in what part of its orbit ſoever, they ſtill appear to be in the ſame places; and therefore a globe, whoſe diameter is equal to the earth's orbit, if viewed from a fixed ſtar, at the diſtance of the earth, would appear as a point.

The characters of the Sun and Planets are as follow: the Sun, ☉; Mercury, ☿; Venus, ♀; the Earth, ⊕; Mars, ♂; Jupiter, ♃; Saturn, ♄; and the Moon, ☾.

Other Syſtems of the Univerſe, as I have before obſerved, have been propoſed at different times, as

THE PTOLEMAIC SYSTEM, which ſuppoſes the earth at reſt in the centre of the world, and the planets moving round him in circles; as firſt the Moon, then Mercury, next Venus; then the Sun, and above him Mars; then Jupiter; and next Saturn; and laſtly the ſphere of the fixed ſtars; the planets and ſtars being all ſuppoſed to move round the earth in the ſpace of 24 hours.

THE TYCHONIC SYSTEM ſuppoſes the earth abſolutely at reſt; that the moon and ſun revolve about the earth, the moon in a month, and the ſun in a year; and that the reſt of the planets, Mercury, Venus, Mars, Jupiter, and Saturn, revolve round the ſun, the three laſt encompaſſing the earth. Moreover both the planets and ſtars are all ſuppoſed to have a diurnal motion round the earth.

THE SEMI-TYCHONIC SYSTEM ſuppoſes the planets to revolve round the ſun, while the ſun and moon revolve round the earth as their centre of motion, and it ſuppoſes the earth to move about its axis from Weſt to Eaſt in 24 hours. This differs from the *Tychonic Syſtem* only in this, that it ſuppoſes a diurnal motion of the earth, though. like the *Tychonic*, it denies an annual one.

But none of theſe latter mentioned ſyſtems can account for all the phœnomena, and therefore are juſtly exploded; while, on the other hand, the ſyſtem which I have firſt deſcribed, will ſolve every appearance in nature; and its truth is demonſtrable with mathematical certainty.

SECT. III.

AN EXPLANATION OF THE RISING AND SETTING OF THE SUN, MOON, AND STARS; THE CAUSE OF DAY AND NIGHT, &c.

THE phœnomena of the apparent motion of the ſun, occaſioned by the real diurnal motion of the earth, is explained thus. See Plate III. *fig.* 2.

Let FGHI be the earth; O, its centre; and let it revolve about an axis perpendicular to the plane of the figure, in the orde IFGH, that is, from Weſt to Eaſt.

Let A be the ſun; draw AFOHG and GOI perpendicular to it; alſo ſuppoſe a ſpectator placed at I; then ſince A is at an immenſe diſtance, a ray of light iſſuing therefrom will nearly reach the point I; or, which is the ſame, a line drawn from A as a tangent to the earth's ſurface will nearly touch the earth in the point I, and therefore the ſun at A will be riſing in the horizon at I. As the earth moves round, the ſpectator is carried towards F, and the ſun at A ſeems to riſe gradually higher, till the ſpectator is arrived at F, when the ſun is at the higheſt. When the ſpectator comes towards G, the ſun appears to deſcend, as if it moved towards D; and when the ſpectator is arrived at G, then the ſun appears in the tangent or horizon at G, and therefore the ſun is then ſetting. While the ſpectator is moved through GHI, the ſun is inviſible, being under the horizon, till the ſpectator arrives at I, when it ſeems to riſe again.

Now, it is evident, that while that part of the earth on which the ſpectator is ſituate, is illuminated, that it is day-light; and whilſt he is carried through the dark hemiſphere, GHI, it is night; the points F and H, being noon and midnight. And thus the viciſſitude of day and night appears by the rotation of the earth round its axis.

What

What has been ſaid of the ſun, is equally true of the moon; or any ſtar placed at A; and therefore all the celeſtial bodies ſeem to riſe and ſet by turns, one after another, according to their various ſituations. For let A, B, C, D, be four ſtars; when the ſpectator is at I, the ſtar A riſes, and when at G, it ſets; when at F, the ſtar B riſes, and when at H, it ſets; And when the ſpectator is at G, the ſtar C riſes, and when at I, it ſets; alſo when the ſpectator comes to H, D riſes, and when at F, it ſets. And thus for others, according to their particular poſitions.

The Earth's Diurnal Motion may be proved thus:

It is clear that either the earth muſt move round its axis once in 24 hours, or elſe the heavens, with all their furniture, muſt revolve round the earth in the ſame time.

Now if any body revolve round another as its centre, it is evident, from the laws of motion and the doctrine of centripetal forces, that the central body muſt always be in the plane in which the revolving body moves, let the curve deſcribed be what it may. Wherefore, if the ſun move round the earth in a day, the earth muſt be in a plane deſcribed by the ſun in a day: but this does not happen, except on two days of the year, viz. at the equinoxes, for at all other times the ſun is vertical to, and apparently moves round, parallel circles, which have not the earth for their centre; conſequently the ſun in ſuch caſe can no more be ſaid to revolve about the earth, than a body moving round the baſe of a cone can be ſaid to revolve about the vertex. On the other hand, allowing the earth's diurnal and annual motion, the ſun is always in the plane of the earth's orbit, which is agreeable to the laws of nature, and is obſerved by the other planets and by all the ſatellites. Wherefore the diurnal motion belongs to the earth, and not to the ſun.

SECT. IV.

AN EXPLANATION OF THE DIFFERENT SEASONS OF THE YEAR, WITH THE REASON OF THE LENGTHENING AND SHORTENING OF DAYS, &c.

See Plate III. Fig. 3.

The orbit of the earth extended to the heavens is called the ecliptic, and is divided by Aſtronomers into 12 equal parts, called ſigns, as will be afterwards more fully explained. Now this orbit is ſo ſmall in reſpect to the diſtance of the fixed ſtars, that the ſame aſpect of the heavens will appear whether a ſpectator is placed on the earth or on the ſun. Therefore, if the earth be at ♈, a ſpectator will ſee the ſun in ♎, and when the earth comes to ♉ he will ſee the ſun ♏, and the ſun will appear to have moved through ♎ ♏. Again, whilſt the earth is moving to ♊, the ſun will ſeem to paſs through ♏ ♐; and, hence, a perſon on the earth obſerves the ſun to go through the ſame ſpace in the heavens as the earth would appear to go through to a ſpectator at the ſun. And becauſe a ſpectator at the earth is not ſenſible of the earth's motion, he aſcribes that motion to the ſun which in reality belongs to the earth.

Let NEAQ be the earth, and let NA be its axis: N, the north pole; A the ſouth pole, and EQ the equinoctial. Alſo let PR be a parallel of latitude, paſſing through any place; and let a plane G♈I be drawn perpendicular to ♑♋, dividing the illuminated hemiſphere from the dark one. Now the axis NA is inclined to the plane of the ecliptic, or earth's orbit, in an angle of about 66°½; and during the earth's motion in its orbit the axis always remains in a parallel poſition, or pointing to the ſame ſtar. Moreover the earth moves uniformly round its axis, and therefore deſcribes equal diurnal arcs in equal times. Now let the earth be at ♎, then the circle dividing the light and dark hemiſpheres paſſes through the poles N and A; and conſequently by the nature of the ſphere, divides all the parallels, as PR into two equal parts, and therefore any point in that parallel will ſtay as long in the light as in the dark hemiſphere; that is, the days and nights will be equal. Then, as it moves to ♏, the pole N, comes into the light hemiſphere, by reaſon of the oblique poſition and parallel motion of the axis NA; and as it proceeds to ♐, and ♑ the light hemiſphere reaches gradually farther beyond N: till coming to ♑ it is at the fartheſt, reaching to G, and making the arc NG = 23°½, the compliment of N♑S, or 66°½; at which time the oppoſite pole A is far involved in the dark hemiſphere. Whence, in north latitudes, or in the hemiſphere ENQ, the days have been increaſing from ♎ to ♑, where they are at the longeſt, for the greater part of the parallel PDR; as PD is in the illuminated, and only the part DR in the dark hemiſphere; but in the oppoſite or ſouthern hemiſphere the days have been decreaſing, and are at their ſhorteſt at ♑, for all the parallels to EQ have their greater part in the dark hemiſphere.

If, through the point G, a parallel be deſcribed, this parallel is called the Arctic Circle; and all the ſpace contained therein is illuminated, and therefore there is no night there, whilſt the earth is at ♑; and, for the ſame reaſon, all the ſpace within the parallel drawn through I, will be dark; and, therefore, all will be night there. Likewiſe, if a parallel be drawn through B, where ♈♑ cuts the arc NE, that parallel is called the Tropic of Cancer, and the ſun will then ſhine perpendicularly upon the inhabitants of that parallel.

This is the ſummer ſeaſon to thoſe who are in the hemiſphere ENQ and winter to thoſe who live in EAQ; and ſince EQ is equally divided by the circle of light and darkneſs, GI; therefore the days and nights are always equal under the equinoctial.

Moreover, whilſt the earth moves through ♎, and ♓ to ♈, the circle of light and darkneſs comes gradually nearer to the pole N; and the angle N ♑ G, and conſequently that of B ♑ E, become leſs and leſs, till they vaniſh in ♈; when the circle of light and darkneſs paſſes again through the poles, N and A, and, therefore, biſects all the parallels, as PR; and, conſequently, the days and nights are again equal all over the earth.

Whilſt the earth moves through ♈, ♉, ♊, to ♋, the ſun will ſeem to go through ♍, ♏, ♐, to ♑; when the circle of light and darkneſs will fall ſhort, more and more, of the north pole, N; and will go further and further beyond the ſouth pole A, whence the parallels cut by that circle will have the greater part of the north hemiſphere, PD, in the dark; but, of the ſouthern hemiſphere, the greater part will be illuminated. Therefore it is winter to the northern hemiſphere, ENQ, the days being at ſhorteſt, but ſummer to the ſouthern hemiſphere, EAQ, the days there being at the longeſt.

Alſo, within the parallel drawn through G, there will be no day whilſt the earth is at ♋, and, in the parallel drawn through I, there will be no night. At the pole A it will be day for ſix months; and, at the pole N, it will be night for ſix months; being juſt the contrary of what happens when the earth is at ♑. In this poſition, if a parallel be drawn through B, the ſun will ſhine perpendicularly to the earth in that parallel, and it is called the Tropic of Capricorn; alſo a parallel drawn through I is called the Antarctic Circle.

Furthermore, let the earth move from ♋ through ♌ and ♍ to ♎ again, in which caſe it is evident that the circle of light and darkneſs draws gradually nearer to the poles N and A, by which the light and dark parts of the parallels become nearer to an equality, and ſo alſo do the days and nights. Therefore, in the north hemiſphere, ENQ, the days are increaſing; and, in the ſouth hemiſphere, they are decreaſing; and, when the earth arrives at ♎, the days and nights become equal in every place.

Thus it appears, that the different ſeaſons are occaſioned by the obliquity of the earth's axis of rotation to the plane of the earth's orbit; for, if that axis was perpendicular to the plane of the earth's orbit, there could be no variety of ſeaſons, or in the length of days, in whatever part of the orbit the earth was; for there would be a perpetual uniformity, and it would be difficult to determine the length of the year without obſervation of the ſtars.

SCHOLIUM. For the ſame reaſons the inhabitants of all the other planets will obſerve the like motions in the ſun, as we do from our earth. For example, an inhabitant of Jupiter would imagine that the ſun turns round him, making a revolution once in twelve years; and, to a ſpectator in Saturn, the ſun would appear to finiſh his period in thirty years.

Since, therefore, it is impoſſible that the ſun can have all theſe motions really in itſelf, and there can be no reaſon aſſigned why any one of them ſhould belong to the ſun more than the reſt, we may ſafely affirm, that there are none of them real, but apparent only, and ariſe from the real motions of the ſeveral planets.

The annual Motion of the Earth may be proved thus:

All obſervations teſtify, that either the earth turns round the ſun, or the ſun round the earth, in ſuch a manner, as that equal areas are deſcribed in equal times; and Sir Iſaac Newton has demonſtrated, that, when two bodies revolve round each other, according to ſuch law, the one muſt of neceſſity gravitate to the other; and, therefore, if the ſun in its motion does gravitate to the earth, action and re-action being equal and contrary, the earth muſt, likewiſe, gravitate to the ſun.

Alſo, Sir Iſaac has demonſtrated, that when two bodies gravitate to one another, without approaching each other in right lines, they muſt both of them turn round their common centre of gravity. The ſun and earth do therefore turn round their common centre of gravity. But the ſun is ſo great a body in reſpect of the earth, that the common centre of gravity of the earth and ſun lies within the body of the ſun, and not far from its centre. Wherefore, the earth turns round a point which is within the body of the ſun, and, conſequently, revolves round the ſun; and the ſun turns round a point within himſelf; which obſervations prove to be the caſe.

He has alſo demonſtrated, that if ſeveral bodies gravitate round another, the ſquares of their periodical times will be as the cubes of their mean diſtances from the centre of their orbits: and, by comparing the periods of the planets, with their diſtanc s from the ſun, as determined from the niceſt obſervations, we find them all in the moſt exact harmony to this law; whereas, on the contrary ſuppoſition, of the ſun and planets revolving round the earth, the whole is deſtitute of any order, being inharmonious, and full of confuſion; for, according to the ſaid law (which Sir Iſaac has demonſtrated, muſt neceſſarily, without any utter ſubverſion of the laws of nature, obtain in bodies revolving round another) if the ſun moved round the earth, the ſun, in order to harmonize with the motion of the moon, would be above 54700 years in performing one revolution, whereas its *apparent* revolution is but one year. Hence the abſurdity of ſuch a ſyſtem is manifeſt, and the proof of the contrary unanſwerably eſtabliſhed.

SECT.

SECT. V.

OF THE DIFFERENT PHASES OF THE MOON.

THAT the moon moves round the earth, has been already ſignified in the deſcription of the Solar Syſtem. Her revolution ſhe performs in about twenty-ſeven days and ſeven hours, during which ſhe puts on different phaſes or appearances: for the moon, like the earth, being a dark, opake body, and nearly ſpherical, and ſhining by the borrowed light of the ſun) we ſometimes ſee to increaſe and become bigger, and at length appearing with a full globular face, and afterwards, by a gradual diminution, become leſs, till ſhe loſes all her luſtre, and diſappears.

Alſo, ſometimes ſhe enlightens us the whole night, and at other times ſhe does not appear till late at night: ſometimes ſhe keeps in the ſouthern hemiſphere, and at other times ſhe riſes higher, and viſits the northern hemiſphere.

To illuſtrate her different phaſes as ſeen from the earth, ſee Plate III. *fig.* 4 and 5, where S repreſents the ſun, T the earth, RTS, a portion of the earth's orbit, which it deſcribes in the annual courſe round the ſun. Let ABCDEFG be the orbit of the moon, in which ſhe turns round the earth in the ſpace of a month from the weſt towards the eaſt.

This motion of the moon is evident to our ſenſes; for, if the moon be obſerved to arrive at the meridian any night with a fixed ſtar, the next night ſhe will be 52 minutes later in coming to the meridian, or in ſouthing, than the ſtar, ſhe having receded from the ſtar about 13 degrees towards the eaſt. Join the centres of the ſun and moon with the right line SL, and, through the centre of the moon, imagine a plane MNL to paſs, to which the line SL is perpendicular: the ſection of that plane with the ſurface of the moon, will produce the circle which bounds light and darkneſs in her, and ſeparates the enlightened face from the dark and obſcure ſide. In the ſame manner let the centres of the earth and moon be joined by the right line TL, which is perpendicular to a plane PLO, paſſing through the centre of the moon; that plane will make on the ſurface of the moon, the circle which diſtinguiſheth the viſible hemiſphere, or that which is towards us, from the inviſible, which is turned from us; which circle may therefore be termed the Circle of Viſion.

Hence it is manifeſt, that whenever the moon is in the poſition A, in the point of its orbit oppoſite to the ſun, that then the circle bounding light and darkneſs, and the circle of viſion, do coincide, and that all the illuminated face of the moon will be turned towards the earth, and be viſible by its inhabitants: and then the moon is ſaid to be full, and ſhe ſhines all night long; and in reſpect to the ſun, ſhe is ſaid to be in oppoſition: for the ſun and moon are ſeen in oppoſite parts of the heavens, the one riſing where the other ſets. When the moon comes to B, the whole illuminated diſk, MPN, is not turned towards the earth, there being a part of it, MP, not to be ſeen by us; and then the viſible illumination will be deficient from a circle, and the moon will have a gibbous or humped form, ſuch as is marked in B. The moon arriving at C, where the angle CTS is nearly right, there only one half of the illuminated diſk is turned towards the earth, and to be ſeen from thence; and then we obſerve a half moon, as in C, and ſhe is ſaid then to be biſected or diſchotomized, that is, cut in halves. In this ſituation, the ſun and moon are a fourth part of a circle removed from each other, and the moon is ſaid to be in a quadrate aſpect, or to be in a quadrature. The moon going forward to D, the illuminated face, MPN, has but a ſmall portion of itſelf turned towards the earth, and the ſide of the moon turned towards the earth is, for the greateſt part, in darkneſs: and therefore, of the ſpherical figure of the moon, which appears to us to be plain, that ſmall part which ſhines upon us, will ſeem to be bended into narrow points or angles, and will look like what we call horns; for there the circle, bounding light and darkneſs with the circle of viſion, doth form two ſmall angles at their interſections, and the phaſis ſeen from the earth will appear as in D. The moon at laſt coming to E, will ſhew no part of its illuminated face to the earth, but all the dark ſide of the moon will be turned towards it; and then the moon diſappears, and ſhe is ſaid to be in conjunction with the ſun, the ſun and ſhe being in the ſame point of the ecliptic. This poſition we call New Moon. When the moon advances further to F, ſhe again aſſumes an horned or crooked figure; and as before the New Moon the horns were turned weſtward, ſo now after the time of New Moon, they change their poſitions and look eaſtward. When the moon has proceeded to G, and is again in a quadrate aſpect with the ſun, ſhe will appear biſected, and like a half-moon. In H ſhe will be bigger, but will ſtill be deficient from a whole circle, and be ſeen gibbous: but in A ſhe will again appear circular, and in her full ſplendour.

The arch EL, or the angle STL, contained under lines drawn from the centres of the ſun and moon to the centre of the earth, is called the Elongation of the moon from the ſun. And the arc MO, which is that portion of the illuminated circle MON which is turned towards the earth, and which is the meaſure of the angle that the circle bounding light and darkneſs, and the circle of viſion make with one another, is every where nearly ſimilar to the arc of Elongation EL, or, which is the ſame thing, the angle STL is nearly equal to the angle MLO, which I thus demonſtrate. Produce SL at pleaſure unto X, and the angles TLP and MLS will be equal, they being both right angles: but the angles OLS and PLX are alſo equal, becauſe they are vertical to each other; therefore taking away thoſe equal angles, the angle MLO will remain equal to the angle TLX; but the angle TLX is the external angle of the triangle STL, and is therefore equal to both the inward and oppoſite angles STL and TSL, by the 32d Propoſition of Book I. of Euclid. But the angle TSL is exceeding ſmall, and next to nothing; for when biggeſt in the quadratures, it does ſcarce exceed ten minutes of a degree; the diſtance of the moon from the earth in compariſon of that of the ſun being ſo ſmall, that the angle which it ſubtends as the ſun vaniſhes. And therefore the angle STL by itſelf, is nearly equal to the angle MLO; whence the arc MO will be ſimilar, or like to the arc EL.

The ſemircle OMP, ſince its plane paſſes through the eye, will be projected into a right line, or appear like a right line on the diſk of the moon; but the circle bounding light and darkneſs in the moon, ſince it is ſeen obliquely from the earth, will be projected into an eclipſe, in which form it will appear.

As the moon by reflected light from the ſun illuminates the earth, ſo the earth does more than repay her kindneſs, in enlightening the ſurface of the moon.

In new moons, the illuſtrated ſide of the earth is fully turned towards the moon, and will therefore at that time illuminate the dark ſide of the moon; and then the Lunarians will have a full earth, as we in a ſimilar poſition have a full moon. And from thence ariſes the dim light which is obſerved in the old and new moons, whereby, beſides the bright and ſhining horns, we can perceive the reſt of her body behind them, though but dark and obſcure. Now when the moon comes to be in oppoſition to the ſun, the earth ſeen from the moon will appear in conjunction with him, and its dark ſide will be turned towards the moon, in which poſition the earth will diſappear, after the ſame manner as the moon does diſappear to us in the time of new moon, or in her conjunction with the ſun: in ſhort, the earth will ſhew all the ſame appearances to a ſpectator in the moon, as the moon does to us.

SECT. VI.

OF THE STATIONS AND RETROGRADATIONS OF THE PLANETS.

IF an obſerver was ſituate in the ſun, all the planets would appear to move in due order about him from weſt to eaſt; but to a ſpectator on the earth their motions appear very irregular; ſometimes they appear to move directly from weſt to eaſt, according to their true motions, at other times to loſe all their motion and become ſtationary; and by turns they ſeem to move backward, or become retrograde. The cauſe of theſe phœnomena will be manifeſt from what follows.

1ſt. With reſpect to the inferior planets ☿ and ♀.

Let ABC (Plate III. *fig.* 6.) repreſent an arc of the celeſtial ſphere; EOP, the earth's orbit; LNIG, the orbit of an inferior planet, as of ♀; and S, the ſun; let the earth at firſt be ſuppoſed to ſtand ſtill in its orbit at E: now, it is evident, that the ſun will appear at the point B, and the planet always within the arc AC. Whilſt the planet moves in its orbit from I through Q to N, it will ſeem to move from B to A agreeably to the order of the ſigns, viz. from weſt to eaſt, or as Aſtronomers term it in *conſequentia*: but paſſing from N to L, it will ſeem to an eye at E, to return back from A to B, or be retrograde.

While the planet is at or near the point N, being betwixt moving from B to A, and returning from A to B, and moving as it were in a right line towards the earth, it will for ſome time ſeem to ſtand ſtill near A, that is to be ſtationary. When the planet is in that part of her orbit, N or G, which is contiguous to the tangent EA or EC, ſhe will then appear at A or C, her greateſt diſtance from the ſun, and is ſaid to be in her greateſt ELONGATION. This elongation is meaſured by the angle SEG. The more diſtant a planet is from the ſun, the greater will its angle of elongation be; that of ♀ is about 48°, and of ☿ about 28°.

In the ſpace of a revolution, an inferior planet will, with reſpect to the earth, undergo two conjunctions, one which is beyond the ſun at I; the other when it is at L, between the ſun and the earth; the former is called the ſuperior, and the latter the inferior conjunction.

Whilſt ♀ goes from her ſuperior conjunction, ſhe appears in the arc AB, always to the eaſtward of the ſun, and therefore ſets ſome time after the ſun, and is called the Evening Star: but during the time ſhe is going from her inferior to her ſuperior conjunction, ſhe will be ſeen ſomewhere in the arc BC to the weſtward of the ſun, and ſo will ſet before him in the evening, and riſe before him in the morning; hence, ſhe is called the Morning Star.

Hitherto the planet has been ſuppoſed to move while the earth ſtood ſtill; but when both move, the phœnomena will be much the ſame, only the planet will be more direct in the fartheſt part of the orbit and leſs retrograde; the former ariſing from the ſum of their motions, and the latter from the difference.

2dly. With reſpect to the phœnomena of the ſuperior planets, viz. ♂, ♃, ♄, &c. the *direct*, *ſtationary*, and *retrograde* motions are

are explained much in the ſame manner as thoſe of the inferior planets, but with theſe differences.

1ſt. The retrograde motions of the ſuperior planets happen oftener, the ſlower their motions are; as the retrogradations of the inferior planets happen oftener, the ſwifter their angular motions are; becauſe the retrograde motions of the ſuperior planets depend upon the motions of the earth, but thoſe of the inferior on their own angular motions.

A ſuperior planet is retrograde once in each revolution of the earth; an inferior one, in every revolution of its own.

2d. The ſuperior planets do not always accompany the ſun, as the inferior do, but are often in oppoſition, which neceſſarily follows from the earth's orbit, being included within the orbits of the ſuperior planets.

SECT. VII.

METHODS OF DETERMINING BY OBSERVATION THE PERIODICAL TIMES OF THE EARTH AND PLANETS, TOGETHER WITH THE MAGNITUDES AND SITUATIONS OF THEIR RESPECTIVE ORBITS, THE PLACES OF THE STARS, &c.

DEFINITIONS.

I. THE ORBIT of a planet N is the curve line, which it deſcribes about the Sun, as ABPDA, Plate III. *fig.* 7. The orbit of the earth and all the planets are elipſes, having the ſun in one of the foci, as at S.

II. THE APSIDES are the two extreme points of the orbit, as A and P. The point A, which is the fartheſt from the ſun, is called the APHELION, or *higher apſis*; and the point P, which is the neareſt to the ſun, is named the PERIHELION, or *lower apſis*. Alſo the tranſverſe axis AP, is called the LINE OF APSIDES.

III. THE ECCENTRICITY is the diſtance of SC, from the focus to the centre.

IV. THE MEAN DISTANCE of a planet is the line SB, drawn from the focus S, to the end B or D of the conjugate axis BD. This line SB is equal to half the tranſverſe axis AC or CP.

THE PERIODICAL TIME, is the time of a planet's deſcribing its orbit, or of returning to the ſame point in its orbit.

V. THE NODES of any orbit are the points where its plane cuts the plane of the earth's orbit, ſuppoſing them both produced to the fixed ſtars, or the planets move in orbits whoſe planes are all different from that of the earth, and from one another. And the ſun being in all theſe planes, they conſequently cut one another in lines paſſing through the ſun.

If ECFD, Plate III. *fig.* 8. be the earth's orbit, and GCHD, the orbit of a planet cutting the earth's orbit in the line CD, then C and D are nodes; and CD the line of the nodes.

That node through which a planet paſſes towards the north pole, is called the ASCENDING NODE; and that through which it moves towards the ſouth pole, is named the DESCENDING NODE.

VII. THE INCLINATION OF A PLANET'S ORBIT is the angle which the plane of it makes with the earth's orbit or ecliptic, as EDG. This is meaſured by the arc of a circle EG, at a quadrant's diſtance from the nodes.

VIII. ELONGATION OF A PLANET, is the angle between the ſun and the planet, as taking at the earth; or angle between the ſun and place of a planet reduced to the ecliptic, of which I have ſpoken in Sect. VI.

IX. PARALLAX, is the difference between the real and apparent place of a planet, or the difference of its apparent places, as viewed from the earth's centre, and from ſome given point on its ſurface.

X. THE ANNUAL PARALLAX, or Parallax of the earth's orbit, is the difference between the places of a ſtar, as ſeen from oppoſite points of the earth's orbit.

XI. THE MOON'S APOGEE is that point in her orbit, which is fartheſt from the earth. This correſponds with the aphelion of a planet.

XII. THE MOON'S PERIGEE is that point in her orbit, which is the neareſt to the earth. This is the ſame as the perihelion of a planet.

XIII. THE MOON'S SYNODIC REVOLUTION, is the time that elapſes between her being in conjunction with the ſun, and her coming into conjunction with him again.

XIV. THE SYZIGES of the moon's orbit, are the points where a line drawn through the earth and ſun cuts it. Theſe are the points of conjunction and oppoſition.

XV. THE QUADRATURES are the points of the moon's orbit, which are at a quadrant's diſtance from the ſyziges; and the OCTANTS, are alike diſtant from the ſyziges and quadratures.

Theſe things premiſed, I proceed to the following Problems.

PROBLEM I. *To find the Latitude of a Place.* (See Sect. IX. Definition 43.)

With a good quadrant, or other proper inſtrument, take the altitude of the pole ſtar when it is at the higheſt, which is known by continuing your obſervations till it begins to deſcend. Alſo about 12 hours after, take its altitude when it is at the loweſt, then half the ſum of the two altitudes is the height of the pole or latitude required.

N. B. Inſtead of the pole ſtar, any other ſtar may be choſen that is out of the power of refraction.

Or thus: If the ſun's declination be known at that time, take his meridian altitude, which you may know by continuing the obſervation till he begins to deſcend. Then if the declination be towards the elevated pole, add it to the complement of the altitude; but if the declination be contrary, take the difference between the declination and the complement of the altitude, and the reſult in either caſe will be the latitude required.

PROBLEM II. *To draw a Meridian Line in any Place.*

See Plate III. *Fig.* 9.

Upon a plain board placed parallel to the horizon deſcribe a circle ABF; and on the centre C, erect a ſtile or gnomon perpendicular to it, and ſo high that the top of its ſhadow may fall upon the circumference of the circle, about the middle of the forenoon. Mark exactly the point B, where the top of the ſhadow falls in the forenoon. Likewiſe mark the point F, where the top of the ſhadow falls again on the circumference, in the middle of the afternoon. Then through the centre C, draw the line ACD biſecting the arc BF, ſo will AD be the meridian required.

SCHOLIUM. It will be proper to draw ſeveral concentric circles, and to make obſervations with them all, that they may confirm each other. It will alſo be beſt to make the obſervations at or near the time of the ſolſtices, when the ſun does not ſenſibly alter his declination; and the ſummer ſolſtice is to be preferred.

PROBLEM III. *To find the Obliquity of the Ecliptic.* See Sect. IX. Definition 21.

Take the ſun's meridian altitude at both ſolſtices; ſubtract the leſs from the greater, and take half the difference, and it will be the obliquity required. This is on the ſuppoſition that the ſun is on the ſame ſide of the zenith at both obſervations; but, if the reverſe is the caſe, add the complements of the two altitudes together, and half the ſum will be the obliquity of the ecliptic. If the obſervations are made when the ſun is low, regard muſt be had to refraction, and the altitude muſt be diminiſhed by a quantity equal to the refraction.

Or thus: If you have the latitude of the place, take the meridian altitude of the ſun at the ſummer ſolſtice, ſubtract its complement from the latitude, and the remainder will be the obliquity ſought.

SCHOLIUM. By comparing the obſervations of the ancients with thoſe of modern aſtronomers, it appears that the obliquity of the ecliptic has been continually decreaſing; and is now found to be ſcarce 23° : 28'.

PROB. IV. *To find the Time when the Sun is in the Equinoctial.*

Having the latitude of the place, and conſequently the height of the equator, (or co-latitude) by careful obſervation, take the ſun's meridian altitude on thoſe days when it is equal to the height of the equator, or nearly ſo.

If it ſhould happen to be exactly equal to the co-latitude, the ſun is at that inſtant in the equinoctial, or on the equator. But if it is greater or leſs than the co-latitude, you muſt obſerve till you get the meridian altitudes on two ſucceſſive days, one greater than it and the other leſs; then the time of its being in the equinox is evidently between the times of theſe obſervations. And to determine the time exactly, the 24 hours elapſed between one obſervation and the other muſt be divided in proportion to the exceſs and defect of the altitudes; taking the required time nearer to the noon of that day on which there was the leaſt difference between the altitude and co-latitude.

PROBLEM V. *To find the Length of the Year.*

Find by the laſt Problem the time of the ſun's being in the equinoctial, either at the vernal or autumnal equinox. Alſo find the time of his being in the ſame equinox, the year following. Then the intermediate time is the length of the year. This is called the *tropical year*, and is ſomething leſs than the Sidereal year, or the earth's periodical time, on account of the preceſſion of the equinoxes; or it will be more exact, if the time of the ſun's entering into the ſame equinox be taken at ſeveral years diſtance; for if the whole time between the obſervations be divided by the number of years, it will give the length of the tropical year exactly. By this means the length of the Tropical year is found to be 365 days, 5 hours, 48 minutes, 57 ſeconds.

In like manner the length of the Sidereal year is found by taking the time between the ſun's leaving any fixed ſtar, and returning to it again, after a great many years, and dividing it by the number of years; or it may be found by comparing the place of a fixed ſtar according as it was obſerved many years ſince with its preſent place; for the difference divided by the number of years, will give the annual preceſſion of the equinoxes, which reduced into time, and added to the *tropical year*, you will have the length of the Sidereal year. This preceſſion of the equinoxes is about

50 yearly, and therefore the Sidereal year is 365 days, 6 hours, 9 minutes, 14 ſeconds.

N. B. By obſervations it is found that the time from the vernal to the autumnal equinox is 186 days, 12 hours, 29 minutes, 30 ſeconds; and from the autumnal to the vernal equinox only 178 days, 17 hours, 19 minutes, 30 ſeconds, ſo that the ſummer half year exceeds the winter by 7 days, 19 hours and 10 minutes.

PROBLEM VI. *To find the Eccentricity of the Earth's Orbit and its Form.*

Make ſeveral obſervations of the ſun about the time when he is in the aphelion, and continue to take his apparent diameter, till you find it at the leaſt.

At half a year's diſtance, when he is about the perihelion, obſerve his apparent diameter till you find it at its greateſt; then through any point as B (Plate III. *fig.* 10.) draw a line PBA; and from B take BP to BA as the ſun's leaſt apparent to his greateſt apparent diameter, ſo will A and P be the aphelion and perihelion of its orbit. Alſo make BC and CF equal to half the difference between BA and BP; and F will be the other focus and C the centre. Then the ellipſis ABPD whoſe foci are B and F will be the form of the orbit; for the diſtance is reciprocally as the apparent diameter.

Or thus. Obſerve with a teleſcope and micrometer what the apparent motion of the ſun is when ſloweſt, and (half a year after) how much his apparent motion is when ſwifteſt. Take SA to SP as the ſquare root of the ſwifteſt motion to the ſquare root of the ſloweſt, ſo will A and P be the aphelion and perihelion; and the reſt will be found as before. By theſe methods the earth's eccentricity is found to be 168; ſuppoſing the mean diſtance, or half the tranſverſe axis to be 10000.

PROBLEM VII. *To find the Place of the Earth's Aphelion, or the Poſition of the Apſides, together with the Time when it is in the Aphelion.*

Obſerve two places of the ſun at a good diſtance from each other, and where the apparent motion is the ſame, or where the apparent magnitude is the ſame. Let theſe places be C and B (Plate III. *fig.* 11.) Biſect the arc BC by the line AF; ſo will A be the aphelion if the magnitude or motion was decreaſing towards A; otherwiſe it is the perihelion. Whence the place of the aphelion is had; and the poſition of the apſides AP. Alſo, if the times be noted when the earth is in C and B, then the mean time between them will be the time when the earth is in the aphelion A.

SCHOLIUM. If the difference between the place of the earth's aphelion ſeveral years paſt, and its preſent place, be divided by the number of years, the quotient will ſhew the annual motion of the aphelion, which is $1'\,0''\,37'''$ in a year.

Note alſo, the time of the earth's revolving from aphelion to aphelion is called the ANOMALISTIC YEAR; and according to Dr. Halley, is 365 days, 6 hours, 13 minutes, 32 ſeconds.

PROBLEM VIII. *To find the Declination of a Star.*

The obſerver being furniſhed with a large quadrant fixed in the plane of the meridian with an index moving round its centre, and teleſcopic ſights, he muſt wait the ſtar's coming upon the meridian, and take its meridian altitude. If the ſtar be towards the equinoctial, and on the North ſide of it, take the difference between the altitude, and colatitude of the place, and the remainder will be the declination North: But if the ſtar be on the South ſide of the equinoctial, then the remainder is the declination South.

Again, if the ſtar be towards the Pole, take the difference between its altitude and the latitude of the place, and it will be the complement of the ſtars declination, which will be North, or South, according as the ſtar and place ſhall be towards the North or South Pole.

PROBLEM IX. *To find the right Aſcenſion of a Star.*

Having a good time piece with minutes and ſeconds, let it be ſo adjuſted that the hand may go through the 24 hours in a Sidereal day, viz. in 23 hours, 56 minutes, 4 ſeconds; then obſerve when the ſun, or known ſtar, is in the meridian, and ſet the clock at that inſtant to the time of the ſun or ſtar's right aſcenſion, and obſerve alſo when the unknown ſtar comes to the meridian; and mark the time exactly, as ſhewn by the time piece, and it will be that ſtar's right aſcenſion in time, which may be reduced into degrees and minutes, by proportioning 15^{0} to 1 hour.

PROBLEM X. *To find the periodic Time of a Planet.*

The planet muſt be obſerved ſeveral times, till it be found to have no latitude, and is therefore in its node. Alſo it muſt be obſerved in like manner when it returns again into the ſame part of its orbit; then the time elapſed between its being in its node, and returning to the ſame again, is the periodic time of the planet. But it will be more exact if the planet be obſerved in its node, at the diſtance of ſeveral revolutions; for the elapſed time divided by the number of revolutions, will give the periodic time required; and the more the revolutions, the more exact will be the reſult.

PROBLEM XI. *To find the Nodes of a Planet's Orbit, and the Planet's Diſtance from the Sun at that Time.*

Let ABD (Plate III. *fig.* 12) be the earth's orbit; FNQ, that of a ſuperior planet; S the ſun; NSQ, the line of nodes.

Take two obſervations when the planet is in the node N; and let the places of the earth, at theſe times, (ſuppoſed to be given) be A and B. Then in the triangle ASB, there is given the ſides BS and AS, and the included $\angle$ASB, to find the ſide AB, and angles at A and B.

Alſo, the angles, SAN and NBS, being known by obſervation, we have the angles NAB and NBA.

Likewiſe, in the triangle ABN, there are given the angles and the ſide AB to find NA, the planet's place from the earth.

Laſtly, in the triangle NAS, we have the ſides NA and AS, with the angle NAS, to find NS, the diſtance of the planet from the ſun, when it is in the node at N, and the angle ASN, which determines the place of the node, and the poſition of the line of nodes, NSQ.

The calculation will be the ſame for an inferior planet, *mutatis mutandis*.

PROBLEM XII. *To find the Inclination of a Planet's Orbit.*

Let the orbit of the planet be PDQ, (Plate III. *fig.* 13) that of the earth, BEQ, and N*n*, the line of the nodes.

At the time when the earth is at Q, in the line of the nodes, obſerve accurately the longitude of the planet at P from the ſun, or the angle OQS, and alſo its latitude PQO. Then it will be as the ſine of the angle SQO: radius:: tangent of latitude, PQO: tangent of the inclination of the orbit. For PO being perpendicular to the plane of the ecliptic, and PQ and OQ being drawn, as alſo OB, perpendicular to N*n*, the angle BPO will be the inclination of the orbit. Now, in the right angled triangles, QPO and BPO, we have, OB: ſine OQB:: QO: radius:: PO: tangent PQO. And alternately, As ſine OQB: tangent PQO:: OB: PO:: radius: tangent PBO.

PROBLEM XIII. *To find a Planet's Orbit, Place of Aphelion, and the Time of its being in its Perihelion.*

Let *n*PN, in the foregoing figure, be the planet's orbit; AEQ, the earth's; S, the ſun; and N*n*, the line of nodes.

Alſo, (the earth's motion in its orbit, and the inclination of the planet's orbit, being ſuppoſed to be known) let the planet be at P in oppoſition to the ſun, the earth being at E. Then draw PO perpendicular to the ecliptic; likewiſe draw SEO; O being the planet's place reduced to the ecliptic. Obſerve the quantity of the angle PEO, the planet's latitude ſeen from the earth.

Then, ſince the ſun's place is known, the planet's place, being oppoſite to it, is known; and, conſequently, its diſtance from the node O*n*, is alſo known. Therefore, in the ſpherical triangle, *n*PO, the ſide O*n*, and the angle O*n*P are known; and hence the ſide P*n* will be known, as alſo PO, which is the meaſure of the angle PSO, the latitude of the planet ſeen from the ſun.

Likewiſe, SE is known, being the earth's diſtance from the ſun. Therefore, in the triangle PSE, having all the angles and the ſide SE, the planet's diſtance, SP, from the ſun, becomes known. Conſequently, we have the planet's place in its own orbit.

And, by taking in this manner two more obſervations of the ſame planet, in a poſition oppoſite the ſun, we ſhall have two more places, D and G, of the planet's orbit.

Hence we have the magnitude and poſition of three lines, SP, SD, and SG, drawn from the focus of an ellipſis; and, conſequently, the curve may be deſcribed, which will be the orbit of the planet, and from thence every requiſite may be determined.

The application of this method is confined to the ſuperior planets.

The following Method is applicable to an inferior Planet.

Let GHI be the earth's orbit, (Plate III. *fig.* 14) APE, the planet's orbit; S, the ſun; and DSN, the line of the nodes. Let the planet be at P whilſt the earth is in any place T. Draw PB perpendicular to the plane of the ecliptic, and TB to meet the line of the nodes in N. Alſo, draw SB and TC parallel to BP, and make TD perpendicular to DN, and join CD, then the $\angle$ TDC is the inclination of the orbit. Therefore, the $\angle$BTP, the planet's latitude at the earth, and the $\angle$BTS, its diſtance from the ſun in the ecliptic, being obſerved, there are given in the triangle NTS, ST, the ſide or diſtance of the earth and ſun; the $\angle$TSN, or the earth's diſtance from the node; and the $\angle$NTS, or BTS, to find NT; and, in the right-angled triangle, TSD, we have TS, and $\angle$TSD, to find TD. Alſo, in the right-angled triangle, TDE, we have TD and $\angle$TDC, to find TC; and, in the right angled triangle, TCN, there are TC and NT to find $\angle$TNC.

Likewiſe, in the triangle NTP, we have the $\angle$NTP or BTP, and PNT or CNT, together with the ſide NT, to find TP; and, in the right-angled triangle, PTB, we have TP, and $\angle$PTB, to find BT and BP.

Furthermore, in the triangle TSB there will be given TB and TS, and $\angle$BTS, to find SB and $\angle$TSB, which is the place of the planet, reduced to the ecliptic: then in the right angled triangle PBS, there are had the ſides PB and BS, to find SP, the planet's diſtance from the ſun, and $\angle$PSB, the planet's latitude ſeen from the ſun.

Again, in the right-angled ſpherical triangle, APB, we have PB and $\angle$PAB, to find AB and AP. Conſequently, the planet's place in his orbit is known, and alſo his diſtance from the ſun.

And

And, if by this method two more places of the planet are found, and its diſtance from the ſun, there will be three lines drawn from the focus of an ellipſis given in magnitude and poſition, to deſcribe the ellipſis, (for the performance of which, ſee CONIC SECTIONS) which ellipſis will be a juſt deſcription of the planet's orbit.

PROBLEM XIV. *To find the greateſt Elongation of an inferior Planet.*

Let ABD (Plate III. *fig.* 14) be the orbit of the planet; E, a point in the earth's orbit, and S, the ſun. Then, from the point E, draw the line EB to touch the orbit, ABD, of the inferior planet, and the angle SEB will be the planets greateſt elongation. Draw, therefore, SB to the point of contact B, and it will be perpendicular to the tangent EB: whence, in the right angled triangle EBS, there are given ES and SB, the diſtances of the earth and planet from the ſun, to find the angle SEB, the elongation.

But, to do this experimentally, the greateſt elongation, SEB, muſt be repeatedly taken by an inſtrument when it is about the extremity of its orbit, and the greateſt angle contained between the ſun and planet, is that ſought.

But, in elliptical orbits, the ſame ſhould be repeated ſeveral times, when the earth and planets are in different parts of their orbits, and the greateſt obſerved angle is the elongation required.

PROBLEM XV. *To find the Parallax of a Planet.*

Let AD (Plate III. *fig.* 15) be the earth; C, its centre; P, the planet; and let the planet's diſtance, CP, from the centre of the earth, be given. Then the angle ZAP is the complement of the apparent altitude, and ZCP, the complement of the true altitude. And it will be, as CP: earth's radius AC :: ſine ∠ZAP: ſine ∠CPA = the parallax.

Or thus: If the diſtances of two planets or ſtars, having the ſame apparent altitude, and alſo the parallax of one of them be known, and if P and G be the planets in the line APG, then ∠APC is the parallax of P, and ∠AGC the parallax of G. Hence, in the triangle, CPG, there are had, CP, CG, and an angle oppoſite, (as G) to find the other oppoſite angle. Conſequently, as diſtance CP: diſtance CG :: ſine ∠CGP: ſine ∠CPG: or CPA: that is, the ſines of the parallaxes are reciprocally as the diſtances from the earth's centre.

COR. I. The parallaxes of two planets, are as the coſines of the apparent altitudes directly, and their diſtances from the earth's centre reciprocally.

COR. II. The horizontal parallax of one body ſeen from another, is equal to the apparent ſemi-diameter of that other ſeen from the firſt.

PROBLEM XVI. *Having the Parallax of a Planet, and its Poſition in reſpect to the Ecliptic and Circles of Longitude, &c. to find the Parallax of Latitude and Longitude; or the Parallax of Right Aſcenſion and declination.*

Let HO (Plate III. *fig.* 16) be the horizon; EC, the ecliptic; Z, the zenith; P, the pole of EC; S, the apparent place of a planet; ZSB, a vertical circle drawn through the planet; A, the true place of the planet; PAL and PSI, circles of longitude. Draw AD parallel to EC; then AS is the parallax of altitude, SD, the parallax of latitude, and LI the parallax of longitude; L being the true place of the planet reduced to the ecliptic, and I the apparent place. Therefore, having AS and ∠ASD in the ſmall right angled triangle ASD, the parallax of latitude, SD, will be had, and the ſide AD.

Wherefore in the triangles PAD and PLI, it will be as ſine PD: radius :: AD: LI, the parallax of longitude.

Alſo, whether it is to be added to, or ſubtracted from the longitude at L, will eaſily appear, by the poſition of the circles EC, ZB, and PL.

But if EC be the equinoctial, and P its pole, then SD will be the parallax of declination, and LI the parallax of right aſcenſion.

COR. I. If the circles PS and ZS coincide, SD will be equal to AS, and AD = 0. That is, the Parallax of longitude or right aſcenſion is nothing, and the parallax of latitude or declination is equal to the parallax of altitude.

COR. II. If the circles EC and ZS coincide, then AS = LI, and SD = 0. That is, the parallax of longitude or right aſcenſion (as the caſe is) is equal to the parallax of altitude: and the parallax of latitude or declination is nothing.

PROBLEM XVII. *To find the Moon's Periodical Time, Orbit, and Parallax.*

I. The moon's periodic time is known by obſerving the diſtance of time between her conjunction with any fixed ſtar, and her next returning to the ſame ſtar again. But this being different at different times, it will be proper to take the time between her conjunction with any known ſtar, as obſerved ſeveral years ſince, and her preſent conjunction with the ſame ſtar, and divide it by the number of her revolutions within that period, and it will give her mean periodic time, which is 27 days, 7 hours, 43 minutes, 12 ſeconds, being ſomething more than the time of her return to the ſame point of the ecliptic, which is 27d. 7h. 43m. 5″.

II. The time of the moon's ſynodic revolution, or the time of her revolving from conjunction to conjunction with the ſun, is found in the ſame manner by two obſervations, made at a conſiderable diſtance of time from each other, and has been determined at 29d. 12h. 44m. 3″.

III. To find the parallax, proceed as in Problem XV. or as follows:

In an eclipſe of the moon, obſerve when the horns of the moon are in the ſame verticle circle, and at that moment take the altitude of both the horns: then half the ſum is the apparent altitude of the moon's centre.

Now the place of the ſun in the ecliptic is known, and conſequently the place of the centre of the earth's ſhadow, which is oppoſite to it, is alſo known; and the altitude of the moon, at that time, is equal to the altitude of the centre of the ſhadow, becauſe they are both in a line parallel to the horizon. Hence find the altitude of that point of the ecliptic in which the centre of the ſhadow is, from which ſubtract the apparent altitude of the moon, and the remainder is her parallax; and thus her mean horizontal parallax is found to be about 57′ 12″.

IV. To find her diſtance. Let AD (Plate III. *fig.* 17,) be the earth, whoſe centre is C, and A the place of obſervation; and let F be the place of the moon. Find her parallax, as above directed, and her apparent diameter; then in the triangle AFC, we have the angle F, or parallax, and the angle CAF, (the ſupplement of ZAF) her apparent zenith diſtance, to find her apparent diſtance AF.

Now if G be another place of the moon whoſe diſtance is ſought, then the moon's apparent diameter at G muſt be obſerved, and her altitude BAG; and it will be as her apparent diameter at G: her apparent diameter at F :: AF: AG.

Now in the triangle CAG, having the ſides AG, AC, and CAG, (= right-angle CAB + altitude BAG) the ſide CG will be found, on her mean diſtance from the earth's centre = 60.3 of the earth's radius at her mean diſtance.

V. *To find the tranſverſe Axis of her Orbit and Eccentricity.*

Find her diſtance from the earth's centre by a great number of obſervations, continued through her period (as in Art. IV.) Out of theſe ſelect the greateſt and leaſt, and the ſum of them is the greater axis of her orbit; and half the difference is the eccentricity. After this manner it is found, that the moon's mean eccentricity is about 55 of ſuch parts as her mean diſtance contains 1000.

VI. *To find the Place of the Moon's Apogee.*

Obſerve two places of the moon when ſhe has the ſame apparent diameter, and the ſame altitude; biſect that arc to find the intermediate place, for the apſis of her orbit paſſes through it, and conſequently the poſition of the apſis is known. Alſo, that point where the apparent diameter is the leaſt, is the apogee; and, by comparing two ſucceſſive revolutions, the motion of the apogee will be known. Or it may be more exactly determined by dividing the whole ſpace gone through in a long time by the number of revolutions.

By this method it has been found that the apogee makes a revolution, *in conſequentia* to the ſame point of the ecliptic in 8 years, 309 days, 8 hours, 20 minutes.

VII. To find the place of her nodes; obſerve the latitude of the moon ſeveral times, till you find it to be nothing, allowing for the parallax, and that is the place of her node. If the moon be advancing northward, it is the aſcending node; but if ſouthward, it is the deſcending node.

The motion of the moon's nodes may be found by comparing their places at a diſtant period with the preſent time. By obſervation it is found, that the motion of the nodes is retrograde, and makes a revolution to the ſame point of the ecliptic in about 18 years, 224 days, 5 hours.

VIII. To find the inclination of the moon's orbit; obſerve her latitude ſeveral times when ſhe is near a quadrant from her node, and the greateſt latitude is the inclination of her orbit, allowing for the parallax. By obſervation it is found, that the inclination of her orbit is different at different times, but never leſs than 5°, nor greater than 5° 18′.

PROBLEM XVIII. *To find the Refraction of a Star.*

The earth being ſurrounded by a body of air, named the atmoſphere, through which the rays of light paſs to the eye from all the celeſtial bodies; and theſe rays paſſing through a vacuum, and falling obliquely upon the atmoſphere, they will, by the laws of optics, be refracted in lines approaching nearer to the perpendicular of the refracting ſurface.

Therefore let AD (Plate III. *fig.* 18) be the earth ſurrounded by the atmoſphere, PQR; and let F be a ſtar, whoſe rays paſs through the atmoſphere QA, to the obſerver at A.

Now, ſince the atmoſphere is denſer near the earth, and becomes rarer by degrees as the height encreaſes, therefore, at the top, Q, the refraction is but ſmall; but the nearer a ray approaches the earth, the air being denſer, it will be more refracted, and gradually bent into a curve, QA. By this means the ſtar comes to the eye in the direction GA, which is a tangent to the curve at A; and ſo the ſtar, inſtead of being ſeen at F, where it really is, appears to be at G, ſituated in the line AG.

And ſince the refraction is made in a plane which is perpendicular to the ſurface of the atmoſphere, or to the ſurface of the earth, and which conſequently paſſes through the centre of the earth, therefore, both the true and apparent place, F and G, are in the ſame verticle circle, whoſe plane paſſes through A, the place of the obſerver, and the centre of the earth C.

It is evident alſo, that the refraction will be the ſame at all

diſtances

diſtances from the earth, when the latitude is the ſame, for from whatever part of the line FQ the rays proceed, they will be refracted along the curve QA to A.

Likewiſe we know from the principles of optics, that if a ray of light paſs through ſeveral refracting mediums it will only ſuffer the ſame refraction as if it paſſed immediately out of the firſt into the laſt. Now it has been confirmed by experiments, that light falling upon a medium of air of a mean denſity, and at a very ſmall angle in inclination, will make the refracted angle about 33″. Now to find the refraction at any other altitude, it will by the laws of dioptrics be as radius : coſine 33′ : : coſine of the true altitude of a ſtar : coſine of the apparent altitude by refraction. Then the true altitude, ſubtracted from the apparent altitude, leaves the refracted angle, which is the refraction of the ſtar.

N. B. The refraction will vary a little, as the denſity of the air either increaſes or decreaſes.

To find the refraction by obſervation, take the altitude of a fixed ſtar when it is at the loweſt point under the pole; and again at about 12 hours diſtance, take its altitude when it is at its higheſt, and clear of refraction, or nearly ſo. Then having the latitude of the place, you will find the diſtance of the ſtar from the pole at each obſervation, and by taking the leſs diſtance from the greater, you will have the refraction of the ſtar at the leſs altitude.

In this obſervation a ſtar ſhould be choſen which comes near the zenith, either northward or ſouthward, and ſo its refraction at the greateſt altitude will be inſenſible. If, however, you ſuſpect that it has ſome ſmall refraction when it is at the higheſt, it may be determined thus. As tangent of greater zenith diſtance; tangent of leſs zenith diſtance, : : the refraction at the lower altitude : the refraction at the higher. The lower refraction muſt be corrected, by ſubtracting this from it; and the remainder will be the proper refraction, provided the lower altitude is not leſs than 8° or 10°.

The refraction at 10° altitude is about 5′, and in the horizon from 30′ to 37′.

Note, Refraction makes an object appear higher than it really is, but parallax makes it appear lower. And hence on account of the variableneſs of refraction, it comes to paſs that the top of a mountain may, perhaps, be ſeen in the morning or at night, and be inviſible at noon in the ſame place. Alſo if a teleſcope be placed in a fixed horizontal poſition a whole day, it will ſometimes happen that the ſights will preſent you with the lower part of a tower at one hour of the day, and with the higher part thereof at another hour of the day.

PROBLEM XIX. *To determine the Sun's Parallax and Diſtance.*

This is done by finding firſt the parallax of ſome of the planets, which being known, the ſun's parallax will become known, for the parallaxes of two celeſtial bodies are reciprocally as their diſtances; and the proportional diſtances of the planets from the ſun and from one another are known, and therefore the parallax of one being determined, the parallaxes of the reſt may be determined alſo.

For this purpoſe the planet Mars, when in oppoſition to the ſun, will be the fitteſt to be made uſe of, becauſe at that time he comes neareſt the earth, and his parallax is then the greateſt. The parallax of Mars will be determined by Problem XV.

Mr. Flamſtead found the parallax of Mars leſs than 30″, and thence determines the ſun's parallax not to be above 10″.

PROBLEM XX. *To find the Diſtance of the fixed Stars.*

See Plate III. *Fig.* 19.

Chooſe two ſtars S and D as near together as may be, or if poſſible in one line AST, obſerving alſo to have one a large ſtar and the other a very ſmall one, and that the difference between the longitude of the ſtars, and that of the earth or ſun, be about a quadrant or 90°. Now let ADB be the earth's orbit, and let the earth be ſuppoſed at A, then being furniſhed with as good a teleſcope as can be had, for otherwiſe the attempt will be in vain, obſerve diligently the ſtars S and T, in or near the line AST, and take their diſtance (if it is determinable that they have any) as near as poſſible. And at the diſtance of about half a year, when the earth is in the oppoſite point of its orbit, obſerve the ſame ſtars again, with the ſame inſtrument, which then will appear further diſtant from each other, and will be ſeen under the angle SBT, which muſt be accurately taken. But if you can obſerve no difference between this angle and that of the former obſervation, then the earth has no ſenſible parallax, and therefore no certain concluſions can be drawn.

If a difference can be aſcertained between the angle at A (if any) and the angle at B, that difference will be nearly equal to the parallax of the annual orbit ADB, or ∠ ASB, and hence the ratio of AB to AS will be known.

If the ſtars S and T are taken near the pole of the ecliptic, then in order to find what alteration appears in the two ſtars; obſervations may be made in any two oppoſite points of the ecliptic, or in as many places as ſhall appear requiſite.

If the ſtars are not very different in magnitude, the angles at B and T may be eſtimated by the diſtances BS and ST, and theſe alſo will be expounded by the magnitude of the ſtars. However, theſe angles are ſo exceeding ſmall, that they can ſcarcely be aſcertained by any inſtrument whatever, and hence the aſtoniſhing diſtance of the neareſt fixed ſtars is evident; for if any fixed ſtar, when viewed through a teleſcope that magnifies 100 times, ſhould appear under an angle of half a minute, the true apparent diameter would not exceed 18 thirds, which is leſs than the 6000th part of the ſun's apparent diameter, and therefore ſuppoſing ſuch ſtar to be of the ſame magnitude as the ſun, its diſtance muſt be at leaſt 6000 times more than that of the ſun.

For the following accurate method of determining the parallax of the fixed ſtars, we are beholden to that excellent aſtronomer Dr. Herſchel.

The doctor firſt premiſes, that the fixed ſtars, one with another, may well be ſuppoſed to be of a magnitude nearly equal to that of the ſun; and ſecondly, that the difference of their apparent magnitudes is owing to their different diſtances; ſo that the ſtar of the ſecond, third, or fourth magnitude, is two, three, or four times as far off as one of the firſt. Theſe principles, which he premiſes as poſtulata, have ſo great a probability in their favour, that they will hardly be objected to by thoſe who are in the leaſt acquainted with the doctrine of chances. Accordingly, let OE, Plate III. *fig.* 20, be the whole diameter of the earth's annual orbit, and let *a*, *b*, *c*, be three ſtars ſituated in the ecliptic, in ſuch a manner that they may be ſeen all in one line O *a*, *b*, *c*, when the earth is at O. Let the line O *a b c*, be perpendicular to OE, and draw PE parallel to *c*O: then, if O *a*, *a b*, *b c*, are equal to each other, *a* will be a ſtar of the firſt magnitude, *b* of the ſecond, and *c* of the third. Let us now ſuppoſe the angle O *a* E, or parallax of the whole orbit of the earth, to be 1″ of a degree; then we have PE *a* = O *a* E = 1″: and becauſe very ſmall angles having the ſame ſubtenſe O E may be taken to be in the inverſe ratio of the lines O *a*, O *b*, O *c*, &c. we ſhall have O *b* E = $\frac{1}{2}$″, O *c* E = $\frac{1}{3}$″, &c. Now when the earth is removed to E, we ſhall have P E *b* = E *b c* = $\frac{1}{2}$″, and P E *a* − P E *b* = *a* E *b* = $\frac{1}{2}$″: i. e. the ſtars, *a*, *b*, will appear to be $\frac{1}{2}$″, diſtant. We alſo have P E *c* = E *c* O = $\frac{1}{3}$″, and P E *a* − P E *c* = *a* E *c* = $\frac{2}{3}$″; i. e. the ſtars *a*, *c*, will appear to be $\frac{2}{3}$″ diſtant when the earth is at E. Now ſince we have *b* E P = $\frac{1}{2}$″, and *c* E P = $\frac{1}{3}$″, therefore *b* E P − *c* E P = *b* E *c* = $\frac{1}{2}$″ − $\frac{1}{3}$″, = $\frac{1}{6}$″; i. e. the ſtars *b*, *c*, will appear to be only $\frac{1}{6}$″ removed from each other when the earth is at E. Whence we may deduce the following expreſſion, to denote the parallax that will become viſible in the change of diſtance between the two ſtars, by the removal of the earth from one extreme of its orbit to the other. Let P expreſs the total parallax of a fixed ſtar of the firſt magnitude, M the magnitude of the largeſt of the two ſtars, *m* the magnitude of the ſmalleſt, and *p* the partial parallel to be obſerved by the change in the diſtance of a double ſtar; then will $p = \frac{m - M}{M\,m} P$; and *p*, being found by obſervation, will give us $P = \frac{p\,M\,m}{m - M}$

E. G. Suppoſe a ſtar of the firſt magnitude ſhould have a ſmall ſtar of the twelfth magnitude near it; then will the partial parallax we are to expect to ſee be $\frac{12 \times 1P}{12 - 1}$ or $\frac{1}{11}$ of the total parallax of a fixed ſtar of the firſt magnitude; and if we ſhould, by obſervation, find a partial parallax between two ſuch ſtars to amount to 1″, we ſhall have the total parallax $P = \frac{1 \times 1 \times 12}{12 - 1}$ = 1″.0909. If the ſtars are of the third and twenty fourth magnitude, the partial parallax will be $\frac{24-3}{3 \times 24} = \frac{21}{72}$ P; and if, by obſervation, *p* is found to be a tenth of a ſecond, the whole parallax will come out $\frac{1 \times 3 \times 24}{24-3}$ = 0″.3428.

Farther, ſuppoſe the ſtars being ſtill in the ecliptic, to appear in one line, when the earth is in any other part of its orbit between O and E; then will the parallax ſtill be expreſſed by the ſame algebraic formula, and one of the maxima will ſtill lie at O, the other at E; but the whole effect will be divided into two parts, which will be in proportion to each other as radius − ſine to radius + ſine of the ſtars diſtance from the neareſt conjunction or oppoſition.

When the ſtars are any where out of the ecliptic, ſituated ſo as to appear in one line O *a b c*, perpendicular to O E, the maximum of parallax will ſtill be expreſſed by $\frac{m-M}{Mm} P$; but there will ariſe another additional parallax in the conjunction and oppoſition, which will be to that which is found 90° before or after the ſun, as the ſine (S) of the latitude of the ſtars ſeen at O is to the radius (R); and the effect of this parallax will be divided into two parts; half of it lying on one ſide of the large ſtar, the other half on the other ſide of it. This latter parallax, moreover, will be compounded with the former, ſo that the diſtance of the ſtars in the conjunction and oppoſition will then be repreſented by the diagonal of a parallelogram, whereof the two ſemiparallaxes are the ſides; a general expreſſion for which will be $\sqrt{\left(\frac{m-M}{2\,m}P\right)^2 \times \frac{SS}{RR} + 1}$; for the ſtars will apparently deſcribe two ellipſes in the heavens, whoſe tranſverſe axis will be to each other in the ratio of M to *m*

ſt.

(*fig.* 21), and A *a*, B *b*, C *c*, D *d*, will be the cotemporary ſituations. Now, if *b* Q be drawn parallel to A C, and the parallelogram *b q* B Q be completed, we ſhall have *b* Q = ½ C A − ½ *c a* = ½ C *c* = ½ *p*, or ſemiparallax to 90° before or after the ſun, and B *b* may be reſolved into, or is compounded of *b* Q and *b q*; but *b q* = ½ B D − ½ *b d* = the ſemiparallax in the conjunction or oppoſition. We alſo have R : S :: *b* Q : $bq = \frac{p\,S}{2R}$; therefore the diſtance B *b* (or D *d*) = $\sqrt{\left(\frac{p}{2}\right)^2 + \left(\frac{p\,S}{2R}\right)^2}$; and by ſubſtituting the value of *p* into this expreſſion, we obtain $\sqrt{\left(\frac{m-M}{2\,M\,m}\,P\right)^2 \times \frac{SS}{RR} + 1}$, as above. When the ſtars are in the pole of the ecliptic, *b q* will become equal to *b* Q, and B *b* will be 7071 P $\frac{m-M}{M\,m}$. Again, let the ſtars be at ſome diſtance, *e. g.* 5″ from each other, and let them both be in the ecliptic. This caſe is reſolvable into the firſt; for imagine the ſtar *a* (*fig.* 22.) to ſtand at *x*, and in that ſituation the ſtars *x*, *b*, *c*, will be in one line, and their parallax expreſſed by $\frac{m-M}{M\,m}$ P. But the angle *a* E *x* may be taken to equal *a* O *x*; and as the foregoing formula gives us the angles *x* E *b*, *x* E *c*, we are to add *a* E *x* or 5′ to *x* E *b*, and we ſhall have *a* E *b*. In general, let the diſtance of the ſtars be *d*, and let the obſerved diſtance at E be D, then will D = *d* + *p*, and the whole parallax of the annual orbit will be expreſſed by $\frac{D\,M\,m - d\,M\,m}{M - m}$ = P.

Suppoſe the two ſtars now to differ only in latitude, one being in the ecliptic, the other, *e. g.* 5′ north, when ſeen at O. This caſe may alſo be reſolved by the former; for imagine the ſtars, *b*, *c*, (*fig.* 23) to be elevated at right angles above the plane of the figure, ſo that *a* O *b*, or *a* O *c*, may make an angle of 5″ at O; then, inſtead of the lines O *a b c*, E *a*, E *b*, E *c*, E P, imagine them all to be planes at right angles to the figure; and it will appear that the parallax of the ſtars in longitude muſt be the ſame as if the ſmall ſtar had been without latitude. And ſince the ſtars *b*, *c*, by the motion of the earth from O to E, will not change their latitude, we ſhall have the following conſtruction for finding the diſtance of the ſtars, *a b*, *a c*, at E, and from thence the parallax P. Let the triangle *a b* β (*fig.* 24.) repreſent the ſituation of the ſtars; *a b* is the ſubtenſe of 5′, the angle under which they are ſuppoſed to be ſeen at O. The quantity *b* β by the former theorem is found, $\frac{m-M}{M\,m}$ P, which is the partial parallax that would have been ſeen by the earth's moving from O to E, if both ſtars had been in the ecliptic; but on account of the difference in latitude, it will be now repreſented by *a*β, the hypotheneuſe of the triangle a *b* β: therefore, in general, putting *a b* = *d*, and *a* β = D, we have $\sqrt{\frac{DD - dd}{m - M} \times m} = P.$ Hence D being taken by obſervation, and *d*, M, and *m*, given, we obtain the total parallax.

If the ſituation of the ſtars differs in longitude as well as latitude, we may reſolve this caſe by the following method. Let the triangle *ab*β (*fig.* 25.) repreſent the ſituation of the ſtars, *ab* = *d* being their diſtance ſeen at O, *ab*β = D, their diſtance ſeen at E. That the change *b*β which is produced by the earth's motion will be truly expreſſed by $\frac{m-M}{M\,m}$ P may be proved as before, by ſuppoſing the ſtar *a* to have been placed at α. Now let the angle of poſition *b a* α be taken by a micrometer, or by any other method ſufficiently exact; then, by ſolving the triangle *ab*α, we ſhall have the longitudinal and latitudinal differences *a* α and *b* α of the two ſtars. Put *a* α = *x*, *ba* = *y*, and it will be $x + \frac{m-M}{M\,m}\,P = a\,q$, whence D = $\sqrt{\left(x + \frac{m-M}{M\,m}\,P\right)^2 + y\,y}$; and $\sqrt{\frac{D^2 - y^2 \times M^2\,m - x\,M\,m}{m - M}} = P.$

If neither of the ſtars ſhould be in the ecliptic, nor have the ſame longitude or latitude, the laſt theorem will ſtill ſerve to calculate the total parallax whoſe maximum will lie in E. There will moreover, ariſe another parallax, whoſe maximum will be in the conjunction and oppoſition, which will be divided, and lie on different ſides of the large ſtar; but as we know the whole parallax to be exceedingly ſmall, it will not be neceſſary to inveſtigate every particular caſe of this kind; for by reaſon of the diviſion of the parallax, which renders obſervations taken at any other time, except where it is greateſt, very unfavourable, the formulæ would be of little uſe.

SECT. VIII.

A MORE PARTICULAR DESCRIPTION OF THE PLANETS, &c.

MERCURY is a ſmall ſtar, but emits a very bright white light; though on account of his keeping always near the ſun he is ſeldom to be ſeen, and when he does appear, his motion towards the ſun is ſo very ſwift, that he can only be diſcerned for a ſhort time. He appears a little after ſun-ſet; and again a little before ſun-riſe.

When this planet is viewed through a good teleſcope he appears equally luminous throughout his whole ſurface. He has different phaſes like the moon, being ſometimes horned, ſometimes gibbous, and ſometimes ſhining almoſt with a round face, though not entirely full, becauſe his enlightened ſide is never turned directly towards us; however, at all times he appears bright and well defined, and without a ragged edge.

The diameter of Mercury is computed at about .367 of the Earth's diameter, and its mean diſtance from the ſun at about .3871 of the earth's diſtance from him; alſo at a mean rate it makes a revolution through its orbit, to the ſame point of the ecliptic, in 87 days, 23 hours, 14 minutes 34 ſeconds; the inclination of its orbit to the plane of the ecliptic, is 6° 59′ 20″; but the inclination of the axis of Mercury to the axis of the ecliptic is not determined.

Its apparent diameter at a mean diſtance from the earth is 20″, which is about 1″ leſs than it would appear if ſeen from the ſun, the place of its deſcending node at the beginning of the preſent year, 1789 (according to Dr. Halley's tables) is 16° 1′ 30″ in ♉; and of its aphelion 14° 1′ 24″ ♐. The nodes of this planet move forward 50″ per year, and the place of the aphelion moves in like manner 52″ 34‴ per year.

Alſo ſuppoſing the ſemi-tranſverſe diameter of its orbit to be 1, its eccentricity is .20589.

Of Venus.

VENUS is the moſt beautiful ſtar in the firmament, and is known by the names of the morning and evening ſtar; ſhe likewiſe keeps near the ſun, though ſhe recedes from him almoſt double the diſtance of Mercury. She is never ſeen in the eaſtern quarter of the heavens, when the ſun is in the weſtern; but always ſeems to attend him in the evening, or to give notice of his approach in the morning. This planet alſo has the like phaſes as the moon.

Some aſtronomers have thought that they have ſeen a ſatellite moving round Venus, particularly Mr. Montaigne on the 3d and 11th of May 1761, who from the obſervations that he made, concluded that its ſynodic revolution was about 12 days. But nothing further has been diſcovered to confirm this matter: and it is generally thought that Mr. Montaigne was miſtaken.

Mr. Dunn of Cheſea, and other gentlemen in obſerving the tranſit of Venus in A. D. 1761, ſaw a penumbra or ſmall diminution of light, which grew darker and darker for the ſpace of about 5 ſeconds before the internal contact preceding the egreſs; and from thence Mr. Dunn concluded, that Venus is ſurrounded with an atmoſphere of about 50 Geographical miles high.

The diameter of Venus is eſtimated at 1.0275 of the earth's diameter, and its mean diſtance from the ſun at .72333 of the earth's diſtance from the ſun; alſo it turns round its axis in 23 hours and 20 minutes, and makes a revolution in its orbit to the ſame point of the ecliptic in 224 days, 16 hours 41 minutes, 30 ſeconds. The inclination of its axis to the axis of the ecliptic is about 75° and its orbit to the plane of the ecliptic 2° 23′ 5″.

Its apparent diameter at a mean diſtance from the earth is 1′ 20″, and as viewed from the ſun at a mean diſtance 30″. Alſo the eccentricity of its orbit is .0069813 parts of its ſemi-tranſverſe axis.

The place of its node from the equinox, at the commencement of the year (1789) 14° 43′ 52″ ♊, and of its aphelion 7° 55′ 15″ ♋. The nodes move forward 31″ per year.

Of the Earth.

The Earth, or planet which we inhabit, is about 7940 miles in diameter, and at a mean rate, about 81 millions of miles diſtance from the ſun. It performs a revolution through its orbit to the ſame point of the ecliptic in 365 days, 5 hours, 48 minutes, 57 ſeconds, and revolves round its axis in 23 hours, 56 minutes, 4 ſeconds.

Sir Iſaac Newton, from philoſophical principles, demonſtrated that the figure of the Earth could not be that of a perfect ſphere, but that its equitorial diameter is to its diameter from pole to pole as 230 to 229, which has likewiſe been confirmed by experiments.

The eccentricity of the Earth's orbit is .0168 parts of the ſemi-tranſverſe axis, and the inclination of its axis to the plane of its orbit is 23° 28′. Its apparent diameter, as ſeen from the ſun, is about 21″, and the place of its aphelion, at the commencement of the preſent year, (according to Dr. Halley) is ♈ 9′ 8″ 9‴, which moves forwards 1° 23′ 20″ in 100 years.

Of the Moon.

The Earth has one Satellite, namely, the Moon, revolving in an orbit at the diſtance of about 60 of the earth's ſemi-diameters. The diameter of the Moon to that of the earth is as .274 to 1.

The Moon performs a revolution to the ſame point of the ecliptic in 27 days, 7 hours, 43 minutes, 5 ſeconds: in which time alſo ſhe makes a rotation round her axis, the time of her ſynodic revolution, or the mean period between New Moon and New Moon, is 29 days, 12 hours, 44 minutes, 3 ſeconds, the apparent diameter of the Moon at a mean diſtance from the earth, is 31′ 16½″, and is viewed from the ſun at a mean diſtance 6″.

The inclination of her axis to the axis of the ecliptic is about 2° 10′, and of her orbit to the ecliptic, from 5° to 5° 18′; the mean eccentricity of her orbit is .055, the greateſt .0667, and the leaſt .0433 parts of the ſemi-tranſverſe axis.

The greateſt equation of the Moon's apogee is 12° 18′, and of her node, 1° 29′ 40″. Her mean horizontal parallax is 57′ 5″, and the ratio of the moon's parallax to her diameter, is as 107 to 99.

That there are many inequalities in the Moon's ſurface, is allowed by all; ſome of which, it is ſuppoſed, are deep cavities, and others prominences or mountains.

Many aſtronomers have attempted to aſcertain the heights of the lunar mountains, but their concluſions have differed ſo much from each other, as muſt prevent any reliance on what they have done. The method, however, purſued by Dr. Herſchel in this buſineſs, is by far the moſt ſcientific and mathematical, and, allowing the caſe to be poſſible, it bids the faireſt to come at truth.

His method ſuppoſes the obſervations to be made when the Moon is not in her quadratures, and is as follows: (ſee Plate III. *fig.* 26.)

"Let SLM, ſays he, or *slm*, be a line drawn from the ſun to the mountain, touching the moon at L or *l*, and the mountain at M or *m*. Then, to an obſerver at E or *e*, the lines L M, *l m*, will not appear of the ſame length, though the mountains ſhould be of an equal height; for L M will be projected into *o n*, and *l m* into O N. But theſe are the quantities that are taken by the micrometer when we obſerve a mountain to project from the line of illumination.

From the obſerved quantity *o n*, when the Moon is not in her quadrature, to find L M, we have the following analogy:

The triangles *o* O L, *r* M L, are ſimilar; therefore, L *o* : L O :: L *r* : L M, or $\frac{LO \times on}{L\,o} = LM$: but LO is the radius of the Moon, and L *r* or *o n* is the obſerved diſtance of the mountain's projection; and L *o* is the ſine of the angle ROL = *o* LS; which we may take to be the diſtance of the ſun from the moon without any material error, and which therefore we may find at any given time from an ephemeris.

"The teleſcope uſed in theſe obſervations was a Newtonian reflector, of ſix feet eight inches focal length, to which a micrometer was adapted, conſiſting of two parallel hairs, one of which was moveable by means of a fine ſcrew. The value of the parts ſhewn by the index was determined by a trigonometrical obſervation of a known object at a known diſtance, and was verified by ſeveral trials. The power was always 222, excepting where another is expreſsly mentioned; and this was alſo determined by experiment, which frequently differs from theory on account of ſome ſmall errors in the data, hardly to be avoided. The moon having ſufficient light, an aperture of no more than four inches was made uſe of; and, ſays Dr. Herſchell, I believe, that, for diſtinctneſs of viſion, this inſtrument is perhaps equal to any that ever was made."

With this inſtrument he obſerved a prominence, which he calls a rock, ſituated near the Lacus Niger of Hevelius, and found that it projected 41″.56″. To reduce this into miles, put R for the ſemidiameter of the moon in ſeconds, as given by the nautical almanack at the time of obſervation, and Q for the obſerved quantity, alſo in ſeconds and centeſimals; then it will be in general, R : 1090 (the moon's ſemidiameter in miles) : : Q : $\frac{1090\,Q}{R} = o\,n$ in miles. Thus it is found, that 41.56″ is 46.79 miles. The diſtance of the ſun from the moon at that time was, by the nautical almanack, about 93° 57½′; the ſine of which to the radius 1 is .9985, &c. $\frac{o\,n}{L\,o}$ in this caſe is LM = 46.85 miles.

Then, $\sqrt{46.85^2 + 1090^2} = 1091$ miles = OM; and 1091 − 1090 = 1 mile = MP, the height of the mountain.

As the moon has on its ſurface mountains and vallies, in common with the earth, ſome modern aſtronomers have diſcovered a ſtill greater ſimilarity, viz. that ſome of theſe are volcanoes, emitting fire as thoſe on earth do.

Dr. Herſchell has particularly obſerved ſeveral irruptions of the lunar volcanoes, the laſt of which he gives an account of in the philoſophical tranſactions for 1787.

"April 19, 10h. 36′ ſidereal time. I perceive (ſays he) three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwiſe in a ſtate of going to break out; which perhaps may be decided next lunation. The third ſhews an actual eruption of fire or luminous matter. I meaſured the diſtance of the crater from the northern limb of the moon, and found it 3′ 57·3″; its light is much brighter than the nucleus of the comet which M. Mechain diſcovered at Paris the 10th of this month.

"April 20, 10h. 2′, ſidereal time. The volcano burns with greater violence than laſt night. Its diameter cannot be leſs than 3″, by comparing it with that of the Georgian planet: as Jupiter was near at hand, I turned the teleſcope to his third ſatellite, and eſtimated the diameter of the burning part of the volcano to be equal to at leaſt twice that of the ſatellite; whence we may compute, that the ſhining or burning matter muſt be above three miles in diameter. It is of an irregular round figure, and very ſharply defined on the edges. The other two volcanoes are much farther towards the centre of the moon, and reſemble large, pretty faint nebulæ, that are gradually much brighter in the middle; but no well-defined luminous ſpot can be diſcerned in them. Theſe three ſpots are plainly to be diſtinguiſhed from the reſt of the marks upon the moon; for the reflection of the ſun's rays from the earth is, in its preſent ſituation, ſufficiently bright, with a ten feet reflector to ſhew the moon's ſpots, even the darkeſt of them; nor did I perceive any ſimilar phœnomena laſt lunation, though I then viewed the ſame places with the ſame inſtrument.

"The appearance of what I have called the actual fire, or eruption of a volcano, exactly reſembled a ſmall piece of burning charcoal when it is covered by a very thin coat of white aſhes, which frequently adhere to it when it has been ſome time ignited; and it had a degree of brightneſs about as ſtrong as that with which ſuch a coal would be ſeen to glow in faint daylight.

"All the adjacent parts of the volcanic mountain ſeemed to be faintly illuminated by the irruption, and were gradually more obſcure as they lay at a greater diſtance from the crater. This eruption reſembled much that which I ſaw on the 4th of May, in the year 1783, but differed conſiderably in magnitude and brightneſs; for the volcano of the year 1783, though much brighter than that which is now burning, was not nearly ſo large in the dimenſions of its eruption: the former ſeen in the teleſcope reſembled a ſtar of the fourth magnitude, as it appears to the naked eye; this, on the contrary, ſhews a viſible diſk of luminous matter, very different from the ſparkling brightneſs of ſtar-light."

Of Mars.

Mars is of a red fiery colour, and always gives a much duller light than Venus, though ſometimes he equals her in ſize. He is not ſubject to the ſame limitations in his motions as Mercury or Venus, but appears ſometimes very near the ſun, and at other times at a great diſtance from him.

The diameter of Mars is to that of the earth as .5229 to 1, and its mean diſtance from the ſun is 152369 of ſuch parts as the diſtance of the earth from the ſun contain 100000; and the eccentricity of its orbit is .09263936 parts of the ſemidiameter. Its apparent diameter, as viewed at a mean diſtance from the earth, in 30″, and as ſeen from the ſun 12. It makes a rotation round its axis in about 24 hours, 40 minutes, and performs a revolution through its orbit to the ſame point of the ecliptic in one common year, 321 days, 22 hours, 18 minutes, 19 ſeconds; alſo its ſynodic revolution, or time of returning to the ſame fixed ſtar, is 1 year, 321 days, 23 hours, 29 minutes and 2 ſeconds.

The inclination of the axis of Mars, with reſpect to its own orbit, is about 61° 18″; and conſequently the obliquity of the ecliptics is 28° 42″; the place of the node of the axis is in 19° 28′ ♓: alſo the inclination of its orbit to the ecliptic is 1° 51″; the place of its aphelion ♍ 1° 18″, and of its node ♉ 21° 4″. Its aphelion moves forward 1° 56′ 40″, in 100 years, and its node 1° 3′ 20″. in 100 years.

From the beſt obſervations the form of Mars is that of a ſpheriod, its equatorial diameter being to its polar diameter in the proportion of about 131 to 127; and there is little doubt but the forms of all the planets are ſpheroids, at leaſt if they may be all ſuppoſed to revolve round their axis, as a motion of that kind cannot be thought to fail of producing ſuch effects: for it was on this principle that Sir Iſaac Newton determined the figure of the earth, and the ratio of equatorial and polar diameters, which has ſince been confirmed by actual menſuration.

It has been commonly related by aſtronomers, that the atmoſphere of this planet is poſſeſſed of ſuch ſtrong refractive powers, as to render the ſmall fixed ſtars near which it paſſes, inviſible. Dr. Smith relates an obſervation of Caſſini, where a ſtar in the water of Aquarius, at the diſtance of ſix minutes from the diſk of Mars, became ſo faint before its occultation, that it could not be ſeen by the naked eye, nor with a three feet teleſcope. This would indicate an atmoſphere of very extraordinary ſize and denſity; but the obſervations of Dr. Herſchel ſhew, that it is of much ſmaller dimenſions: however, after relating what obſervations he has made, he concludes, "that this planet is not without a conſiderable atmoſphere; for, beſides the permanent ſpots on its ſurface, he has often noticed occaſional changes of partial bright belts, and alſo, once a darkiſh one in a pretty high latitude; and theſe alterations can hardly be aſcribed to any other cauſe than the variable diſpoſition of clouds and vapours floating in the atmoſphere of the planet."

Of Jupiter.

Jupiter often appears at a great diſtance from the ſun, and ſhines with a bright white light, and has the ſame general appearance with Mars, only that the belts on his ſurface are much larger, and more permanent; but they are not to be obſerved without an excellent teleſcope. Fontana and two other Italians are ſaid to be the firſt who diſcovered them; but Caſſini was the firſt who gave any tolerable account of them.

Their number is very variable, as ſometimes only one, and at others no fewer than eight may be perceived. They are generally parallel to one another, but not always ſo; and their breadth is likewiſe variable, one belt having been obſerved to grow narrow, while another in its neighbourhood has increaſed in breadth, as if the one had flowed into the other.

The

The time of their continuance is very uncertain, ſometimes remaining unchanged for three months; at others, new belts have been formed in an hour or two. In ſome of theſe belts large black ſpots have appeared, which moved ſwiftly over the diſk from eaſt to weſt, and returned in a ſhort time to the ſame place; from whence the rotation of this planet about its axis has been determined.

The time of its rotation is about 9 h. 56 min. and it makes a revolution in its orbit to the ſame point of the ecliptic in 11 years, 313 days, 8 hours, 35 minutes, 4 ſeconds; and the time of its ſynodic revolution is 4332 days, 12 hours, 20 min. 9 ſeconds.

Its apparent diameter, as ſeen at a mean diſtance from the earth, is 39", and as viewed from the ſun 37": its real diameter is 9 1468 of the earth's diameter. The denſity of this planet is to that of the earth as .23625 to 1. The proportion of light and heat on its ſurface, to that on the earth, is as .0369 to 1, and the ratio of its polar and equatorial diameters are as 12 to 13. The eccentricity of its orbit is .0482192 parts of its ſemi-tranverſe axis; its mean diſtance from the ſun 520096 of ſuch parts, as the earth's diſtance contains 100000.

The place of its aphelion at the commencement of the preſent year was ♋ 11° 20′ 36″, and of its node ♋ 8° 48′ 20″. Alſo, its aphelion moves forwards 2° in 100 years, and its node moves 1° 21′ 20″ in 100 years.

The inclination of the axis of Jupiter to the ecliptic is undetermined, but the inclination of his orbit to that of the ecliptic is 2° 33½′. It is, however, ſaid, that the plane of his equator is nearly coincident with that of his orbit; and if ſo, there can be very little difference of ſeaſons on Jupiter's ſurface.

Of Jupiter's Satellites.

The moſt remarkable circumſtance attending Jupiter, is his having four moons, which conſtantly revolve round him at different diſtances. Theſe are all ſuppoſed to move in ellipſis; though the eccentricities of all of them are too ſmall to be meaſured, excepting that of the fourth; and even this amounts to no more than 0.007 of its mean diſtance from the primary. The orbits of theſe ſecondary planets were thought by Galileo to be in the ſame plane with that of their primary; but Mr. Caſſini found that their orbits make a ſmall angle with it; and that their nodes are nearly in the ſame plane.

The firſt of theſe ſatellites revolves at the diſtance of 5.697 of Jupiter's ſemidiameters, or 1′ 51″ as meaſured by proper inſtruments; its periodical time is 1d. 18h 27′ 34″. The next ſatellite revolves at the diſtance of 9.017 ſemidiameters, or 2′ 56″, in 3d. 13h. 13′ 42″; the third at the diſtance of 14.384 ſemidiameters, or 4′ 42″, in 7 d. 3 h. 42′ 36″; and the fourth at the diſtance of 25 266, or 8′ 16″, in 16 d. 16 h. 32′ 09″.

When a ſatellite is in its ſuperior ſemicircle, or that half of its orbit which is more diſtant from the earth than Jupiter is, its motion appears to us direct, according to the order of the ſigns; but in its inferior ſemicircle, when it is nearer to us than Jupiter, its motion appears retrograde; and both theſe motions ſeem quicker the nearer the ſatellites are to the centre of the primary, ſlower the more diſtant they are, and at the greateſt diſtance of all they appear for a ſhort time to be ſtationary.

From this account of the ſyſtem of Jupiter and his ſatellites, it is evident, that occultations of them muſt frequently happen by their going behind their primary, or by coming in betwixt us and it. The former takes place when they proceed towards the middle of their upper ſemicircle; the latter, when they paſs through the ſame part of their inferior ſemicircle. Occultations of the former kind happen to the firſt and ſecond ſatellite; at every revolution, the third very rarely eſcapes an occultation, but the fourth more frequently by reaſon of its greater diſtance. It is ſeldom that a ſatellite can be diſcovered upon the diſk of Jupiter, even by the beſt teleſcopes, excepting at its firſt entrance, when by reaſon of its being more directly illuminated by the rays of the ſun than the planet itſelf, it appears like a lucid ſpot upon it. Sometimes, however, a ſatellite in paſſing over the diſk, appears like a dark ſpot, and is eaſily to be diſtinguiſhed. This is ſuppoſed to be owing to ſpots on the body of the ſecondary planets; and it is remarkable, that the ſame ſatellite has been known to paſs over the diſk at one time as a dark ſpot, and at another ſo luminous that it could not be diſtinguiſhed from Jupiter himſelf, except at its coming on and going off. To account for this, we muſt ſay, that either the ſpots are ſubject to change; or if they be permanent, like thoſe of our moon, that the ſatellites at different times turn different parts of their globes towards us. Poſſibly both theſe cauſes may contribute to produce the phœnomena juſt mentioned.

When the ſatellites paſs through their inferior ſemicircles, they may caſt a ſhadow upon their primary, and thus cauſe an eclipſe of the ſun to his inhabitants if there are any; and in ſome ſituations this ſhadow may be obſerved going before or following the ſatellite. On the other hand, in paſſing through their ſuperior ſemicircles, the ſatellite may be eclipſed in the ſame manner as our moon by paſſing through the ſhadow of Jupiter: and this is actually the caſe with the firſt, ſecond, and third of theſe bodies; but the fourth, by reaſon of the largeneſs of its orbit, paſſes ſometimes above or below the ſhadow, as is the caſe with our moon. The beginnings and endings of theſe eclipſes are eaſily ſeen by a teleſcope, when the earth is in a proper ſituation with regard to Jupiter and the ſun; but when this or any other planet is in conjunction with the ſun, the ſuperior brightneſs of that luminary renders both it and the ſatellites inviſible. From the time of its firſt appearing after a conjunction until near the oppoſition, only the immerſions of the ſatellites into this ſhadow, or the beginnings of the eclipſes, are viſible; at the oppoſition, only the occultations of the ſatellites, by going behind or coming before their primary, are obſervable; and from the oppoſition to the conjunction, only the emerſions, or end of the eclipſes, are to be ſeen. This is exactly true in the firſt ſatellite, of which we can never ſee an immerſion with its immediately ſubſequent emerſion: and it is but rarely that they can be both ſeen in the ſecond; as in order to their being ſo, that ſatellite muſt be near one of its limits, at the ſame time that the planet is near his perihelion and quadrature with the ſun. With regard to the third, when Jupiter is more than 46 degrees from conjunction with, or oppoſition to, the ſun, both its immerſions and immediately ſubſequent emerſions are viſible; as they likewiſe are in the fourth, when the diſtance of Jupiter from conjunction or oppoſition is 24 degrees.

Of Saturn.

Saturn is alſo frequently ſeen at a great diſtance from the ſun, and ſhines with a pale faint light, and when viewed through a good teleſcope makes a more remarkable appearance than any of the other planets.

Galileo firſt diſcovered his uncommon ſhape, which he thought to be like two ſmall globes, one on each ſide of a large one: and he publiſhed his diſcovery in a Latin ſentence; the meaning of which was, that he had ſeen him appear with three bodies; though, in order to keep the diſcovery a ſecret, the letters were tranſpoſed. Having viewed him for two years, he was ſurpriſed to ſee him become quite round without theſe appendages, and then after ſome time to aſſume them as before. Theſe adjoining globes were what are now called the *anſæ* of his ring, the true ſhape of which was firſt diſcovered by Huygens about 40 years after Galileo. From the diſcoveries made by him and other aſtronomers, it appears that this planet is ſurrounded by a broad thin ring, the edge of which reflects little or none of the ſun's light to us, but the planes of the ring reflect the light in the ſame manner that the planet itſelf does; and if we ſuppoſe the diameter of Saturn to be divided into three equal parts, the diameter of the ring is about ſeven of theſe parts. The ring is detached from the body of Saturn in ſuch a manner, that the diſtance between the innermoſt part of the ring and the body is equal to its breadth. Being commonly viewed at an oblique angle, appears of an oval form, and through very good teleſcopes double, as repreſented Plate III. *Fig.* 27. Both the outward and inward rim is projected into an ellipſis, more or leſs oblong according to the different degrees of obliquity with which it is viewed. Sometimes our eye is in the plane of the ring, and then it becomes inviſible; either becauſe the outward edge is not fitted to reflect the ſun's light, or more probably becauſe it is too thin to be ſeen at ſuch a diſtance. As the plane of this ring keeps always parallel to itſelf, that is, its ſituation in one part of the orbit is always parallel to that in any other part, it diſappears twice in every revolution of the planet, that is, about once in 15 years; and he ſometimes appears quite round for nine months together. At other times, the diſtance betwixt the body of the planet and the ring is very perceptible.

When Saturn appears round, if our eye be in the plane of the ring, it will appear as a dark line acroſs the middle of the planet's diſk; and if our eye be elevated above the plane of the ring, a ſhadowy belt will be viſible, cauſed by the ſhadow of the ring, as well as by the interpoſition of part of it betwixt the eye and the planet. When it appears double, the ring next the body of the planet appears brighteſt. He has alſo two belts, diſcovered with very long teleſcopes, which appear parallel to that formed by the edge of the ring abovementioned; but theſe are rectilinear when the ring appears elliptic, and ſeem to be permanent. In 1683, however, Dom. Caſſini and Fatio perceived a bright ſtreak upon Saturn, which was not permanent like the dark belts, but was viſible one day, and diſappeared the next, when another came into view near the edge of his diſk. This induced Caſſini to ſuppoſe, that Saturn might have a rotation round his axis; but the diſtance of this planet is ſo great, that we can ſcarce hope to determine his revolution ſo accurately as that of the others.

The aſtronomer-royal, Dr. Maſkelyne, informs us, the phœnomena of diſappearance and re-appearance may be expected to take place as follows:

"May 2d, 1789, Saturn's ring will diſappear; the earth being about to paſs from its northern ſide, which is enlightened, to its ſouthern ſide, which is obſcure.

"Auguſt 27th, the earth having repaſſed to the northern or enlightened ſide, the ring will re-appear.

"October 8th, the ring will diſappear; its plane being near paſſing through the ſun, when it will change its enlightened ſide from the northern to the ſouthern one, conſequently the dark ſide will be then turned to the earth.

"January

"January 30th, 1790, the earth having paſſed from the northern or dark ſide of the ring, to the ſouthern or enlightened one, the ing will become viſible, to continue ſo until the year 1803.

The diameter of Saturn is to the earth's diameter as 7.2661 to 1; and its mean diſtance from the ſun 954006 of ſuch parts as the earth's diſtance contains 100000: alſo the eccentricity of its orbit is .05700322 parts of the ſemi-tranſverſe axis.

Its apparent diameter, as ſeen at a mean diſtance from the earth, is 16″, which is much about the ſame as when ſeen at a mean diſtance from the ſun. The time of its rotation round its axis is undetermined. But its periodical revolution to the ſame point of the ecliptic is 10750 days, 13 hours, 14 minutes, 42 ſeconds; and its ſynodic revolution 10759 days, 6 hours, 36 minutes.

The inclination of its orbit to the ecliptic is 2° 33′½; but the inclination of its axis to the ecliptic is not determined. The proportion of its light and heat to that of the earth is as .010987 to 1. The place of Saturn's aphelion at the commencement of the preſent year was ♑ 0° 31′ and of its node ♋ 21° 31′ 48″. The aphelion moves forward 2° 13′ 20″ in 100 years, and the node 0° 30′ in the ſame.

The Satellites of Saturn.

SATURN is ſtill better attended than Jupiter; having, beſides the ring before mentioned, no fewer than five moons continually circulating round him. The firſt at the diſtance of 2.097 ſemidiameters of his ring, and 4.893 of the planet itſelf, performs its revolution in 1d. 21 h. 18′ 22″; the ſecond at 2.686 ſemidiameters of the ring, and 6.268 of Saturn, revolves in 2 days, 17 hours, 41′ 22″; the third, at the diſtance of 8.754 ſemidiameters of Saturn, and 3.752 of the ring, in 4 days, 12 hours, 25′ 12″; the fourth, called the Huygenian Satellite, at 8.698 ſemidiameters of the ring, and 20.295 of Saturn, revolves in 15 d. 22 h. 4′ 12″; while the fifth, placed at the vaſt diſtance of 59.154 ſemidiameters of Saturn, or 25.348 of his ring, does not perform his revolution in leſs than 79 d. 7 h. 47′. The orbits of all theſe Satellites except the fifth, are nearly in the ſame plane, which makes an angle with the plane of Saturn's orbit of about 31°; and by reaſon of their being inclined at ſuch large angles, they cannot paſs either acroſs their primary or behind it with reſpect to the earth, except when very near their nodes; ſo that eclipſes of them happen much more ſeldom than of the ſatellites of Jupiter.

The New Planet, or Georgium Sidus.

The New Planet, called Georgium Sidus, was firſt obſerved by Dr. Herſchel on the 13th of March 1781, near the foot of Caſtor, and his attention was drawn by its ſteady light. On applying an high magnifying power to his teleſcope, it appeared manifeſtly to increaſe in diameter; and two days after, he obſerved that its place was changed. From theſe circumſtances he concluded, that it was a comet, and ſent an account of it as ſuch to the aſtronomer royal, which very ſoon ſpread all over Europe. It was not long however, before it was known, eſpecially by the Engliſh aſtronomers to be a planet. The circumſtances which led to this diſcovery were, its vicinity to the ecliptic, the direction of its motion, and its being nearly ſtationary at the time, in ſuch a manner as correſponds with the like appearances of the other planets. The French aſtronomers, however, ſtill imagine it to be a comet, although it had not that faint train of light which uſually accompanies theſe bodies, nor would its ſucceſſive appearances correſpond with ſuch an hypotheſis: ſo that they were at laſt obliged to own that it went round the ſun in an orbit nearly circular. Its motion was firſt computed on this principle by Mr. Lexel profeſſor of aſtronomy at St. Peterſburg; who ſhowed that a circular orbit, whoſe radius is about 19 times the diſtance of the earth from the ſun, would agree very well with all the obſervations which had been made during the year 1781. On the 1ſt of December that year it was in oppoſition with the ſun; whence one of its ſtations was certainly determined.

Before the end of the year 1782, it was found that the angular motion of the planet was increaſing; which ſhowed, that it was not moving in a circle, but in an eccentric orbit, and was approaching towards the ſun. Aſtronomers, therefore, began to inveſtigate the inequality of this angular heliocentric motion, in order to diſcover the form and poſition of the ellipſis deſcribed. This was a very difficult taſk, as the ſmall inequality of motion ſhewed that the orbit was nearly circular, and the arch already deſcribed was no more than one-fiftieth of the whole circumference.

From the obſervations made on this planet in the year 1781, M. De La Lande, calculated its courſe for 1782, and found its diſtance from the ſun, to be nineteen times greater than that of the earth, agreeable to the computation of Mr. Lexel. He alſo determined its magnitude to be about eighty-nine times greater than the earth, or its diameter to that of the earth to be as 4.454 to 1; and that it revolves round the ſun in an orbit, which is nearly circular, in about 82 years.

The inclination of its orbit is 43′ 35″, and its apparent diameter only about 4″; ſo that it can ſeldom be plainly ſeen by the naked eye, but may eaſily be diſcovered in a clear night when above the horizon, by a good teleſcope, its ſituation with reſpect to the fixed ſtars being previouſly known.

At the commencement of the preſent year, its heliocentric longitude was ♌ 2½°, and its heliocentric latitude about 36′, alſo its geocentric longitude was ♌ 4°, and its geocentric latitude 37′. The annual motion of its heliocentric longitude is about 4° 38′.

The light of this planet is of a bluiſh white colour, and its brilliancy between that of the Moon and Venus.

Whether it was attended by any ſatellites, was at firſt only a matter of conjecture, but Dr. Herſchel has ſince diſcovered two; and from the remote ſituation of the planet, it is probable there are ſeveral others. He has not ſeen them long enough to aſcertain their periodical times with great accuracy, but is led to ſuppoſe that the firſt performs its revolution in about 8¾ days, and the other 13¼ days nearly.

As a mark of reſpect to his preſent Majeſty, and to convey to poſterity an idea of the time and place of Diſcovery, Dr. Herſchel has diſtinguiſhed this planet by the name of Georgium Sidus.

His Majeſty has ſince taken Dr. Herſchel under his patronage, and granted him an annual ſalary.

Of the Sun.

The Sun, about which all the planets and comets move, though to human eyes ſo extremely bright and ſplendid, is yet frequently obſerved, even through a teleſcope of but very ſmall powers, to have dark ſpots on his ſurface.

There is great variety in the magnitude of the ſolar ſpots; the difference is chiefly in ſuperficial extent of length and breadth; their depth or thickneſs is very ſmall; ſome have been ſo large as, by computation, to be capable of covering the continents of Aſia and Africa; nay, the whole ſurface of the earth, or even five times the ſurface.

The diameter of a ſpot, when near the middle of the diſk, is meaſured by comparing the time it takes in paſſing over a croſs hair in a teleſcope, with the time wherein the whole diſk of the ſun paſſes over the ſame hair; it may alſo be meaſured by the micrometer; and by either of theſe methods we may judge how many times the diameter of the ſpot is contained in the diameter of the ſun. Spots are ſubject to increaſe and diminution of magnitude, and ſeldom continue in the ſame ſtate. They are of various ſhapes; moſt of them having a deep black nucleus ſurrounded by a duſky cloud, whereof the inner parts near the black are a little brighter than the outſkirts. They change their ſhapes ſomething in the manner that our clouds do; though not often ſo ſuddenly: thus, what is of a certain figure to-day, ſhall to-morrow, or perhaps in a few hours, be of a different one; what is now but one ſpot, ſhall in a little time be broken into two or three; and ſometimes two or three ſpots ſhall coaleſce, and be united in one.

Dr. Long, many years ſince, while he was viewing the image of the Sun through a teleſcope caſt upon white paper, ſaw one roundiſh ſpot, by eſtimation not much leſs than the diameter of our earth, break into two, which receded from one another with prodigious velocity.

From theſe Phœnomena it is evident, that the ſpots are not endowed with any permanency, nor are they at all regular in their ſhape, magnitude, number, or in the time of their appearance or continuance. Hevelius obſerved one that aroſe and vaniſhed in 16 or 17 hours; nor has any been obſerved to continue longer than 70 days, which was the duration of one in the year 1676: thoſe ſpots that are formed gradually, are gradually diſſolved; while thoſe that ariſe ſuddenly, are for the moſt part ſuddenly diſſolved. When a ſpot diſappears, that part where it was generally, becomes brighter than the reſt of the ſun, and continues ſo for ſeveral days; on the other hand, thoſe bright parts (called faculæ, as the others are called maculæ) ſometimes turn to ſpots.

The ſolar ſpots appear to have a motion which carries them acroſs the ſun's diſk. Every ſpot, if it continues long enough without being diſſolved, appears to enter the ſun's diſk on the eaſt ſide, to go from thence with a velocity continually increaſing, till it has gone half its way; and then to move ſlower and ſlower, till it goes off at the weſt ſide, after which it diſappears for about the ſame ſpace of time that it ſpent in croſſing the diſk, and then enters upon the eaſt ſide again, nearly in the ſame place, and croſſes it in the ſame tract, and with the ſame unequal motion as before.

This apparent inequality in the motion of the ſpots, is purely optical, and is in ſuch proportion as demonſtrates them to be carried round equally, or in a circle, the plane of which continued, paſſes through or near the eye of a ſpectator upon the earth.

The ſpots are by no means confined to one part of the ſun's diſk; though we have not heard of any being obſerved about his polar regions: and though their direction is from eaſt to weſt, yet the paths they deſcribe in their courſe over the diſk are exceedingly different; ſometimes being ſtrait lines, ſometimes curves, ſometimes deſcending from the northern to the ſouthern parts of the diſk, ſometimes aſcending from the ſouthern to the northern.

By obſervations on the ſpots, the ſun is found to move round its axis once in about 25½ days.

The apparent ſemidiameter of the ſun at a mean diſtance from the earth is 32′ 12″, and his real diameter is to that of the earth as 91.7431 to 1. The inclination of its axis to the axis of the ecliptic is 7″½. And the denſity of the ſun to that of the earth is as 1 to 4. Alſo the proportion of light and heat on the ſurface of the ſun to that on the earth is as 45025 to 1.

THE

Fig. 1.

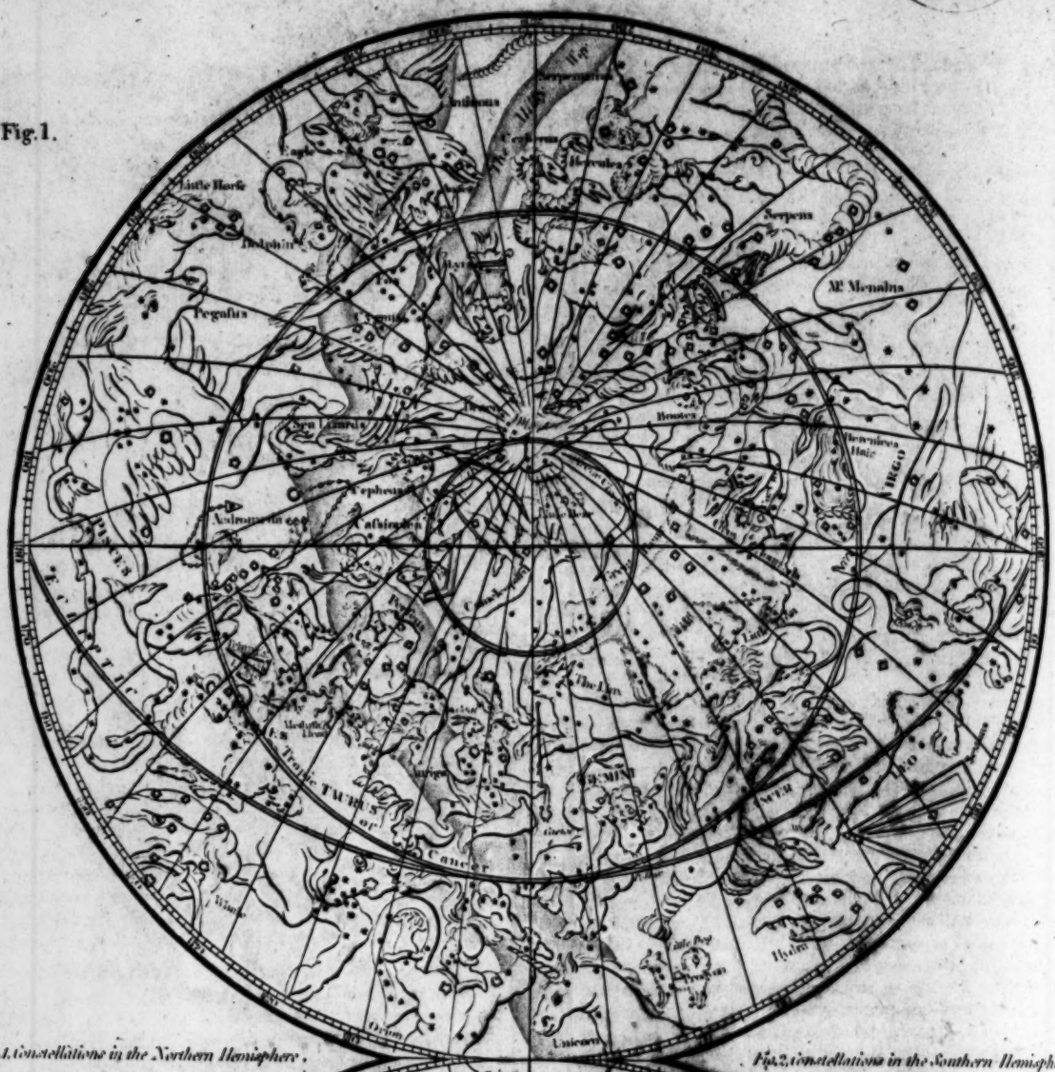


Fig. 1. Constellations in the Northern Hemisphere.

Fig. 2.

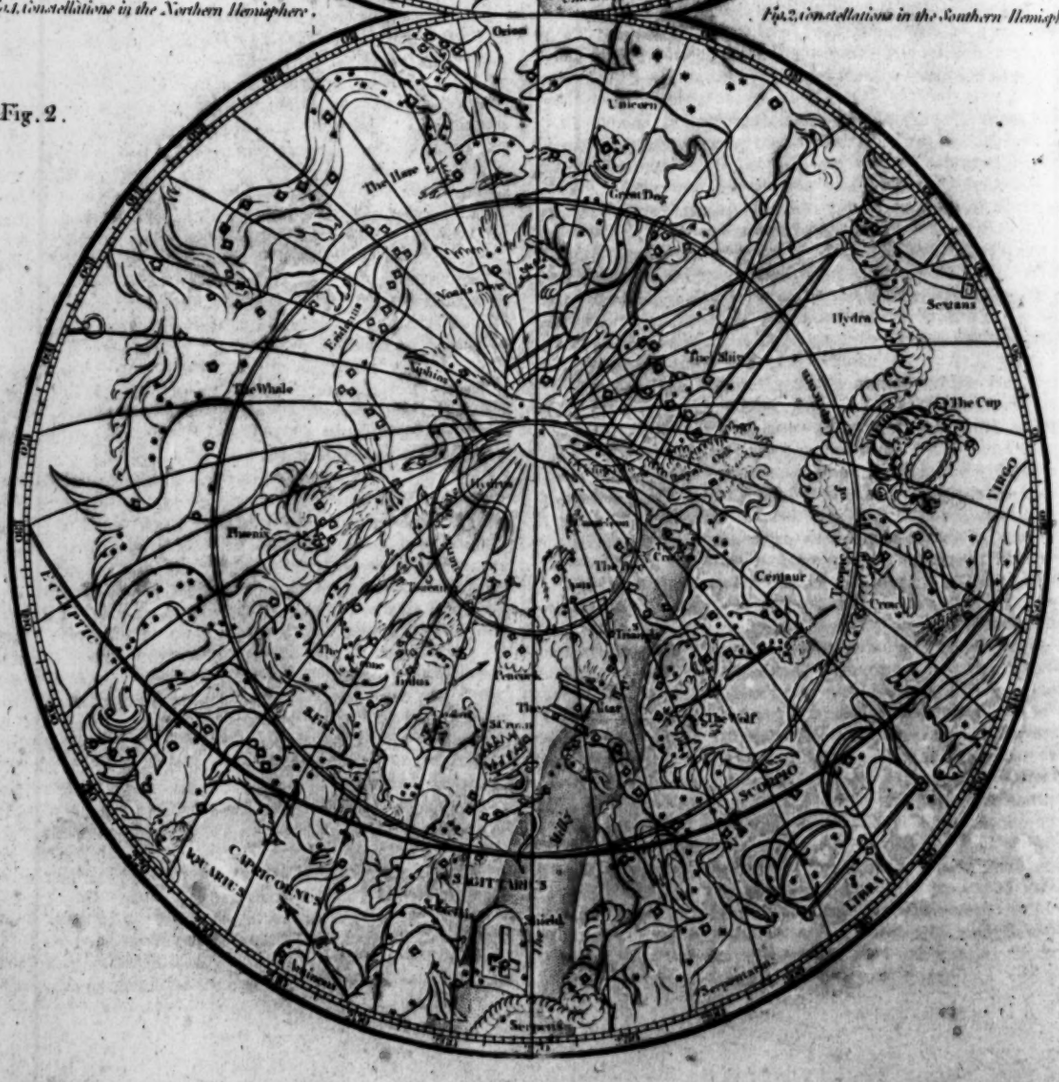
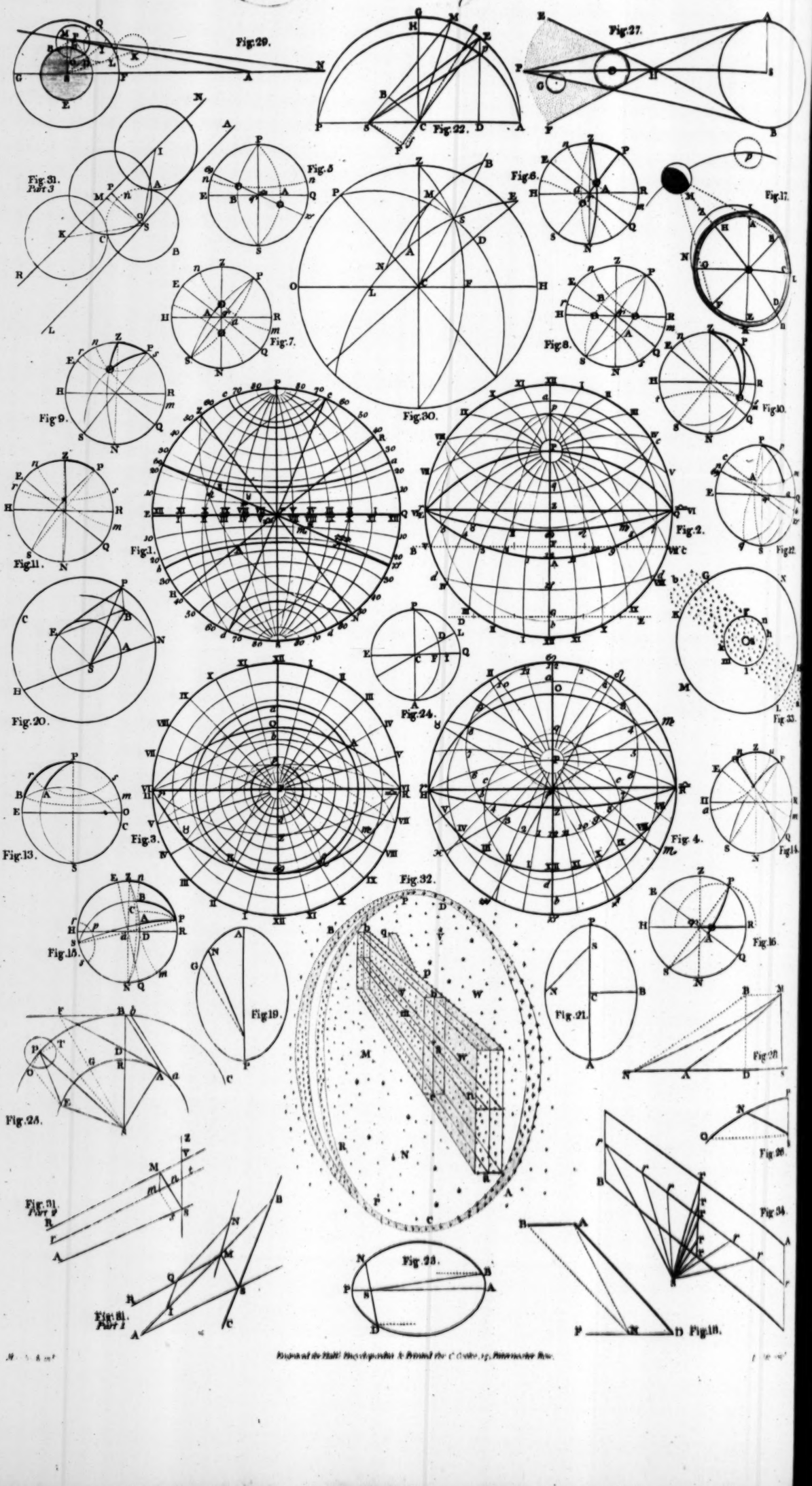


Fig. 2. Constellations in the Southern Hemisphere.

Astronomy — See the System — Section 9.



ASTRONOMY.

The fixed Stars.

The fixed ſtars, as was obſerved in Section II. do not belong to this Syſtem, but are probably diſpoſed as ſo many ſuns to other ſyſtems. It is certain, that they are not opake bodies as are the planets, but ſhine by their own native luſtre.

Among the fixed ſtars great changes have often been obſerved. Stars of a ſuperior magnitude have by degrees become leſs and leſs, ſo as hardly to be perceptible; and ſome have even vaniſhed, and have never been ſeen more; while others of an inferior ſize have gradually increaſed till they appeared as large as thoſe of the 2d or 3d magnitude, when they have again decreaſed and afterwards increaſed again, and ſo on in regular order.

Theſe phænomena of the ſtars may ariſe from each Syſtem's revolving round its centre of gravity, which Sir Iſaac Newton has demonſtrated muſt be the caſe when one body gravitates round another; for by this means they will at different periods be at different diſtances from us, and ſo appear under unequal magnitudes. However, it muſt be confeſſed, that unleſs the orbits they deſcribed in this way were very conſiderable, it would not materially alter their appearance; for we find their diſtance is ſo immenſe, that when they are obſerved from oppoſite parts of the earth's orbit it produces no ſenſible change. It is probable, therefore, that ſome of theſe phænomena may be effected by dark ſpots ariſing on their ſurface, ſimilar to thoſe on the ſun, which for a time eclipſe their brightneſs, and ſo cauſe them to appear of an inferior magnitude till the ſpots by degrees vaniſh, when they appear again of full ſize.

In order to keep a proper account of the ſtars, Aſtronomers ſuppoſe the heavens to be divided into what they call conſtellations, each containing a certain number of ſtars, of different magnitudes. The conſtellations are 80 in number, viz. 12 in the zodiac, 36 in the northern hemiſphere, and 32 in the ſouthern hemiſphere. The ſtars compoſing each conſtellation are for the eaſe of being remembered, ſuppoſed to form the outlines of ſome animal or figure, and accordingly in the maps of the ſtars we ſee the conſtellations thus repreſented, though the ſtars in moſt of them form very imperfect out-lines of the figures aſcribed to them.

The names of the conſtellations and the number of ſtars of each magnitude, are as follow:

Northern Conſtellations.

Names.	Number.	Magnitudes. 1	2	3	4	5	6	Names.	Number.	Magnitudes. 1	2	3	4	5	6
Lit. Bear	12	0	2	1	4	3	2	Camelop.	23	0	0	0	5	7	11
Gr. Bear	105	0	5	5	16	30	49	Serpent	50	0	1	7	6	5	31
Dragon	49	0	1	7	8	10	23	Serpentar.	67	0	1	6	12	17	31
Cepheus	40	0	0	3	7	10	20	Sob. Shield	8	0	0	0	2	3	3
Greyho.	24	0	0	0	1	7	16	Eagle	29	1	0	5	1	4	18
Bootes	53	1	0	7	10	12	23	Antinous	34	0	0	5	2	7	20
M. Mænal	11	0	0	0	1	0	10	Dolphin	18	0	0	0	0	2	10
Ber. Hair	24	0	0	0	0	8	16	Colt	12	0	0	0	4	1	7
Chs Heart	3	0	1	0	0	0	2	Arrow	13	0	0	0	4	1	8
N. Crown	11	0	1	0	6	3	1	Androm.	66	0	3	2	10	16	35
Hercules	92	0	0	12	12	28	40	Perſeus	67	1	1	5	10	14	36
Cerberus	9	0	0	0	0	3	1	5	Pegaſus	81	0	3	4	9	11	54
Harp	24	1	0	3	2	8	10	Auriga	46	1	1	1	9	9	25
Swan	73	0	1	5	15	20	32	Lynx	55	0	0	1	8	21	25
Fox	29	0	0	0	0	6	11	12	Lit. Lion	20	0	0	1	0	5	8
Gooſe	10	0	0	0	0	0	2	8	Gr. Tri.	10	0	0	0	3	1	6
Lizard	12	0	0	0	0	3	5	4	Lit. Tri.	5	0	0	0	0	0	5
Caſſiopeia	52	0	0	5	7	7	33	Muſca	6	0	0	1	2	2	1

Southern Conſtellations.

Names.	Number.	Magnitudes. 1	2	3	4	5	6	Names.	Number.	Magnitudes. 1	2	3	4	5	6
Whale	80	0	2	8	13	10	47	Peacock	14	0	1	3	5	4	1
Eridanus	72	1	0	0	24	19	18	S. Crown	12	0	0	0	1	3	8
Phœnix	13	0	1	5	5	0	2	Crane	14	0	2	1	2	9	0
Am. gooſe	9	0	0	4	2	3	0	S. Fiſh	15	1	0	2	9	2	1
Orion	93	2	4	3	19	15	50	Hare	25	0	0	4	9	4	8
Monocer.	32	0	0	1	10	10	11	Noah's D	10	0	2	0	1	6	1
Little Dog	14	1	0	1	0	2	10	Cha's Oak	13	0	1	2	6	4	0
Hydra	53	0	1	3	14	13	22	Ship Argo	48	1	6	11	13	14	3
Sex. Urani	4	0	0	0	0	0	4	Great Dog	29	1	5	1	4	10	8
Cup	11	0	0	0	8	2	1	Bee	4	0	0	0	2	2	0
Crow	8	0	0	2	2	2	2	Swallow	11	0	0	0	4	3	4
Centaur	36	3	6	6	14	8	0	Indus	12	0	0	0	4	6	2
Wolf	36	0	0	3	6	18	9	Cameleon	10	0	0	0	0	9	1
Altar	9	0	0	1	6	1	1	Flyingfiſh	7	0	0	0	0	6	1
S. Trian.	3	0	1	2	0	2	0	Sword-fiſh	7	0	0	2	2	1	2

CONSTELLATIONS IN THE ZODIAC.

Names. Northern.	Number.	Magnitudes. 1	2	3	4	5	6	Names. Southern.	Number.	Magnitudes. 1	2	3	4	5	6
Aries	46	0	1	1	3	5	36	Libra	33	0	2	1	8	3	19
Taurus	109	1	1	3	9	24	71	Scorpio	44	1	3	6	14	5	15
Gemini	94	1	2	4	8	13	66	Sagittari.	48	0	1	5	9	11	22
Cancer	75	0	0	0	6	8	61	Capricor.	58	0	0	2	5	9	42
Leo	91	2	2	6	13	11	57	Aquarius	93	0	0	4	7	18	54
Virgo	93	1	0	5	11	24	52	Piſces	110	0	0	1	7	28	74

The above Tables ſhew the number of what is uſually called the Conſtellation Stars; but, excluſive of thoſe, there are a variety of others diſcoverable by teleſcopes.

Dr. Herſchel, with his improved teleſcope, has diſcovered ſeveral thouſands of Stars which were not obſerved before; ſo that his Catalogue of Stars extends to three or four times the number contained in that given by Mr. Flamſtead.

There is a ſort of Stars named Nebulous Stars, from their appearing like a bright cloud. They are not to be diſtinguiſhed by the naked eye, and when viewed through a teleſcope, appear as a cluſter of very ſmall Stars. And, indeed, to whatever part of the Heavens a good teleſcope is directed, a number of Stars will appear which are not diſcoverable by the eye alone.

Hence, though it is almoſt demonſtrable that the number of Stars is not infinite, yet it may be reaſonably inferred that there are thouſands, perhaps millions, which cannot be diſcovered, even by means of the beſt teleſcopes whatever; and hence is demonſtrable the infinite wiſdom, omnipotence, and omnipreſence of the Creator of the Univerſe.

The following Table of Stars has been carefully adjuſted with reſpect to their Right Aſcenſions, Declinations, &c. to the preſent Time, which renders the Table a valuable Acquiſition to thoſe who enter into the practical Part of Aſtronomy; as it will be found not only an accurate Account of thoſe particular Stars therein mentioned, but will alſo be of uſe to determine the Latitudes of Places on this Globe, by means of the obſerved Altitudes of thoſe Stars taken at particular Times.

A TABLE of the RIGHT ASCENSIONS, DECLINATIONS, LONGITUDES, LATITUDES, and MAGNITUDES, of Twenty-one of the principal FIXED STARS, accurately rectified to the Commencement of the Year, 1789.

Names.	Right Aſcen.	Declination.	Longitude.	Latitude.	Mag.
γ Pegaſi	° ′ ″ 0 35 55	° ′ ″ 14 10 36 N	♈ ° ′ ″ 0 13 3	° ′ ″ 12 33 35 N	2
α Arietis	28 49 40	22 27 31 N	♉ 4 42 47	9 57 30 N	2
α Ceti	42 49 6	3 15 10 N	♉ 11 22 23	12 36 16 S	2
Aldebaran	65 57 28	16 4 21 N	♊ 6 50 30	5 29 2 S	1
Capella	75 16 54	45 45 35 N	18 54 38	22 51 46 N	1
Rigel	76 6 6	8 27 27 S	13 52 53	31 9 10 S	1
βTauri	78 14 32	28 24 51 N	19 37 46	5 21 59 N	2
αOrionis	85 56 21	7 21 10 N	25 48 32	16 3 31 S	1
Sirius	98 58 7	16 25 36 S	♋ 11 10 53	39 32 55 S	1
Caſtor	110 16 52	32 20 7 N	17 18 18	10 4 35 N	2
Procyon	112 4 11	5 45 49 N	22 52 57	15 58 8 S	1
Pollux	113 6 16	28 32 4 N	20 18 43	6 40 5 N	2
Regulus	149 17 2	12 59 32 N	♌ 26 53 58	0 27 27 N	1
SpicaVirg.	198 31 35	10 3 14 S	♎ 20 53 59	2 2 11 S	1
Arcturus	211 31 20	20 18 14 N	21 17 30	30 54 11 N	1
Antares	244 7 34	25 56 52 S	♐ 6 49 7	4 32 17 S	1
ε Sagittarii	272 32 43	34 27 52 S	♑ 2 8 14	11 0 45 S	2
αAquillæ	295 7 3	8 19 9 N	28 47 40	29 18 36 N	1
2αCapricor.	301 35 7	13 11 11 S	♒ 0 54 46	6 57 16 N	3
Fomalhaut	341 29 30	30 44 4 S	♓ 0 53 14	21 6 28 S	1
αPegaſi	343 34 2	14 4 23 N	20 32 57	19 24 38 N	2

SECT. IX.

THE ASTRONOMY OF THE SPHERE.

ALTHOUGH the celeſtial bodies are placed at different diſtances from the earth, as has been before ſhewn; yet, an obſerver, living upon the earth, is not naturally ſenſible thereof, but imagines them all to be ſituate in one concave ſurface, of which the earth is the centre.

Likewiſe, though in reality the cauſe of day and night is the rotation of the earth round its own axis; and of the ſeaſons, its motion through its own orbit (or ecliptic) in a year; yet, to a ſpectator on the earth, theſe appear to be effected by the motion of the ſun, or heavens.

And as in moſt Aſtronomical Problems, it is the apparent or relative motions only that we have to determine; therefore, for

the eaſe of imagination, and ſince it amounts to one and the ſame thing whether way theſe appearances are effected. Aſtronomers chuſe to ſuppoſe all celeſtial objects placed in one concave ſphere, as above; and to aſcribe to them all the motions which they ſeem to have, while the earth is conſidered as being at reſt.

Definitions.

I. The Aſtronomy of the ſphere is the method of finding (from proper data) the meaſure of certain arcs and angles, formed on the ſurfaces of the celeſtial and terreſtrial ſpheres by the *apparent motions* of the bodies which are ſeen in the heavens.

II. The ſurfaces of thoſe ſpheres are ſuppoſed to be concentric to the centre of the earth, and to have correſpondent circles deſcribed on both ſpheres.

III. GREAT CIRCLES, are ſuch as divide either ſphere into two equal parts.

IV. LESSER CIRCLES, are thoſe which divide either ſphere into unequal parts.

V. The POLES OF A CIRCLE, are thoſe points on the ſphere that are equally diſtant from that circle.

VI. An AXIS is a right line ſuppoſed to connect the poles.

VII. The CELESTIAL AXIS, is that right line about which the heavens ſeem to revolve.

VIII. The North and South poles of the world, are thoſe two points where the axis cuts the celeſtial ſphere.

IX. The EQUINOCTIAL, in the celeſtial; or EQUATOR, on the terreſtrial ſphere, is that *great circle* which is equally diſtant from the poles of the world.

X. MERIDIANS, or HOUR CIRCLES, or CIRCLES OF RIGHT ASCENSION, or CIRCLES of "TERRESTRIAL LONGITUDE," are great circles perpendicular to the equator, and paſſing through the poles of the world.

XI. The Ecliptic is a great circle inclined to the equator in an angle of 23° : 28′, and cutting it in two points diametrically oppoſite. This circle is ſuppoſed to be divided into 12 equal parts, called ſigns, beginning from one of its interſection with the equator; alſo each ſign is ſuppoſed to be divided into 30 equal parts, called degrees; each degree, into 60 minutes; each minute into 60 ſeconds, &c. and in general every great circle is divided into 360 degrees, and each degree into 60 minutes, &c.

The names and characters of the ſigns of the ecliptic, are as under.

Aries,	Taurus,	Gemini;	Cancer,	Leo,	Virgo,
♈	♉	♊	♋	♌	♍;
Libra,	Scorpio,	Sagittarius,	Capricornus,	Aquarius,	Piſces.
♎	♏	♐	♑	♒	♓

The former ſix being on the north ſide of the equinoctial, are called northern ſigns; and the latter ſix, being on the ſouth ſide thereof, are named ſouthern ſigns.

XII. The CARDINAL POINTS OF THE ECLIPTIC, are the four firſt points of the ſigns ♈, ♋, ♎, ♑; thoſe of ♈ and ♎ are called EQUINOCTIAL POINTS; and thoſe of ♋ and ♑ are called SOLSTITIAL POINTS.

When the motion in the ecliptic is according to the order of ſigns, as from ♈ to ♉, and from ♉ to ♊, &c. it is ſaid to be forward, or *in conſequentia*: but when the motion is the contrary way, as from ♉ to ♈, from ♈ to ♓, &c. then it is ſaid to be backward, or in *antecedentia*.

Alſo when two planets, &c. are referred to the ſame point of the ecliptic, they are ſaid to be in *conjunction*. When they are referred to oppoſite points, they are ſaid to be in *oppoſition*. If they are 3 ſigns diſtant, they are in *quartile aſpect*; if 4 ſigns diſtant, in a *trine aſpect*. If 2 ſigns apart, in a *ſextile aſpect*. The characters uſed by Aſtronomers for denoting theſe aſpects, are the following ☌, conjunction; ☍, oppoſition: □, quartile; △, trine; and ⚹, ſextile.

The point of the ecliptic, which is riſing at any place, is called the *horoſcope*: the higheſt point of it is named the *nonageſimal degree*. The point in the meridian, is the *medium cæli*, or culminating point; the oppoſite point, the *imum cæli*.

XIII. The EQUINOCTIAL COLURE is a meridian, paſſing through the equinoctial points.

XIV. The SOLSTITIAL COLURE is a meridian, paſſing through the ſolſtitial points.

N. B. The colures cut one another at right angles in the poles of the world.

XV. CIRCLES OF CELESTIAL LONGITUDE, are great circles perpendicular to the ecliptic.

XVI. The LATITUDE OF ANY POINT in the heavens, is an arc of a circle of longitude intercepted between that point and the ecliptic, and is called north or ſouth latitude, according as the point is on the north or ſouth ſide of the ecliptic.

XVII. PARALLELS OF CELESTIAL LATITUDE, are ſmall circles parallel to the ecliptic.

XVIII. The LONGITUDE OF ANY POINT in the heavens, is an arc of the ecliptic intercepted between the firſt point of Aries, and a circle of longitude paſſing through that point.

XIX. The RIGHT ASCENSION OF ANY POINT of the celeſtial ſphere, is an arc of the equator contained between the firſt point of Aries, and a meridian paſſing through that point; or it is the angle formed by the equinoctial colure, and the meridian paſſing over that point.

XX. The DECLINATION OF ANY POINT is an arc of the meridian, contained between that point and the equinoctial. If the point is on the north-ſide of the equinoctial, it is called north declination; but, if it is on the ſouth-ſide thereof, it is called ſouth declination.

XXI. THE OBLIQUITY OF THE ECLIPTIC is the angles made by the interſection of the equator and ecliptic, and is meaſured by the ſun's greateſt declination, which, according to modern obſervations is about 23° : 28′.

XXII. PARALLELS OF DECLINATION are ſmall circles, parallel to the equinoctial.

The TROPIC OF CANCER is a parallel of declination in the northern hemiſphere, diſtant 23° : 28′ from the equinoctial; and the TROPIC OF CAPRICORN is a parallel of declination in the ſouthern hemiſphere, and at the like diſtance from the equinoctial. Alſo the ARTIC POLAR CIRCLE is a parallel of declination at 23° : 28′ diſtance from the North Pole; and the Antartic Polar Circle is a parallel of declination, as far diſtant from the ſouth pole.

XXIII. The ZENITH is that point of the heavens directly over a place.

XXIV. The NADIR is that point of the ſphere, which is directly under a place.

XXV. The HORIZON is that great circle of the ſphere, which is equally diſtant from the Zenith and Nadir of any place, and divides the ſphere into the upper and lower hemiſpheres.

XXVI. The RISING of a celeſtial object, is when its centre appears in the moſt diſtant part of the horizon.

XXVII. The SETTING of a celeſtial body, is when its centre diſappears in the weſtern quarters of the horizon.

XXVIII. AZIMUTHS, or VERTICAL CIRCLES, are great circles perpendicular to the horizon, paſſing through the Zenith and Nadir.

XXIX. The PRIME VERTICAL, is that vertical circle which paſſes through the eaſt and weſt points of the horizon, and is at right angles to the *Meridian of the Place*, which is a vertical circle paſſing through the north and ſouth points of the horizon.

XXX. The AZIMUTH of any celeſtial object, is an angle at the Zenith formed by the meridian of any place, and a vertical circle paſſing through that object when it is above the horizon; or, it is meaſured by the arc of the horizon intercepted between thoſe vertical circles.

XXXI. The AMPLITUDE OF ANY POINT in the heavens, is an arc of the horizon contained between that point at his riſing or ſetting, and the interſection of the meridian of the place with the horizon; or, it is the angle at the zenith included between the meridian of a place and a vertical circle, paſſing through the point at its riſing or ſetting.

XXXII. The ALTITUDE OF ANY POINT in the heavens, is an arc of a vertical circle, intercepted between that point and the horizon.

XXXIII. The ZENITH DISTANCE of any object, is an arc of a vertical circle contained between that point and the zenith.

N. B. The altitude and zenith diſtance are complements of one another.

XXXIV. The MERIDIAN ALTITUDE, or MERIDIAN ZENITH DISTANCE, is the altitude, or zenith diſtance, when the object is on the meridian of a place.

XXXV. The CULMINATING of any celeſtial object is the time it tranſits, or comes to the meridian.

XXXVI. ALMICANTHERS, or PARALLELS OF ALTITUDE, are ſmall circles parallel to the horizon.

XXXVII. A PARALLEL SPHERE, is that poſition of the ſphere wherein the circles apparently deſcribed by the diurnal rotation, are parallel to the horizon; which can happen only at the Poles.

XXXVIII. A RIGHT SPHERE, is that when the diurnal motions are at right angles to the horizon. This is the caſe with all places on the equator.

XXXIX. AN OBLIQUE SPHERE, has all the diurnal motions oblique to the horizon. And thus the motions appear to all parts of the earth, except under the poles, and on the equator.

XL. DIURNAL ARCS, are thoſe parts of the parallels of declination of celeſtial objects, apparently deſcribed between the times of the riſing and ſetting of thoſe objects.

XLI. NOCTURNAL ARCS, are the parts of thoſe parallels apparently deſcribed from the time of ſetting to the time of riſing.

N. B. SEMI-DIURNAL AND SEMI-NOCTURNAL ARCS, are the parts of the parallels between the meridian and their interſection with the horizon. The correſponding part of the equator anſwering to the ſemi-diurnal arc, gives the time between noon and the riſing or ſetting; and the equatorial part anſwering to the ſemi-nocturnal arc, ſhews the time between midnight and the time of riſing or ſetting.

XLII. The OBLIQUE ASCENSION of any point in the heavens is

is the degree of the equator, which rises with that *point* in an *oblique sphere*.

XLIII. The OBLIQUE DESCENSION of any point in the heavens is the degree of the equator, which sets with that point in an oblique sphere.

XLIV. The ASCENSIONAL DIFFERENCE belonging to any celestial object, is the difference between its *right* and *oblique ascensions*. In the sun, it is the time that he rises or sets before or after the hour of six.

XLV. The LATITUDE of any place on the earth, is an arc of a terrestrial meridian contained between that place and the equator; being called North or South latitude, according as it is on the North or South side of the equator.

XLVI. The LONGITUDE of any place on the earth, is an arc of the equator contained between the meridian of that place and the meridian which is chosen for the first, where the reckoning of longitude begins.

Or, it is the angle at the pole formed by the first meridian, and that of the given place. The English compute the longitude of all places from the meridian of London.

XLVII. REFRACTION, in an Astronomical sense, is the difference between the true and apparent altitudes of an object; it is owing to the atmosphere's making all celestial objects appear more elevated above the horizon than they really are.

XLVIII. The TWILIGHT, is that medium between light and darkness which happens in the morning before sun rise, and in the evening after sun-set. This is occasioned by the atmosphere's refracting the soler rays upon any place, although the sun is below the horizon of that place; and by observation, it is found to begin and end at about 18° below the horizon.

XLIX. The CREPUSCULEM is a small circle parallel to the horizon at 18° below it.

That these Definitions and the following Problems may be the better understood, I shall shew the method of projecting the circles of the sphere *in plano*. There are three sorts of projection, Stereographic, Orthographic, and Gnomonic; but the first being the best adapted to the present occasion, I shall not insist upon the latter two in this place, but refer to the word PROJECTION, and System of DIALLING for an account of the other.

In the Stereographic projection the eye is supposed to be placed at the pole of the plane, or primitive circle, on which the projection is made.

PROBLEM I. *To project the Sphere upon the Plane of the Solstitial Colure, or upon the Plane of the Meridian of any Place; those Planes being supposed to coincide.*

The method here the eye is supposed to be in the first point of ♈, or the common intersection of the equator, ecliptic, and equinoctial colure; that being the pole of the plane of projection, or primitive circle.

1st. With a chord of 60 degrees describe a circle PEQ, (Plate IV. *Figure* 1.) to represent the solstitial colure, whose centre ♈ is its pole.

2d. A diameter EQ will be the equator, and another PS, at right angles to it will shew the equinoctial colure, or the axis of the world, whose extremities P, S, will be the North and South poles.

3d. For *Parallels of Declination*. On the primitive circle beginning at E and Q, lay off the chords of the given degrees of declination, suppose every 10 degrees; and also the distances of the tropics and polar circles from the equator, namely, 23½° and 66½. Then from the centre ♈ in the axis PS, produced, apply the respective secants of the complements of the degrees laid on the primitive, and these will give the centres of the corresponding parallels of declination; from which centres, with the extents to the several divisions in the circumference, describe the small circles 10, 10; 20, 20; 30, 30; &c. and these will be the parallels of declination required. Among which *a* ♋, *b* ♑, are the tropics of Cancer and Capricorn; and *cc*, *dd*, the artic and antartic polar circles.

4th. *For the Circles of Right Ascension*, or *Hour Circles*. In the diameter E Q produced, lay off from the centre ♈, both ways, the tangents of 15°, 30°, 45°, 60°, 75°, respectively; and they will be the centres of circles to be described through P, and S, cutting the equator in the points representing the 24 hours; the solstitial colure being the 12 o'clock, and the equinoctial colure, P. S. the 6 o'clock hour circles. And in like manner, may any other of these kind of circles be drawn.

5th. The *Ecliptic* ♋ ♑ is drawn, making with the equator an angle of 23½°; whose poles *c*, *d*, are the intersections of the polar circles with the solstitial colure.

6th. *Parallels of Celestial Latitude* are drawn parallel to the ecliptic, in the same manner as circles of declination are drawn parallel to the equator.

7th. *Circles of Celestial Longitude* are described through *c*, *d*, the poles of the ecliptic, in the same manner as the circles of right ascension were described through P, S, the poles of the equator; and thus were the divisions found that are marked with the signs.

8th. The *Horizon* is represented by drawing a diameter HR making an angle with the axis PS, equal to the latitude of the place; and the poles of the horizon Z, N, the zenith and nadir; are at 90° distant from the circle.

9th. *Azimuth*, or *Vertical Circles*, making any angle with the meridian, are described like circles of right ascension. Thus ZN is the prime vertical, and ZAN is another azimuth, 45° from the south.

10th. *Almicanthars*, or *Parallels of Altitude*, are in this projection drawn parallel to the horizon, in like manner as were the circles of declination drawn parallel to the equator.

PROBLEM II. *To project the Sphere upon the Plane of the Horizon.*

In this projection the eye is supposed in one of the poles of the horizon, or plane of projection. (See Plate IV. *Figure* 2.)

1st. *The Horizon* is represented by the primitive circle, where the upper XII is the South; the lower XII, the North; E, the East; and Q, the West points.

2d. *The Azimuth Circles*, are represented by diameters, drawn through Z, the centre or pole of the horizon. Thus the diameter XII, XII, is for the meridian, and EZQ for the prime vertical; and other azimuth circles, forming any angle with the meridian, are readily drawn by laying off their distances in the primitive, from the North or South points.

3d. *Parallels of Altitude* are concentric to the primitive, and are described about the pole, Z, with the half tangent of their distance from it. Thus the small circle, whose diameter is *a b*, is a parallel of altitude 10° above the horizon, or at 80° distance from its pole, Z.

4th. *The Equinoctial*'s distance from the zenith is equal to the latitude of the place, and therefore this circle makes with the horizon an angle, which is measured by the complement of the latitude; then letting off from the centre Z, in Z XII, continued, the tangent of 50° (the latitude, in this example, being supposed to be 40°) it will give the centre of the circle EAQ representing the equinoctial; and the half tangent of 50°, set the same way from Z, will give P the pole of the world.

5th. *Six o'Clock Hour Circle* passes through the poles of the world, making with the horizon an angle equal to the measure of the latitude; therefore, taking in the meridian from Z towards A, the tangent of the latitude 40°, it gives G, the centre of the six o'clock hour circle EPQ.

6th. *The Hour Circles* pass through the poles of the world, and make with one another angles of 15°. Therefore in a line DE, drawn through G, at right angles to the meridian, set off on both sides of G, the tangents 15°, 30°, 45°, 60°, 75°, to the radius PG, and they will give the centres of the several hour circles passing through P, and cutting the horizon and equinoctial in the hour points.

7th. *The Polar Circles, Tropics, and other Circles of Declination*, are described parallel to the equinoctial, about its pole P, at given distances from it, setting off on each side of Z, the half tangents of their greatest and least distances from Z; then the middles of those intervals are the centres sought.

Thus, the artic circle is distant from P about 23½°; then, to and from ZP=50°, add and take, 23½°, and there will be 73½° and 26½° respectively; and the half tangents of these set off from Z, give *p* and *q*; then, a circle being described on the diameter, *p q* is the artic circle.

In like manner will the centres of the tropic of Cancer *c* ♋ *c*, and of Capricorn *d* ♑ *d* be obtained.

8th. The northern portion of the ecliptic ♈ ♋ ♌ is described from a centre distant from Z towards P the tangent of 73½°, = the angle which the ecliptic makes with the horizon.

9th. *Circles of Longitude.* ♈ *p* ♌, *p* ♉, *p* ♊, *p* ♋, *p* ♍ are described through *p*, the pole of the ecliptic from centres in the line BFC, in like manner as the hour circles were described through P, the pole of the equator.

10th. *Circles of Celestial Latitude* VIII *q* VI, are described about *p* as the circles of declination were described about P, the pole of the equinoctial.

PROBLEM III. *To project the Sphere upon the Plane of the Equator.*

In this projection the eye is supposed to be in one of the poles of the equator, (suppose in the south pole) and projecting the north hemisphere. (Plate IV. *Figure* 3.)

1st. *The equator* is represented by the primitive circle, whose centre and pole is P.

2d. *The Hour Circles* are expressed by diameters making angles of 15° deg with one another, of which XII P XII is the meridian or solstitial colure, and VI P VI, the six o'clock circle, or equinoctial colure.

3d. *Circle of Declination*, are circles parallel and concentric to the equator, described from its centre with radii equal to the half tangents of their several distances from the Pole P, or half co-tangents of their degrees of declination. Thus *p q*, the artic circle, and *a* ♋; the tropic of Cancer are described with the half tangents of 23½°, and 66½° respectively, and so of the others.

4th. *The Ecliptic*, make an angle of 23½° with the equator; therefore, the tangent of these degrees, laid from P towards *a* will give the centre for describing the ecliptic ♈ ♋ ♌, whose pole *p* is in the polar circle.

5th,

5th. *Circles of Longitude*, are deſcribed through p, the pole of the ecliptic, in like manner as the hour circles were deſcribed through P, the pole of the equator, in the laſt Problem; and thus were the diviſions ♑, ♒, ♓, ♈, obtained.

6th. *Circles of Celeſtial Latitude*, are projected in the ſame manner as the circles of declination in the laſt Problem.

7th. *The Horizon of any place*, ſuppoſe of London, being inclined to the equator, in angle equal to the co-latitude 38° 28', the tangent of this, laid from P to Z, will give the centre, and Z the pole of the horizon HOR.

8th. *The prime vertical* HZR, making an angle with the equator equal to the latitude of the place, 51° 32' its centre is found by laying the tangent thereof from P towards s.

9th. *Azimuth Circles*, making given angles with the meridian, Z s, are thus deſcribed: In a line drawn through the centre of the prime vertical, at right angles to the meridian, take diſtances from that centre, equal to the tangents of the propoſed azimuth angles, the ſemidiameter of the prime vertical being radius, thoſe diſtances give the centres ſought; and thus was the azimuth, ZA, deſcribed.

10th. *Parallels of Altitude* are deſcribed about Z, the pole of the horizon, at the diſtances of the co-altitudes, in the ſame manner as were the circles of declination in the laſt Problem deſcribed about P, the pole of the equator; and thus was the ſmall circle V b VII deſcribed, at 10° diſtance from the horizon, or 80° diſtance from its pole Z.

PROBLEM IV. *To project the Sphere upon the Plane of the Ecliptic.*

The eye is here ſuppoſed to be in one of the poles of the ecliptic, and thence ſeeing the northern hemiſphere projected. Plate IV. *Figure* 4.

1ſt. *The Ecliptic* is here repreſented by the primitive circle, whoſe centre p is the pole of the ecliptic.

2d. *Circles of Longitude*, are herein ſhewn by diameters, theſe making angles of 30° with one another being drawn through the diviſions marked with the ſigns of the zodiac.

3d. *Parallels of Celeſtial Latitude*, are circles deſcribed about p, concentric to the ecliptic; ſuch is the ſmall circle whoſe diameter is ab, repreſenting the parallel of 10° of latitude.

4th. *The Equator* makes an angle of 23½° with the ecliptic: therefore, the tangent of this inclination laid from p towards ♋, will give the centre of the equator ♈ XII ♎; and the half tangent of 23½° laid from p, the ſame way, gives P the pole of the equator.

5th. *The Equinoctial Colure*, which here makes the ſix o'clock hour circle, forms an angle with the ecliptic of 66½°, and the tangent thereof laid from p towards ♑, gives the centre of the ſix o'clock hour circle, ♈ P ♎.

6th. *Hour Circles*, paſſing through P, and making angles of 15° with one another, are deſcribed from centres, found in a right line paſſing through the centre of ♈ P ♎, and drawn at right angles to the ſolſtitial colure ♋ p ♑; by laying off in that line the tangents of 15°, 30°, 45°, 60°, 75°, reckoned from the centre of ♈ P ♎, on both ſides, the ſemidiameter of this circle being radius. Theſe hour circles cut the equator in the hour points.

7th. *Parallels of Declination*, ſuch as the tropic of Cancer, and arctic circle, whoſe diameters are 12, 19, and p q, are deſcribed by laying off from p, the half tangents of their greateſt and leaſt diſtances. Thus q, being diſtant from p 47°, make pq = ½ tangent of 47°; then the middle of pq will be the centre of the polar circle.

8th. *The Horizon*, HOR, muſt make an angle with the ecliptic, equal to the difference between the co-altitude and the obliquity of the ecliptic, when P is projected to the north of p; otherwiſe, that angle is equal to the ſum of the ſaid quantities.

For London, where the aforementioned difference is 15° (= 38° 28' − 23° 28') the tangent of 15° gives the centre of HOR; and the half tangent gives Z the zenith.

9th. The prime vertical HZR, is deſcribed by laying from p, towards O, the co-tangent of pZ, for a centre.

10th. *Azimuth Circles* are deſcribed through Z, making given angles with the meridian ZO, by finding their centres in a line drawn through the centre of HZR in the manner deſcribed for the hour circles in Problem II.

11th. *Parallels of Altitude*, are repreſented by deſcribing ſmall circles parallel to the horizon HOR, at given diſtances from it; or, which comes to the ſame, by deſcribing ſmall circles about the pole Z, at diſtances equal to the complements of the given altitudes. And thus the circle *cde* was deſcribed for a parallel of 33° of altitude.

PROBLEMS OF THE SPHERE.

PROBLEM V. *Given the Sun's Longitude, and the Obliquity of the Ecliptic; required the Sun's Right Aſcenſion and Declination.*

EXAMPLE. Let the obliquity of the ecliptic, or the ſun's greateſt declination, be 23° 28'; and let his place be 13° 16' in ♉, what is his right aſcenſion and declination? (Plate IV. *Figure* 5.)

Here the primitive circle, PESQ, repreſents the plane of the ſolſtitial colure, whoſe centre is ♈; the diameter EQ is the equator; and the diameter PS, is the equinoctial colure; E ♋ is the ſun's declination, (= 23° 28') ♋ ♑ is the ecliptic; ⊙ is the place of the ſun; and ♈ ⊙, is the ſun's longitude from ♈, = 34° 16'; alſo, P ⊙ B is the circle of right aſcenſion.

Then in the right-angled ſpherical triangle ♈ ⊙ B, there is given ♈ ⊙ = 43° 16' and the angle ⊙ ♈ B = 23° 28', to find ♈ B, the ſun's right aſcenſion, and B ⊙, his preſent declination. Hence theſe proportions. See SPHERICAL TRIGONOMETRY.

As radius	—		10.0000000
Is to ſine ſun's long. ♈ ⊙ (43° 16')	}	9.8133408	
So is ∠ ⊙ ♈ B (23° 28')	}	9.6001181	
To B ⊙, the declination 13° 51', *ſere*	}	9.4136389	
As radius	—		10.0000000
To tangent ♈ ⊙ (43° 16')	}		9.9717071
So cof. ∠ ⊙ ♈ B, (23° 28')	}		9.9623076
To tang. right aſcen. = 40° 48' nearly	}		9.9340147

SCHOLIUM I. While the ſun is moving from ♈ to ♋, or is in the firſt quadrant of the ecliptic, the given longitude is the hypothenuſe in the triangle ♈ ⊙ B, the declination B ⊙ is north, and ♈ B is the right aſcenſion: but when the ſun is paſt the ſolſtice ♋, and is deſcending towards ♎, he is then ſaid to be in the ſecond quadrant, and his longitude or diſtance from ♈, being taken from 180°, the remainder ♎ ⊙ becomes the hypothenuſe, and the declination is ſtill north; but the arc B ♎, which in the above caſe is the right aſcenſion, will then be only the ſupplement, and therefore it muſt be ſubtracted from 180°, in order to give the right aſcenſion required.

SCHOLIUM II. When the ſun is paſt the point ♎, and deſcending towards ♑, has got into the third quadrant, then the longitude reckoned from ♈ will be greater than 180°.

In this caſe, the exceſs above 180°, or the diſtance the ſun is removed from ♎, will be the hypothenuſe ♎ ⊙; the declination will be South, and the arc ♎ A, found for the right aſcenſion muſt be added to 180°, to give the right aſcenſion eſtimated from ♈.

SCHOLIUM III. When the ſun has paſt the ſolſtice ♑, and is deſcending towards ♈, he is then in the fourth quadrant, and therefore its longitude is greater than 270°, and muſt be taken from 360°, to give the hypothenuſe ♎ ⊙.

In this caſe the declination is South, and the right aſcenſion ♎ A, as found by the proportion, muſt be taken from 360° to give the right aſcenſion from ♈.

COR. At equal diſtances from the equinoctial points ♈ or ♎, the ſun will have equal quantities of declination, but they will be of different names, according as the ſun is on the north or ſouth ſides of the equinoctial.

PROBLEM VI. *Given the Obliquity of the Ecliptic, and the Sun's preſent Declination, to find his Longitude and Right Aſcenſion.*

Here, in the ſaid right-angled ſpherical triangle ♈ ⊙ B, there are given the angle ⊙ ♈ B, or ſun's greateſt declination, (23° 28') and ⊙ B, the preſent declination, to find ♈ ⊙, the ſun's longitude, and ♈ B, his right aſcenſion.

And therefore, by Trigonometry, As ſine ∠ ⊙ ♈ B (the greateſt declination): ſine ⊙ B the preſent declination) :: radius : ſine ♈ ⊙, the ſun's longitude; and as radius : co-tangent ∠ ⊙ ♈ B :: tangent ⊙ B : ſine of the right aſcenſion.

N. B. The right aſcenſion may be either greater or leſs than a quadrant. But when the ſun's longitude is greater than a quadrant, his right aſcenſion will be ſo too.

It would be ſuperfluous to enumerate examples. If the deſcription of each Problem, and the proportions for the ſolution thereof be laid down, nothing farther can be either neceſſary or deſirable in a work of this kind. For the reſt lays merely in taking out and adding up, &c. the logarithms for each caſe, which none who are acquainted with the previous requiſites (namely TRIGONOMETRY) can be ignorant of.

PROBLEM VII. *Given the Obliquity of the Ecliptic, and the Sun's Right Aſcenſion, to find his Longitude and preſent Declination.*

Here, in the aforeſaid right-angled ſpheric triangle, ♈ ⊙ B, the leg ♈ B, or given right aſcenſion, and ∠ ⊙ ♈ B, or obliquity of the ecliptic, being known, the hypothenuſe ♈ ⊙, or ſun's longitude, and the other leg, ⊙ B, or his preſent declination, will be found by the following proportions:

1ſt. As rad. : co-tangent ∠ ⊙ ♈ B :: co-tangent ♈ B : co-tangent ♈ ⊙.

2d. As rad. : tangent ∠ ⊙ ♈ B :: ſine ♈ B : tangent ⊙ B.

PROBLEM VIII. *Given the Latitude of the Place, and the Sun's preſent Declination; required the Sun's Altitude and Azimuth at 6 o'Clock?*

Here, in Plate IV. *Figure* 6. HR is the horizon; ZN, the prime vertical; RP, the latitude; PS, the ſix o'clock hour circle; EQ, the equator; nm, the parallel of declination; and ZON, the azimuth circle.

Now the things given and required, fall in either of the right angled triangles Z ⊙ P, or ♈ ⊙ A, they being ſupplemental triangles to each other. In the former ſpheric triangle, right angled at P, there are given ZP, the co-latitude; ⊙ P, the complement of the declination to find Z ⊙, the co-altitude, and the ∠ ⊙ ZP = the azimuth; or, in the ſpheric triangle ♈ A ⊙, right angled at A, there are given the latitude A ♈ ⊙, and the declination ♈ ⊙, to find A ⊙, the altitude, and ♈ A the co-azimuth; in which caſe the propertions are as follow:

As rad. : fine ♈☉ :: fine A♈☉ : fine A☉ the altitude. And as rad. : cofine A♈☉ :: tangent ♈☉ : tangent ♈A, the azimuth, which taken from 90° leaves the azimuth required.

SCHOLIUM. From a due conſideration of this Problem, it is evident, that as the declination increaſes, the altitude increaſes, but the azimuth leſſens; and the contrary happens, while the declination is diminiſhing. Hence, when the ſun has no declination, the altitude at ſix o'clock will be nothing, or the ſun will be in the horizon; and the azimuth then being 90°, the ſun will riſe due eaſt in the morning, and ſet due weſt in the evening.

PROBLEM IX. *Given the Latitude of the Place, and the Sun's Declination. Required the Altitude and Hour, when the Sun is due Eaſt and Weſt?* See Plate IV. *Figure* 7.

The primitive circle is the meridian; HR, the horizon; ZN, the prime verticle; RP, the latitude; PS, the ſix o'clock hour circle; EQ, the equator; *n m*, the parallel of declination; ☉ the ſun's place, and P☉S, the hour circle. Here the things concerned in the Problem, fall in either of the triangles PZ☉, or ♈A☉.

In the ſpheric triangle PZ☉, right angle at Z, there are given PZ, the co-latitude, and P☉ the co-declination, to find Z☉ the co-altitude, and ∠ZP☉, the hour from noon.

Alſo in the ſpheric triangle ♈A☉, right angle at A, there are given ∠A♈☉ = latitude, and A☉ = declination; to find ♈☉, the altitude, and ♈A, the hour from ſix o'clock; for which the proportions are as under.

As ſine ∠A♈☉ : ſine A☉ :: rad. : ſine ♈☉, the altitude. And as rad. : co-tangent A♈☉ :: tangent A☉ : ſine A♈, the aſcentional difference, or time from 6, which muſt be turned into hours and minutes, &c. by reckoning 15° to the hour; and then this added to ſix o'clock, gives the time in the morning when the ſun is eaſt; or ſubtracted therefrom, leaves the time in the evening when the ſun is weſt.

SCHOLIUM. When the latitude of the place and ſun's declination have the ſame name, then the greater the declination and latitude, the greater will be the altitude and time from 6. Likewiſe, when they have contrary names, the ſame things happen; but with this difference, that in the former caſe the days lengthen on account of the increaſe of the latitude and declination; whereas, in the latter caſe, the days ſhorten on that account.

PROBLEM X. *Given the Latitude of a Place, and the Sun's Declination. Required his Amplitude and Aſcenſional Difference.* See Plate IV. *Figure* 8.

Here the primitive circle is the meridian of the place; HR, is the horizon; RP, the latitude; PS, the 6 o'clock hour circle; EQ, the equator; *n m*, the parallel of declination; ☉, the place of the ſun; and P☉S, the hour circle.

Then as the arc QR = co-latitude, meaſures the ∠Q♈R, there are given in the ſpheric triangle ♈☉A, (right angled at A) the ſun's declination = A☉; the co-latitude, A♈☉, to find the amplitude ♈☉ and the aſcenſional difference ♈A. Wherefore as ſine ∠A♈☉ : ſine A☉ :: rad. : ſine ♈☉, the amplitude, reckoned from the eaſt or weſt points of the horizon.

And as rad. : tangent ∠A♈☉ : : tangent of A☉ : ſine ♈A, the aſcenſional difference.

SCHOLIUM I. If the declination is north, the amplitude is north; and if the ſouth, it is ſouth.

SCHOLIUM II. If *r s* be a parallel of a declination, as far ſouth as *m s* is north; the hour circle PBS, paſſing through ☉, the place of the ſun at his riſing or ſetting will form a triangle ♈☉B = △♈☉A, where the amplitude is to the ſouthward of the eaſt and weſt points.

SCHOLIUM III. When the latitude and declination have the ſame name, the ſun riſes before and ſets after 6, and then the aſcenſional difference converted into time muſt be ſubtracted from 6 for the time of ſun-riſe, and added to 6 for the time of the ſun's ſetting; but when they are of contrary names, the ſun riſes after and ſets before 6, in which caſe the aſcenſional difference in time muſt be added to 6, for the time of riſing, and ſubtracted therefrom for the time of ſetting.

SCHOLIUM IV. The time of the ſun's ſetting being doubled, gives the length of the day; and the double of the time of his riſing, gives the length of the night.

SCHOLIUM V. When the latitude and declination have the ſame name, the difference between the right aſcenſion and the aſcenſional difference, is the oblique aſcenſion; and their ſum is the oblique deſcenſion; but when they are of contrary names, their ſum is the oblique aſcenſion, and their difference is the oblique deſcenſion.

SCHOLIUM VI. When the declination is equal to the co-latitude of any place (which can only happen to the places within the polar circles) then the parallel of the declination will not cut the horizon, and conſequently the ſun will not ſet in thoſe places during the time his declination exceeds the co-latitude. The like alſo holds with reſpect to the ſtars, for every ſtar whoſe co-declination, or polar diſtance, is not leſs than the latitude; or which is the ſame thing, whoſe declination is not leſs than the co-latitude of the place, thoſe ſtars will never deſcend below the horizon of that place; however, the above is to be only underſtood, when they are in the ſame hemiſphere with the given places; for when the ſtars are in a contrary hemiſphere, and the co-latitude of the place does not exceed the declination of thoſe celeſtial objects, then will they never riſe above the horizon of that place, and conſequently are never viſible there.

PROBLEM XI. *Given the Latitude of a Place, the Sun's Declination and Altitude. Required the Hour from Noon and the Azimuth?* See Plate IV. *Figure* 9.

The primitive circle ZRNH, repreſents the meridian of the place; HR, the horizon; ZN, the prime vertical; RP, the latitude of the place; EQ, the equator; *n m*, the parallel of declination; *r s*, the parallel of altitude; ☉, the place of the ſun; Z☉N, an azimuth circle; and P☉S, an hour circle.

Then in the oblique angled ſpherical triangle P☉Z there are given the co-latitude, ZP; the co-altitude, or Zenith diſtance, Z☉; and the co-declination, or polar diſtance, ☉P; to find ∠☉ZP = the azimuth, and ∠☉PZ = the hour from noon. Hence by trigonometry.

As ſine Z☉ × ſine ZP : rad. :: ſine $\frac{\odot P+ZP-Z\odot}{2}$ × ſine $\frac{\odot P+Z\odot-ZP}{2}$: ſine ſquare of ½ ∠☉ZP, the degrees of which being doubled gives the ∠☉ZP, the azimuth.

And as ſine PZ × ſine ☉P : rad. ſquare : : ſine $\frac{Z\odot+ZP-\odot P}{2}$ × ſine $\frac{Z\odot+\odot P-ZP}{2}$: ſine ſquare of ½ ∠☉PZ; then the degrees, &c. of this being doubled gives ∠☉PZ, which, when converted into time, is the time from noon required.

N. B. Theſe proportions are adapted to the uſe of natural ſines, &c. but will be equally inſtructive in the caſe of *logarithm fines*, to thoſe who are ſufficiently acquainted with their nature and uſe.

PROBLEM XII. *Given the Latitude of the Place, and Sun's Declination. Required the Time when the Twilight begins and ends?* See Plate IV. *Figure* 10.

Here ZRNH is the meridian of the place, HR, the horizon ZN, the prime vertical, and *t s* a ſmall parallel circle at 18° below it; alſo RP is the latitude; EQ, the equator; *n m*, the parallel of declination; ☉, the place of the ſun; Z☉N, a vertical circle; and P☉S, the hour circle.

Then in the oblique angle ſpheric triangle Z☉P, there are given the co-latitude ZP, and the polar diſtance or co-declination, P☉; to find ∠ZP☉, the hour from noon.

This caſe is ſimilar to the latter in the preceding Problem; I ſhall therefore not repeat the proportion, but give a rule for ſolving the ſame by logarithms.

Take the ſine log. co-arith. P☉, the ſine log. co-arith. ZP, the log. ſine $\frac{Z\odot+P\odot=PZ}{2}$, and the log. ſine $\frac{Z\odot=P\odot+PZ}{2}$, add, the whole together, then the half ſum will be equal to the ſine of ½ ∠ZP☉, the degrees, &c. of which being doubled, give ZP☉, which being converted into hours, &c. is the time from noon. Wherefore, ſubtracting the ſame from 12, will give the time of day break, and adding it to 12, will ſhew the end of twilight.

N. B. When the declination becomes greater than the difference between the co-altitude and 18°, then the parallel of declination *n m*, will not cut the parallel *t s* 18° below the horizon, and conſequently at that time there will be no night in that place, but the twilight will continue from ſun ſetting to ſun riſing.

PROBLEM XIII. *Given the Time of the Year, the Latitude of the Place, and the Altitude of a known fixed Star. Required the Hour of Night, when the Obſervation was made?* See *Figure* 11.

Here the meridian, horizon, and equator, are as before; *r s*, the parallel of altitude; ZP, is the co-latitude of the place; *n m*, the parallel of the ſtars declination; ✳, the place of the ſtar; Z✳N, a vertical circle; and P✳S, the hour circle. Then in the oblique angled ſpheric triangle P✳Z, there are given PZ, the co-latitude; Z✳, the co altitude; ✳P, the Polar diſtance, or co-declination of the ſtar, to find ∠ZP✳, or the hour from noon.

This is alſo a ſimilar caſe to the latter in Problem XI. and the ſame proportion will hold, ſubſtituting the ſtar for the ſun.

N. B. The ſtar's declination muſt be taken from a correct table of known ſtars, adjuſted to the preſent time.

PROBLEM XIV. *Given the Obliquity of the Ecliptic, and a Star's right Aſcenſion and Declination. Required his Latitude and Longitude?* See *Figure* 12.

Here the primitive circle repreſents the ſolſtitial colure, EQ the equator; *n m* the parallel of the ſtars declination; ♈ *a* is equal to the ſtars right aſcenſion P✳S, a circle of right aſcenſion; ✳ the place of the ſtar; E♋ = 23° 28', the obliquity of the ecliptic; ♋ ♈, the ecliptic; *p* and *q*, its poles; and *p*✳*q*, a circle of longitude.

Then in the oblique angled ſpheric triangle *p*P✳, there is given the obliquity of the ecliptic *p*P, the co-declination P✳, and the

right aſcenſion = ∠pP✳, to find p✳, the co-latitude, and ∠Pp✳ = longitude.

Therefore, by ſpheric trigonometry. As rad. : coſine of right aſcenſion : : tangent of the obliquity of the ecliptic : tangent of a 4th arc, which will be acute or obtuſe, according as ∠pP✳ is acute or obtuſe.

Alſo take the difference between this 4th arc, and the co-declination P✳; and call that the 5th arc. Then it will be as the coſine of the 4th arc : coſine of the 5th arc : : coſine of the obliquity of the ecliptic : the ſine of the required latitude, which will be north or ſouth, according as the ſtar by its declination is north or ſouth of the ecliptic.

Alſo as ſine of the co-latitude, thus found : ſine of the co-declination : : ſine of right aſcenſion to the coſine of the longitude, which will be in the ſame quadrant with the right aſcenſion.

N. B. On account of the preceſſion of the equinoxes, the fixed ſtars, although they keep always the ſame latitudes, are nevertheleſs conſtantly altering their longitudes, declinations, and right aſcenſions; the alteration in longitude is uniformly about 50″ yearly; but that of the right aſcenſion and declination is continually varying. So that many ſtars which once had north declination come to have ſouth, while others are changing from ſouth to north declination.

PROBLEM XV. *Given the right Aſcenſions and Declinations of two fixed Stars. Required their Diſtance?* See Plate IV. *Figure* 13.

Let the primitive circle repreſent the circle of right aſcenſion of that ſtar, whoſe right aſcenſion is the greateſt; and let a circle of right aſcenſion PAS be drawn, ſo as to make an angle with PBS equal to the difference between the given right aſcenſions; then drawing the parallels of declination B*m* and *r s*, the interſections B and A will be the places of the two ſtars; B, being that whoſe right aſcenſion is the greateſt, and A, the other. Then drawing a great circle, BAC, through BA, there will be given in the ſpheric triangle BPA, the ſide BP = co-declination of the ſtar B; PA = co-declination of the ſtar A; and the included angle APB = difference of their right aſcenſions, to find their diſtance AB.

The data in this Problem are therefore the ſame as in the laſt, and the ſame method which ſolves the firſt caſe of that Problem, is equally applicable in this. See alſo Spherical Trigonometry.

PROBLEM. XVI. *Given the Latitude, and Longitudes of two known fixed Stars. Required their Diſtance?*

The conſtructions of this Problem, is like that of the laſt; only, inſtead of circles of right aſcenſion, read circles of longitude; and uſe parallels of latitude, inſtead of parallels of declination.

The method of computation is alſo the ſame, there being given two co-latitudes; and the included angle, which is the difference betwen the given longitudes.

PROBLEM XVII. *Given the Latitude and Longitude of a fixed Star, and alſo the Obliquity of the Ecliptic. Required the right Aſcenſion and Declination of ſuch Star?*

The conſtruction of this Problem is much the ſame as that of Problem XIV, only here the interſection of a parallel of latitude *c b*, with a circle of longitude *pAq*, will give the place of the ſtar.

The computation is alſo as in Problem XIV. for here are given P*p*, the obliquity of the ecliptic, *p*A = co-latitude, and ∠PpA = co-longitude, to find PA the co-declination, and ∠*p*PA, the right aſcenſion.

PROBLEM XVIII. *Given the Meridional Altitude of any Celeſtial Object, ſuppoſe a Comet, its diſtance from a known Star, and the Latitude of the Place. Required the Declination and right Aſcenſion of that Comet.* See *Figure* 14.

The primitive circle repreſents the meridian of the place; HR, the horizon; and ZN, the prime vertical; alſo RP = the latitude; EQ the equator; *n m* the parallel of declination of the propoſed ſtar; HO, the altitude of the comet; *a a*, a ſmall circle; O*a* being equal to the diſtance of the comet from the ſtar; and the place (✳) where it interſects *n m*, is the poſition of the ſtar at that time; likewiſe P✳S is a circle of right aſcenſion; and ⊙✳, a part of a great circle.

Then ſince HE is equal to the co-latitude, and HO = the altitude of the comet, it follows that EO, the required declination = HOSHE, which is north, when the altitude exceeds the co-latitude.

Alſo, in the triangle P✳O, there are given the three ſides, viz. PO = co-declination of the comet; ⊙✳ = diſtance between the comet and ſtar; and P✳ the co-altitude: to find the ∠OP✳ the difference between the right aſcenſions of the comet and ſtar; for the ſolving of which ſee SPHERICAL TRIGONOMETRY: then this difference ſubtracted from or added to the ſtars right aſcenſion according as the ſame is greater or leſs than the comets, will give the right aſcenſion of the comet.

PROBLEM XIX. *Given the Latitude of a Place, the Suns Declination and Azimuth, required his Altitude, and the Time of Obſervation.* See Plate IV. *Figure* 15.

To illuſtrate this by an example,

Let the latitude be 13¼° north, and the ſun's declination 23° 28′ north; required the ſun's altitude, and the time of the day when he is ſeen on the ENE azimuth circle.

Here the primitive circle repreſents the meridian of the place HR, the horizon; ZN, the prime vertical; RP = the latitude, PS, the ſix o'clock hour circle; EQ, the equator; *nm*, the parallel of the ſun's greateſt declination; ZDN, the vertical circle; which cuts the parallel *nm* in the points A and B, and thereby ſhews, that at two diſtant times in the forenoon the ſun will have the azimuth propoſed; PAS and PBS, drawn through the points of interſection, A and B, are hour circles.

Now, in the ſpheric triangle PZA or PZB, there are known the co-latitude PZ = 76¼°, the co-declination PA or PB = 66° 32′, and the azimuth angle, PZD = 67½°, to find ZA or ZB, and the ∠ ZPA or ZPB.

Now, as radius : coſ. azimuth : : co-tangent latitude : tangent of a fourth arc (M) = 57° 54′; and, as the ſine latitude : ſine declination : : coſ. M. : coſ. of a fifth arc (N) = 24° 54′.

Then, M + N, or 57° 54′ + 24° 54′ = 82° 48′ = ZA, the complement of the leſs altitude; and M — N, or 57° 54′ — 24° 54′ = 33° = ZB, the complement of the greater altitude. Therefore, when the ſun has 7° 12′, or 57° of altitude, he is on the given azimuth.

Again: As coſ. declination : ſine of azimuth : : coſ. leſs altitude : ſine of hour from noon = 88° 2′; and : : coſ. greater altitude : ſine of hour from noon = 33° 16′.

Alſo, 88° 2′ = in time, 5 hours, 52 minutes; and 33° 16′ = 2 hours, 13 minutes, the reſpective times from noon; and conſequently the ſun will be ſeen on the ENE azimuth, at 6 hours, 8 minutes, and again at 9 hours, 48 minutes in the morning. In the afternoon he will be ſeen on the WNW azimuth at 2 hours, 13 min. and at 5 hours, 52 minutes.

If it is required to find at what altitude the greateſt azimuth will happen at that place on the ſame day; then, ſince the azimuth circle in that caſe muſt touch the parallel *nm*, the greateſt diſtance of the equator will be 23° 28′; and, as their poles muſt be at the ſame diſtance, the interſection *p* of a ſmall circle (*rs*) with the horizon deſcribed about the pole S, at the diſtance of 23° 28′, will be the pole of the circle ZCN; then, having deſcribed an hour circle, PCS through *p*, there will be given in the ſpheric triangle, ZPC right-angled at C, the co-latitude PZ = 76¼°, and the co-declination PC = 66° 32′, to find the greateſt azimuth or ∠; PZC (= 70° 36′) the diſtance, ZC, (= 54° 8′); and the hour from noon (= 56° 27′) = 3 hours, 46 minutes.

PROBLEM XX. *Given the Sun's Declination and Amplitude to find the Latitude of the Place.*

Here (Plate IV. *Fig.* 16) HR is the horizon; RO, the azimuth; EO, the equator ♈O, the co-amplitude, AO, the declination; and ∠A♈O, the co-latitude; therefore, in the ſpheric triangle, ♈OA, right-angled at A, there is given ♈O and AO to find ∠A♈O. The proportion is, as ſine ♈O : radius : : ſine AO : ſine ∠A♈O, the co-latitude required.

PROBLEM XXI. *Given the Sun's Declination and his Aſcenſional Difference; required the Latitude of the Place.*

If the foregoing Problems, with their conſtructions, are well underſtood, the reader will not be at a loſs in deſcribing this and the remaining Problems in this Section; and therefore I ſhall only give the method of calculation in each caſe, and paſs over the conſtructions, that we may find room for other matters that are more eſſential to Aſtronomy. The proportion in this caſe is, as radius : co-tangent of the declination : : ſine of the aſcenſional difference : tangent of the latitude.

PROBLEM XXII. *Given the Sun's Declination and Altitude at ſix o'Clock; required the Latitude of the Place.*

SOLUTION.

As ſine of the declination : radius : : ſine of altitude : ſine of latitude.

PROBLEM XXIII. *Given the Sun's Declination and Altitude when he is due Eaſt or Weſt; required the Latitude of the Place.*

SOLUTION.

A ſine of altitude : radius : : ſine of declination : ſine of the latitude.

PROBLEM XXIV. *Given the Sun's Altitude and Hour of the Day, on either Equinox; required the Latitude of the Place.*

SOLUTION.

As ſine of the time from ſix : radius : : ſine altitude : coſine of latitude.

PROBLEM XXV. *Given the Sun's Altitude, Declination and Azimuth; required the Latitude of the Place.*

SOLUTION.

As radius : coſine azimuth : : co-tangent altitude : tangent of a fourth arc. And, as ſine of altitude : ſine declination : : coſine of fourth arc : coſine of a fifth arc. Then the difference between the fifth and fourth arcs is the co-latitude.

PROBLEM XXVI. *Given the Sun's Declination, his Altitude, and the Hour of the Day; required the Latitude of the Place.*

SOLUTION.

As radius : coſine of hour from noon : : co-tangent of declination : tangent of a fourth arc. And, as ſine declination : ſine altitude : : coſine of fourth arc : coſine of fifth arc. Then the difference between thoſe arcs is the co-latitude.

Other

Other Problems might be added, but they are ſuch as ſeldom occur in practice; and thoſe who perfectly underſtand how to ſolve what have been here given, will not find it difficult to ſolve any other of the like nature, the whole depending on the doctrine of ſpherical triangles.

But ſeveral of the foregoing Problems may alſo be applied to other caſes than thoſe propoſed; viz. when the things concerned in each are the ſame, but with this difference, that the thing required in one caſe be given in the other, and that one of the things given in one caſe, be required in the other; for then the ſolution is had by merely varying the proportion.

Thus, in Problem XXIV. ſuppoſe the latitude had been given and the altitude required, then the proportion would have been as radius: ſine of hour from ſix :: coſine latitude: ſine of altitude; and ſo for any other; obſerving, that when the firſt term of any of the proportions is wanted, it will be, as 4th term: 3d term :: 2d term: 1ſt term. When the 2d term is wanted, it will be, as the 3d term: 4th term :: 1ſt term: term required; and when the 3d term is ſought, it will be, as the 2d term: 1ſt term :: 4th term: 3d term; it being evident, from the nature of equations and the doctrine of Ratio's, that the proportions will hold in each caſe.

SECT. X.

OF THE TIDES:

Or, an Explanation of the Flux and Reflux of the Sea.

To account for the ebbing and flowing of the ſea, is a ſubject that has excited the attention of philoſophers in every age; but the diſcovery of its true cauſe was reſerved for the honour of the illuſtrious Newton, who has ſhewn that the flux and reflux of the ſea is a natural conſequence reſulting from the laws and principles of gravitation, effected by the action of the moon upon the earth, or rather by the joint actions of the ſun and moon; that, however, of the moon, being by far the moſt conſiderable.

In explaining the phænomena of the tides it muſt be obſerved, that the power of gravity diminiſhes as the ſquare of the diſtance increaſes; and therefore the waters at Z (See Plate IV. *Figure* 17.) on the ſide of the earth ABCDEFGH next the moon M are more attracted than the central parts of the earth O by the moon, and the central parts are more attracted by her than the waters on the oppoſite ſide of the earth at *n*; and therefore the diſtance between the earth's centre and the waters on its ſurface under and oppoſite to the moon will be increaſed. For, let there be three bodies at H, O, and D; if they are all equally attracted by the body M, they will all move equally faſt toward it, their mutual diſtances from each other continuing the ſame. If the attraction of M is unequal, then that body which is moſt ſtrongly attracted will move faſteſt, and this will increaſe its diſtance from the other body. Therefore, by the law of gravitation, M will attract H more ſtrongly than it does O, by which the diſtance between H and O will be increaſed; and a ſpectator on O will perceive H riſing higher toward Z. In like manner, O being more ſtrongly attracted than D, it will move farther towards M than D does: conſequently, the diſtance between O and D will be increaſed; and a ſpectator on O, not perceiving his own motion, will ſee D receding farther from him towards *n*; all effects and appearances being the ſame, whether D recedes from O, or O from D.

Suppoſe now there is a number of bodies, as A,B,C,D,E,F,G,H, placed round O, ſo as to form a flexible or fluid ring: then, as the whole is attracted towards M, the parts at H and D will have their diſtance from O increaſed; whilſt the parts at B and F being nearly at the ſame diſtance from M as O is, theſe parts will not recede from one another; but rather, by the oblique attraction of M, they will approach nearer to O. Hence, the fluid ring will form itſelf into an ellipſe ZIBL*n*KFNZ, whoſe longer axis *n* OZ produced, will paſs through M, and its ſhorter axis BOF will terminate in B and F. Let the ring be filled with fluid particles, ſo as to form a ſphere round O; then, as the whole moves towards M, the fluid ſphere being lengthened at Z and *n*, will aſſume an oblong or oval form. If M is the moon, O the earth's centre, ABCDEFGH the ſea, covering the earth's ſurface, it is evident, by the above reaſoning, that whilſt the earth by its gravity falls toward the moon, the water directly below her at B will ſwell and riſe gradually towards her; alſo the water at D will recede from the centre (ſtrictly ſpeaking the centre recedes from D), and riſe on the oppoſite ſide of the earth; whilſt the water at B and F is depreſſed, and falls below the former level. Hence, as the earth turns round its axis from the moon to the moon again in 24½ hours, there will be two tides of flood and two of ebb in that time, as we find by experience.

As this explanation of the ebbing and flowing of the ſea is deduced from the earth's conſtantly falling towards the moon by the power of gravity, ſome may find a difficulty in conceiving how this is poſſible, when the moon is full, or in oppoſition to the ſun; ſince the earth revolves about the ſun, and muſt continually fall towards it, and therefore cannot fall contrary ways at the ſame time: or if the earth is conſtantly falling towards the moon, they muſt come together at laſt. To remove this difficulty, let it be conſidered, that it is not the centre of the earth that deſcribes the annual orbit round the ſun, but the common centre of gravity of the earth and moon together: and that whilſt the earth is moving round the ſun, it alſo deſcribes a circle round that centre of gravity; going as many times round it in one revolution about the ſun as there are lunations or courſes of the moon round the earth in a year: and therefore the earth is conſtantly falling towards the moon from a tangent to the circle it deſcribes round the ſaid common centre of gravity.

The earth's diameter bears a conſiderable proportion to its diſtance from the moon; but is next to nothing when compared to its diſtance from the ſun. Therefore the difference of the ſun's attraction on the ſides of the earth under and oppoſite to him, is much leſs than the difference of the moon's attraction on the ſides of the earth under and oppoſite to her; and conſequently the moon muſt raiſe the tides much higher than they can be raiſed by the ſun.

From this theory it may be thought the tides ought to be higheſt directly under and oppoſite to the moon. But we find, that in open ſeas, where the water flows freely, the moon is generally paſt the meridian, when it is high water. The reaſon is obvious: for though the moon's attraction was to ceaſe altogether, when ſhe was paſt the meridian, yet the motion of aſcent communicated to the water before that time, would make it continue to riſe for ſome time after; much more muſt it do ſo when the attraction is only ſomething diminiſhed.

Thus, to inſtance a ſimilar caſe, experience ſhews, that the day is hotter about three in the afternoon, than when the ſun is on the meridian, becauſe of the increaſe made to the heat already imparted.

The tides anſwer not always to the ſame diſtance of the moon from the meridian at the ſame places; but are variouſly affected by the action of the ſun, which brings them on ſooner when the moon is in her firſt and third quarters, and keeps them back later when ſhe is in her ſecond and fourth: becauſe, in the former caſe, the tide raiſed by the ſun alone would be earlier than the tide raiſed by the moon; and, in the latter caſe, later.

When the moon is neareſt the earth, ſhe attracts ſtrongeſt, and ſo raiſes the tides moſt; the contrary happens when ſhe is fartheſt from the earth, becauſe of her weaker attraction. When both luminaries are in the equator, and the moon in perigee, ſhe raiſes the tides higheſt of all, eſpecially at her conjunction and oppoſition; both becauſe the equatorial parts have the greateſt centrifugal force from their deſcribing the largeſt circle, and from the concurring actions of the ſun and moon. At the change, the attractive forces of the ſun and moon being united, they diminiſh the gravity of the waters under the moon, and their gravity on the oppoſite ſide is diminiſhed by means of a greater centrifugal force. At the full, whilſt the moon raiſes the tide under and oppoſite to her, the ſun, acting in the ſame line, raiſes the tide under and oppoſite to him; whence the conjoint effect is the ſame as at the change; and, in both caſes, occaſion what we call the Spring Tides. But at the quarters the ſun's action on the waters at O and H diminiſhes the effect of the moon's action on the waters at Z and N; ſo that they riſe a little under and oppoſite to the ſun at O and H, and fall as much under and oppoſite to the moon at Z and N; making what we call the Neap Tides, becauſe the ſun and moon then act croſs-wiſe to each other. But theſe tides happen not till ſome time after; becauſe in this, as in other caſes, the actions do not produce the greateſt effect when they are at the ſtrongeſt, but ſome time afterward.

The ſun, being nearer the earth in winter than in ſummer, therefore the greateſt tides happen not till ſome time after the autumnal equinox, and return a little before the vernal.

As the tides are principally governed by the moon, they muſt turn on the axis of the moon's orbit, or nearly ſo, which is inclined 23½ degrees to the earth's axis at a mean ſtate: and therefore the poles of the tides muſt be ſo many degrees from the poles of the earth, or in oppoſite points of the polar circles, going round theſe circles in every lunar day.

When the moon is in the equator, the tides are equally high in both parts of the lunar day, or time of the moon's revolving from the meridian to the meridian again, which is 24 hours 50 minutes. But as the moon declines from the equator towards either pole, the tides are alternately higher and lower at places having North or South latitude. Whilſt the moon has North declination, the greateſt tides in the northern hemiſphere are when ſhe is above the horizon; and the reverſe whilſt her declination is South.

But the tides are ſo retarded in their paſſage through different ſhoals and channels, and otherwiſe ſo variouſly affected by ſtriking againſt capes and headlands, that to different places they happen at all diſtances of the moon from the meridian, conſequently at all hours of the lunar day. The tide propagated by the moon in the German ocean, when ſhe is three hours paſt the meridian, takes 12 hours to come from thence to London bridge; where it arrives by the time that a new tide is raiſed in the ocean. And therefore, when the moon has North declination, and we ſhould expect the tide at London to be greateſt when the moon is above the horizon, we find it is leaſt; and the contrary, when ſhe has South declination. At ſeveral places it is high-water three hours before the moon comes to the meridian; but that tide which the

moon puſhes as it were before her, is only the tide oppoſite to that which was raiſed by her when ſhe was nine hours paſt the oppoſite meridian.

SECT. XI.

OF THE ABERRATION OF THE FIXED STARS, CAUSED BY THE COMPOUND MOTION OF THE RAYS OF LIGHT, AND OF THE EARTH IN ITS ORBIT.

IT is found from obſervations of the eclipſes of Jupiter's ſatellites, that light is about 8 minutes in paſſing from the ſun to the earth: and as the earth deſcribes about 1° in a day, it will therefore in 8 minutes deſcribe 20″ in its orbit; and conſequently the velocity of light is to the velocity of the earth in its orbit, as radius to an arc of 20″, or as 10300 to 1.

Now, if AN (Plate IV. *Figure* 18.) be the path of a body in free ſpace, its apparent way on a moveable plane will be different, for it will be that which is made by the reſolution of the two motions on a moveable plane.

Thus let AN be deſcribed in any time by the body, and NF be deſcribed by (a point in) the plane, in the ſame time. Now as the plane moves forward in the direction NF or AB, it leaves all the points of the fixed line AN behind it; all of which will therefore ſeem to move backwards in the plane. Therefore make ND = NF, for the body, inſtead of going to N in free ſpace will ſeem to go to D, and therefore AD will be the apparent path of the body in that plane. Therefore a ray of light emitted from the ſtar in the direction AN, will fall upon the point D of the moving plane; and, hence, an obſerver at D will ſuppoſe the ſtar ſituated in the line DA. Conſequently, if BN be parallel to AD, and the point D tranſlated to N in the ſaid time, an obſerver at N will ſuppoſe the ſtar ſituated in the line NB, making the angle BNF or ADF leſs than ANF, the angle, which it would appear under if the plane was at reſt; ſo that the angle of elevation BNF above the line of direction NF of the obſerver, is leſs than before, being taken on the ſide towards which the obſerver moves. The obſerver, therefore, inſtead of ſeeing the ſtar at A, its real place will ſee it at B, its apparent place. On the contrary, if the obſerver moves from F to N and D; and B, be the real place of the ſtar; then to an obſerver, if at N, its apparent place would be at A.

The apparent place B is always in the plane of aberration, drawn through the way of the obſerver NF, and the line NA drawn from the obſerver to the real place of the ſtar; for AB, being parallel to NF, is in the plane ADNF, and the angle BNA or NAD, is the angle of aberration; and by the quantity of this angle, the ſtar is depreſſed, in going towards it; or raiſed in going from it.

Now in the triangle AND it is as AN : ND :: ſine ADN : ſine NAD; but AN and ND being given, the ſine ∠NAD, the aberration, will be as ſine ADN. And becauſe AN is 10300 times as great as ND, therefore the ſine NAD does not differ from its arc or angle, and conſequently the angle of aberration NAD or ANB, is always as the ſine of the angle of the earth's way, ADN, or ANF. Hence the angle of aberration ANB is greateſt when AN is perpendicular to ND, and becomes nothing when ANF is nothing.

And ſince AN is to ND, as radius to 20″; therefore, when AN is perpendicular to ND, the ∠NAD, or ANB, will be 20″, which is the greateſt it can be. In other caſes it will be as rad. : ſine ANF, (the angle of the earth's way) :: 20″ to the aberration correſponding to that angle, which angle is always taken in the plane of aberration ADNF.

By reaſon of the aberration, if a ſtar was placed in the pole of the ecliptic, it would appear to deſcribe a circle of 40″ diameter round the pole in a year. Any other ſtar will appear to deſcribe a ſmall ellipſis in a year; the tranſverſe axis of which is 40″, and parallel to the ecliptic; and the conjugate axis thereof at right angles to the former, and leſs than it in the ratio of it to the ſine of the ſtar's latitude.

M. De La Caille, in his valuable Treatiſe of Aſtronomy, gives the following methods for finding the aberration in right aſcenſion and declination of a ſtar.

FOR THE ABERRATION IN RIGHT ASCENSION. Seek in the Aſtronomical tables that point of the ecliptic, which correſponds to the point of the equator marked by the right aſcenſion of the ſtar; this point (which call N) is always that wherein the ſun being found, the aberration makes the apparent right aſcenſion the leaſt. Take in the ſame tables the angle made by the ecliptic, and a meridian paſſing through that point N, and ſay, as the product of the radius by the coſine of the declination of a ſtar, is to the product of the coſine of the diſtance of the ſun from the point N, by the ſine of the angle between the ecliptic and meridian of N, ſo is 20″ to the aberration in right aſcenſion; and is additive or ſubtractive, according to the ſituation of the ſun to the point N, which is eaſy to determine.

FOR THE ABERRATION IN DECLINATION. Take from the Aſtronomical tables the declination of the point N, and ſay as the ſum of the declinations of the ſtar and the point N (if of different names) or of their difference (if of the ſame name) is to the coſine of the right aſcenſion of the ſtar; ſo is the ſine of the obliquity of the ecliptic, to the co-tangent of an arc, which is the diſtance between the point N in the ecliptic, where the aberration in right aſcenſion makes his right aſcenſion the leaſt; and that point of the ecliptic (which call T) where the ſun is found, when the aberration in declination makes his declination the leaſt.

The point T is obtained by ſubtracting the arc found from the place of N, if the right aſcenſion of the ſtar is proceeding from 0° to 90° with ſouth latitude and north declination; or from 180° to 270° with north latitude and ſouth declination; or, T is found by adding this arc to the place N, if the right aſcenſion is between 270° and 90° with latitude and declination, both north; or between 90° and 270° with latitude and declination, both ſouth. On the contrary, the ſupplement of the ſaid arc from place N muſt be ſubtracted, if the right aſcenſion is between 90° and 180° with ſouth latitude and north declination; or is between 270° and 360° with north latitude and ſouth declination. Finally, the ſupplement of this arc from the place N muſt be added, if the right aſcenſion is between 270° and 90° with latitude and declination, both ſouth; or between 90° and 270° with latitude and declination, both north.

Then ſay, as the product of the radius by the ſine of NT, is to the product of the coſine of the diſtance of the ſun from the point T, by the ſine of the ſum, or difference, of the declination of the ſtar and point N, ſo is 20″ to the aberration in declination; which is eaſily applied to the true declination of the ſtar, according to its ſituation in regard to the ſun.

The effect of the aberration of light on the planets may be found thus. Say as the horary motion of the ſun, multiplied by the radius of the annual orbit of the earth, is to the diſtance of the earth from the planet multiplied by 20″; ſo is the horary motion of the planet, in longitude, in latitude, in right aſcenſion, or declination, to a quantity, whereby the aberration of light has diminiſhed ſuch longitude, latitude, right aſcenſion, or declination.

SECT. XII.

OF THE IRREGULAR MOTIONS OF THE PLANETS, THE METHODS OF DETERMINING THEIR PLACES, THE EQUATION OF TIME, &c.

IN order to the underſtanding of the matters treated of in this Section, it will be proper to premiſe the following definitions.

I. The TRUE ANOMALY of a Planet, is the angle ASN (at the ſun S) comprehended between the aphelion A, and the planet N, in its orbit; or of a comet between it and the perihelion. See Plate IV. *Figure* 19.

II. The MEAN ANOMALY is an angle ASG, taken proportional to the time of the planet's moving from the aphelion A, to the place N, in its orbit. An arch of a circle, or the area ANS of the ellipſis, may alſo be taken for the mean anomaly.

This angle ASG increaſes uniformly with the time, or with the area ANS; and therefore the motion of SG, round the centre S, is called the MEAN MOTION.

III. THE EQUATION OF THE CENTRE, is the ∠ NSG, or the difference between the True and Mean Anomalies. This is alſo named the *Prothaphaereſis*.

IV. The HELIOCENTRIC PLACE, HELIOCENTRIC LONGITUDE, and HELIOCENTRIC LATITUDE of a Planet, are the planet's place, longitude and latitude, as ſeen from the ſun.

V. If S be the ſun (*Figure* 20) E, the earth; P, the planet, and PB perpendicular to the ecliptic. Then in the triangle EPS, or EBS, reduced to the ecliptic, the angle at the ſun ESP, or ESB, contained between the earth and the planet, is called the ANGLE OF COMMUTATION.

VI. THE ANGLE OF ELONGATION, is the angle at the earth PES, or BES, contained between the ſun and the planet,

VII. THE PARALLAX OF THE ORBIT is the angle at the planet, or its place in the ecliptic EPS, or EBS, contained between the ſun and earth. Here A E is the earth's orbit, NPC the planet's orbit, NB its orbit, reduced to the ecliptic, HSN, the LINE OF THE NODES, and N, the ASCENDING NODE.

VIII. THE CURTATE DISTANCE of a Planet from the ſun or the earth, is the line SB or EB, drawn from the ſun or the earth, to the point where the perpendicular from the planet cuts the ecliptic. This is the diſtance of the planet from the ſun or the earth, reduced to the ecliptic.

IX. THE ARGUMENT OF LATITUDE, is the Angle at the ſun, NSP, between the Planet and its aſcending Node, reckoned in the planet's orbit, NPC.

X. THE RADIX is the place of a planet at ſome remarkable point of time, as the birth of Chriſt, the beginning of a particular century, &c. From this point all the motions are calculated as from a fixed foundation.

XI. APPARENT OR SOLAR TIME, is the time as it is ſhewn by the ſun, and proceeds irregularly, by reaſon of the earth's motion, which is ſometimes quicker or ſlower than at other times.

XII. MEAN OR ASTRONOMICAL TIME, is the Time that goes forward uniformly, without any acceleration or retardation. This is alſo called TRUE TIME.

XIII. AN ASTRONOMICAL DAY, begins at the noon of the preceding day, and ends at the noon of the following day, the hours being reckoned from 1 to 24.

XIV. THE ASTRONOMICAL YEAR begins and ends on the laſt

laſt day of December, at *noon*, and theſe beginnings or endings are different, in different places according to the difference of longitude.

PROPOSITION I. *Having given either the true Anomaly or the Diſtance of a Planet from the Sun, to find the other, and the Time when it will be in that part of its Orbit correſponding therewith, as alſo the mean Anomaly.*

Here the periodical time, the orbit of the planet, and the time of its being in its perihelion being ſuppoſed to be known, Mr. Emerſon has demonſtrated that if PNAB (*Figure* 21) be the orbit, S the ſun, C the centre, P the perihelion, A the aphelion, and if the ſemi-tranſverſe CP be put $= a$, ſemiconjugate CB$= c$, eccentricity CS$= n$, the diſtance of the planet SN$= y$; its periodic time t; coſine of Angle PSN$= z$, and D$=$ number of degrees in the arc whoſe coſine is $\frac{a-y}{n}$, and radius 1, that the time of the planets deſcribing the part of its orbit SPN will be truly exhibited by this expreſſion $\frac{D\,t}{360} - \frac{t\sqrt{2ay-cc+yy}}{2a\quad 3.1416}$, and if y (which is equal $\frac{cc}{a+zn}$) is given, then z, or the true anomaly which is equal to $\frac{cc-ay}{ny}$, is alſo given; or if z, or the true anomoly be given, then y or the time of the planets arriving at N will be known; and the difference between this time and half the periodic time, will give the time of its moving from the aphelion.

If the planet in moving from the perihelion be paſt the aphelion, then the above expreſſion ſhews the time in which it will come to the perihelion again.

Alſo the mean anomaly will be equal to D$-\frac{57.29578\sqrt{nn-a-y)^2}}{a}$ reckoning from the perihelion.

PROPOSITION II. *From the mean Anomaly given to find the true Anomaly.*

By the laſt Propoſition, the Mean Anomaly is found directly from the true; but there is no direct way of finding the true Anomaly from the mean; but Mathematicians are obliged to have recourſe to methods of approximation.

The following Solution, by the late excellent aſtronomer and mathematician, Mr. G. WITCHEL, may be acceptable to our readers.

"To explain this, let AρHP, (Plate IV. *Fig.* 22) be the elliptic orbit of the planet, ACP the tranſverſe axis, HC the ſemi-conjugate, and S, the focus in which the ſun is placed; moreover, let Aρ, and P repreſent any three places of the planet, at three given inſtants of time: then it will be, as the time of deſcribing the elliptic arc Aρ, is to the time of deſcribing the elliptic arc ρP, ſo is the trilinear area AρS, to the trilinear area ρPS, and conſequently, the given area of the ſemi-ellipſe AρPA, is divided by the line ρS, in the given ratio of the time of deſcribing the elliptic arc Aρ, to the time of deſcribing the elliptic arc ρP. To divide an ellipſis in this manner, is the famous Keplerian problem, which has exerciſed geometricians for almoſt two centuries.

Solution.

"Let the ſemi-circle AGP be deſcribed upon the tranſverſe axis ACP, and through ρ, the place of the planet, let DρE be drawn, parallel to the ſemi-conjugate HC, meeting the ſemi-circle, in the point E; join E,S, and the ſemicircle will be divided by the line ES, in the ſame ratio as the ſemi-ellipſe AHP is by the line ρS, as is demonſtrated by the writers on conics; let E,C, be joined, upon which, produced if needful, let fall from S, the perpendicular SF; take the arc EM equal in length to the right-line SF, and join M,C: Then it is evident, that the area of the ſector ECM, will be equal to the area of the triangle ECS, and conſequently, the area of the ſector ACM, will be equal to the trilinear area ASE: hence the ſector AMC, or the angle ACM, will be proportional to the elliptic area AρS, which is called, the mean anomaly, of the planet, as the angle ACE, is denominated, the ECCENTRIC ANOMALY, and the angle ASρ, the true, or co-equate anomaly."

Mr. Witchel proceeds to find the eccentric anomaly, and from thence the true anomaly on principles which evince his profound knowledge in geometry, and concludes with the following

PRACTICAL RULE.

"It will be moſt convenient to have the eccentricity expreſſed in decimal parts of the ſemi-tranſverſe axis: that done, from the log. of the perihelion diſtance, ſubtract the log. of the aphelion diſtance, and let the remainder be called A; likewiſe to the log. of the eccentricity add the log. 1.758123 (being the log. of the number of degrees contained in an arc equal to the radius) and call the ſum B; to the log. A, add the log. tangent of half the mean anomaly, and the ſum will be the log. tangent of an arc; ſubtract this arc from half the mean anomaly, and to the log. ſine of the remainder add the log. 1.758123, and the ſum will be the log. of the difference of the mean and eccentric anomalies, very nearly; then if the mean anomaly be leſs than 180°, ſubtract this difference therefrom, otherwiſe add it thereto, and it will give the firſt value of the eccentric anomaly, which will be ſufficiently exact in each of the planets, except Mars and Mercury: In the former the error, when greateſt, will be about three-fourths of a ſecond; but in the latter, it will amount to one-third of a minute: in order therefore, to correct it, let the log. ſine of the eccentric anomaly, as found above, be added to the log. B, and the ſum will be the log. of the difference of the two anomalies to a ſtill greater exactneſs: then, if to the log. co-ſine of the eccentric anomaly, there be added the log. of the eccentricity, the ſum will be the log. of a fraction, which, if the eccentric anomaly is more than 270°, or leſs than 90°, muſt be added to unity, otherwiſe ſubtracted therefrom, and the ſum, or difference, will be a number, by which if the difference of the two values of the eccentric anomaly be divided, the quotient will be the error of the firſt value of the eccentric anomaly: then if the eccentric anomaly is in the firſt or third quadrant, let the error be ſubtracted therefrom, otherwiſe added thereto, and it will give the eccentric anomaly to a very great degree of exactneſs: laſtly, to the log. tangent of half the eccentric anomaly add half the log. of A, and the ſum is the log. tangent of half the true anomaly."

Mr. EMERSON has demonſtrated the following Properties:

1ſt. That the aphelion diſtance, AS, is to the ſemi-conjugate CH, as the tangent of half the eccentric anomaly, ACE, to the tangent of half the true anomaly ASρ.

2d. That the ſquare root of the aphelion diſtance SA is to the ſquare root of the perihelion diſtance SP, as the tangent of half the eccentric anomaly to the tangent of half the true anomaly.

3d. That the ſine of the true anomaly is to the ſine of the eccentric anomaly, as the ſemi-conjugate to the diſtance (Sρ) of the planet from the ſun.

4th. And that the ſine of half the true anomaly is to the ſine of half the eccentric anomaly, as the ſquare root of the perihelion diſtance, SP, to the ſquare root of Sρ, the diſtance of the planet from the ſun.

From the foregoing propoſitions, Tables may be made for computing the place of a planet in its orbit.

PROPOSITION III. *To find the Equation of Time, or the Difference between the true and apparent Time.*

All uniform motions are proportional to the times in which thoſe motions are performed: hence, if the times are given, the motions will be known, or if the motions are given, the times will be known, and conſequently the motions and times may be taken for the meaſures of one another; but ſince the motion of the earth (or apparent motion of the ſun) in its orbit, is not uniform the apparent time will not be equable.

Likewiſe, as the ſun's apparent motion is not in the plane of the equator, but in an orbit inclined to it in an angle of 23° 28', it will on that account alſo appear to move unequally therein, ſo that there are two cauſes that produce the inequality of natural days, to wit, the elliptical orbit of the earth, and its obliquity to the equator. To explain this, See Plate IV. *Figure* 23. Let ANP be the earth's orbit; S, the ſun, and let the area ASB be $=$ area PSD, then the areas ASB and PSD are deſcribed in equal times; and ſince AS is greater than PS, the arc PD is greater than AB. Conſequently the earth moves ſlower in the aphelion A, and quicker in the perihelion P, varying with an increaſed motion from A to P, ſo that at any place N, the angular motion is reciprocally as $\overline{SN}^2$.

Now, ſuppoſe AB and PD to be deſcribed in times equal to that of the earth's rotation; then, when the earth has made an entire rotation about its axis, the meridian of any place will paſs through the ſame ſtar as it did at the beginning, when it was at A. But the earth in the ſame time having really (or the ſun apparently) moved through an arc of the ecliptic equal to AB, the ſame meridian does not paſs through the ſun, it being then parallel to AS; and therefore the earth muſt continue its revolution about its axis, through an angle equal to ASB, before it can overtake the ſun.

Again, the earth paſſing through PD in the time of its rotation, the meridian, being then parallel to PA, will not paſs through the ſun at S, but the earth muſt continue its rotation through the angle PSD, before the meridian overtakes the ſun.

Now the angle PSD, being greater than the angle ASB, and the earth's diurnal motion being uniform, the meridian will be longer in overtaking the ſun at P than at A, or, which is the ſame, the ſun will be longer in coming to the meridian at P than at A, and ſo the day (viz. including day and night) will be longer when the earth is in the perihelion than in the aphelion; and ſince the perihelion happens near the middle of winter, the natural days will be longer in winter than in ſummer.

Again, by the doctrine of centripetal forces, the mean motion round S will be equal to the true motion, when SN is equal to the ſquare root of the product of the ſemi-axis, and that happens in two points of the orbit.

Let AEPQ, (*Figure* 24) be the prime vertical; EQ, the equinoctial; BL, the ecliptic. Suppoſe the ſun, moving uniformly, to be at D, then the meridian, PDFA, being drawn through the point D, and the poles P and A, it is plain that when D is near C, the motion CD, along the ecliptic, is greater than that along the equinoctial CF, becauſe the hypothenuſe CD is greater than the baſe CF; but when D is near L, the motion along the equi-

noctial FQ is greater than that in the ecliptic DL; for the part DL, almoſt coinciding with a parallel circle, muſt be leſs than the correſponding part, FQ, of the great circle. Hence there is a point between C and L, where the motion along CL is equal to the motion in the equator, CQ, or, which is the ſame, where the motion of longitude is equal to the motion of right aſcenſion; but in all other points theſe two motions are unequal. After a quadrant of the ecliptic is deſcribed, they coincide at L and Q, and therefore they coincide at the equinoctial and ſolſtitial points.

Hence, the equation of time is effected by two cauſes, ſolely independent on each other. When they concur together, they increaſe this inequality; when they are of a contrary kind, they decreaſe it; and, in this caſe, when they are equal to each other, the inequality vaniſhes.

To find the equation of time anſwering to each ſeparate cauſe, proceed thus.

I. *For that depending on the Elliptical Orbit of the Earth.*

Find the true anomaly from the mean, by a table computed for that purpoſe, according to Prop. II. the difference between the true and mean anomalies, converted into time, gives the equation of time; in which caſe obſerve, that from the aphelion to the perihelion, where they coincide, the mean place precedes the apparent place, but from the perihelion to the aphelion, the apparent place precedes the mean; and conſequently, the equation of time will be additive or ſubtractive accordingly.

II. *For the Equation depending on the Obliquity of the Ecliptic.*

Let CD, in the aforeſaid figure, be the ſun's longitude; and let CL (in the equinoctial) be taken equal to CD. Then in the right-angled triangle, CDF, there are given the hypothenuſe CD, and the angle C, to find the right aſcenſion CF; then CF, taken from CD or CI, gives the difference FI, which converted into time, is the equation for the longitude CD: where note, that the mean place, I, precedes the apparent place, F, in the firſt and third quadrants of the ecliptic; but in the ſecond and fourth quadrants, the apparent place precedes the mean, and the equation of time reſulting from this cauſe, is additive or ſubtractive accordingly.

The final, or total equation, as reſulting from both cauſes, is the ſum or difference of theſe equations, according as they are of like or different kinds, and is to be added or ſubtracted accordingly, as ſhall be denoted by the ſign of the greater of the two former equations.

PROPOSITION IV. *To find the Sun's Place and Diſtance at a given Time, by Aſtronomical Tables.*

Let L = the ſun's mean place or longitude; P = the place of the apogee; A = the ſun's mean anomaly; E = the equation belonging to the anomaly A, which is, +or —; G = the arc belonging to the equation of time, which is alſo +or —: and let D = log. diſtance of the ſun, anſwering to the ſaid anomaly; then L+E+C = ſun's true place, or P+A+E+G = ſun's place, and the number anſwering to the log. D, is his diſtance.

PROPOSITION V. *To find the Place of a Planet at a given Time, by Aſtronomical Tables.*

Let L = the planet's mean longitude or place; = F the longitude of the aphelion; L—F = A, the mean anomaly; E = the equation anſwering to A, which is +or —; N = the place of the aſcending node; L+E = H, the heliocentric longitude; H —N, the argument of latitude; R = the reduction belonging to H—N, which is +or —; then L+E+R = the true heliocentric longitude.

Alſo, let B = diſtance anſwering to A; X = the heliocentric latitude; and c = the curtation for H—N; then B—C = curtate diſtance of the planet in the place of the ecliptic; and the difference of the longitudes of the earth and planet is the angle of commutation, or angle at the ſun; then in the triangle made by the ſun, earth, and planet, there are two ſides, and the included angle made at the ſun, given, to find the angle at the earth or angle of elongation, which added to or ſubtracted from the ſun's place, according as the planet's place or ſun's place is foremoſt, (which will appear by the conſtruction, if a figure is drawn) will give the Geocentric Place of the planet.

The Geocentric Latitude will be found by the following proportion:

As the ſine of the angle of commutation reduced to the ecliptic : ſine of the elongation :: tangent of the heliocentric latitude : tangent of the geocentric latitude.

PROPOSITION VI. *To find the Time when a Planet is ſtationari.*

If the orbits of the planets were exact circles, the time might be exactly found, but as they are elliptical, there is no direct method by which this buſineſs can be accurately performed; however, as their orbits do not widely differ from circles, we may approach near to the time, which may be corrected by repeated trials.

Mr. Emerſon has demonſtrated, that if AR, and CB, (Plate IV. *Figure* 25.) be the orbits of two planets, both circular, and in the ſame plane; and S, the ſun in their common centre; and if the radius SA or SR be put = r, and the radius SB = R, then ſuppoſing one of them A, or B, to be the earth, and the other any planet, that ſuch planet will appear ſtationary to a ſpectator on the earth, when the coſine of the angle ASB = $\frac{\sqrt{Rr}}{R+r-\sqrt{Rr}}$, radius being 1. Whereof, having the mean diſtances of the earth and planet, find, by the above Theorem, the angle at the ſun between the earth and planet, when it is ſtationary; and for the time when the planet is ſuppoſed to be ſtationary or nearly ſo, find the heliocentric places of the earth and planet, and you will have the angle between them, as it appears at the ſun; then if this angle be the ſame as the ſtationary angle found as above, the aſſumed time is the time required, nearly; but if not, find the number of days which the earth and planet have to move in their orbits, till they make that angle; which may be done thus: Let P be the periodic time of the planet, p that of the earth, and x = number of days required. Then P : 360° :: x : $\frac{360x}{P}$, the arc run through by the planet; and as p : 360° :: x : $\frac{360x}{p}$, the arc run through by the earth; and the difference of theſe arcs or angles, muſt be put equal to the ſum or difference of the two former mentioned angles, as the caſe requires, which will give an equation from which x will be readily found, and ſo the time of their being ſtationary will be determined nearly; to correct which find the geocentric longitude of the planet for the day ſo determined, and alſo for the following day; if they happen to be the ſame, then the planet is ſtationary on one of theſe days; but if not, obſerve whether it is direct or retrogade. If it be direct, it is either ſhort of the firſt ſtation or paſt the ſecond. If it is retrogade, it is either paſt the firſt or ſhort of the ſecond ſtation. Wherefore you muſt accordingly take 3, 4, or more days, ſooner or later than this time as the caſe requires, and compute a new the geocentric longitude of the planet for that time and the day following; and if as before, theſe do not agree, a new time muſt be taken and their places computed again, till at laſt they are found to correſpond. Then, when you are within a day of the true time, compute the planets geocentric longitude for three ſucceſſive days; and ſo having the progreſs or regreſs of the planet for theſe times, the exact time of the planet's being ſtationary, may be found by the method of interpolation; for which, ſee the word INTERPOLATION.

PROPOSITION VII. *Having given the Time of any one Tranſit of Mercury, or Venus, over the Sun's Diſk to find all the Times, wherein we may expect to ſee a Tranſit of the ſame Planet, when it is in the ſame Node.*

It is known from obſervation that the inferior planets, Mercury and Venus, ſometimes paſs over the ſun's diſk, and appear thereon as black ſpots. This phænomenon can only happen when the earth and planet are in or near the line of nodes, the planet being at the ſame time retrograde.

The ſun muſt be ſo near the node, as that his apparent ſemi-diameter may exceed the geocentric latitude of the planet; for otherwiſe, it is evident the planet will not appear on his diſk.

Alſo, ſince the line of the nodes of each planet is nearly fixed in one place, the earth will be in the line of the nodes, always in or near the ſame point of his orbit; and hence, the planet being retrograde in the aſcending node, and the earth at that time in the line of nodes, the tranſits will conſtantly happen about the ſame time of the year; and the ſame for the deſcending node.

Now let P = the periodic time of the earth; and p, the periodic time of the planet; then we have only to find two whole numbers as x and y, ſuch as that xP may be equal to $y p$, or that $\frac{P}{p}$ may be equal to $\frac{x}{y}$; that is, to find two whole numbers in the ſame ratio, or nearly ſo, as p and P.

For Mercury, thoſe numbers, are $\frac{3}{13}$, $\frac{7}{17}$, $\frac{13}{33}$, $\frac{33}{113}$, $\frac{127}{}$, &c. each ratio approaching nearer and nearer to the truth; the upper number (x) is the number of ſydereal years, in which a tranſit may be expected to return.

At the end of 6 years it rarely happens, but frequently at the end of 7. Alſo at the end of 13, 33, 46, or any additions made by them, a tranſit will probably happen. On November 12, 1782, there was a tranſit of Mercury, and at the diſtance of about 7 years, viz. on November 5, 1789, there was another.—Alſo on May 4, 1786, there was a tranſit of Mercury, and at the diſtance of 13 years, viz. on May 7, 1799, there will be another, which are all that will happen in the preſent century.

For Venus, the numbers $\frac{x}{y}$ are $\frac{8}{13}$ $\frac{235}{382}$ $\frac{713}{1159}$ &c. therefore at the diſtance of 8 years, or 235 years, or 713 years, or their compounds, (though but ſeldom after 8 years) a tranſit of Venus will probably return. In 1639 on November 24, old ſtile there was a tranſit of Venus, and at the diſtance of about 235 years, viz. on November 27 A. D. 1784 old ſtile there will be another, alſo on May 23, A. D. 1769 there was a tranſit of Venus, and on May 28, A. D. 1996, there will be another which are all that will happen before the expiration of the two following centuries.

PROPOSITION VIII. *To find the exact Time of the Ingreſs and Egreſs of an inferior Planet, paſſing over the Sun's Diſk, and its neareſt Approach to the Sun's Centre.*

By the laſt propoſition find the time when the tranſit will nearly happen; and to that time find the place of the earth, and the planets heliocentric longitude: If theſe agree they are then in conjunction; but if not, the time of their conjunction muſt be found thus. Put P, p, for the periodic times of the earth and planet, reſpectively, then $\frac{360}{P} - \frac{360}{p}$ = the degree which the planet gains of the ſun in a day, which put = D. Then ſay as D° : 1 day :: difference between the earth's and planet's heliocentric places in degrees, to the time (in days) either to the conjunction, or paſt it, according as the earth or planet is foremoſt. But if that time ſhould prove to be not the time of the true heliocentric conjunction, the operation muſt be repeated till the true time is had, or the time may be found by the rule of falſe. Then having the heliocentric places of the earth and planet, the place of the node, and the diſtance between them, the daily or horary motions of both the ſun and planets, and the inclination of the orbit, which is the planet's path upon a fixed plane, the path or the planet on the moveable plane of the ſun's diſk may be eaſily found, as alſo its diſtance from the ſun's centre, when neareſt, and the time of the beginning and ending of the tranſit.

PROPOSITION IX. *To find the Quantity of Matter in any Body that has another revolving about it.*

Plate IV. *Figure* 25.

The quantity of matter in any central body, is as the cube of the diſtance of the revolving body directly; and the ſquare of the periodical time inverſly, by centripetal forces.

Let S be the ſun, E the earth, P a planet, T or Q a ſatellite, and let radius PT = r, periodical time of T or Q = p. Then the quantity of matter in the body P is as $\frac{r^3}{p^2}$, or $\frac{PT^3}{pp}$.

Now p or the periodic time is known for all the planets and ſatellites; and to find PT, let ST, EQ, be tangents to the orbit at T and Q; then PT is as SP × angle PST; or PQ, as PE × angle PEQ; becauſe theſe angles are very ſmall. Therefore SP × angle PST = PE × PEQ. Now the greateſt elongation, or the angle PEQ is found by obſervation; and the heliocentric places of the planet P, and the earth E are known, by the theory of the planets. Therefore in the triangle ESP, two ſides ES, SP, and the included angle ESP are given to find EP. And EP being known, as alſo PS, the angle PST will be known; and from hence QT or TP. And therefore the quantity $\frac{PT^3}{pp}$ will be known which is proportional to the quantity of matter in P.

Therefore it will be, as rad. : PE : : S.QEP : PQ or PT.

Or elſe, PS : PE : : angle PEQ : angle PST the heliocentric elongation; and then as rad : PS : : S.PST : PT. Thus the diſtance of Venus from the Sun is known to be 723.4. And PT for Jupiter's 4th ſattellite, is found to be 12.508; for Saturn's 4th ſatellite 8.5084; for the Moon 3.0546. And p or the periodic time for Venus, is 224d.7; for Jupiter's 4th ſatellite, 16.6874; for Saturn's 4th ſatellite, 15.944; and for the Moon, 27.322. Therefore $\frac{PT^3}{pp}$ for the Sun, Jupiter, Saturn, and the Earth, comes out 7497.87; .0255; 2.423; and .03817. Therefore the quantities of matter in the Sun, Jupiter, Saturn, and the Earth, are as 196420; 184.05; 63.48; and 1, reſpectively. This is ſuppoſing the ſun's parallax to be 10″¼ ſeconds, and conſequently the angle, the radius of the moon's orbit, ſubtends at the ſun, 10′ 30″. If the ſun's parallax be more or leſs than 10″¼; the quantity of matter in the earth muſt be increaſed or diminiſhed in the triplicate of that ratio; the reſt remaining the ſame.

COR. I. The real diameters of the ſun, and planets, are; for the Sun 10000, Saturn 790, Jupiter 996, Mars 57, the Earth 109, Venus 112, Mercury 40, the Moon 30.

COR. II. Hence the denſity of the ſun, and ſuch of the planets as have ſatellites, are; the Sun 100, Saturn 65¼, Jupiter 95, the Earth 393.

COR. III. The weight of a body at the ſurface of any planet, is as the denſity and diameter of the planet. And therefore is at the Sun 23.34, Saturn 1.208, Jupiter 2.209, and the Earth 1.

PROPOSITION X. *To find the Proportion between the Axis of the Sun or Planet, and its Equinoctial Diameter.*

Let r = radius of the ſun or planet, f = force of gravity on its ſurface, v = verſed ſine of the arch deſcribed in 1 ſecond by its rotation, to the radius r. H = equinoctial or greateſt radius. Then if the force of gravity f be denoted by the ſpace a heavy body deſcends in a ſecond at its ſurface, v will denote the centrifugal force ariſing from its revolving; and this is equal to the diminution of its gravity. But ſo much as the gravity of a column of the planet is diminiſhed, ſo much is its height increaſed, to make an equilibrium. And this is the ſame within the planet as at the ſurface; as both theſe forces decreaſe in the ſame ratio.

Therefore we ſhall have $f : f - v$: : H : r. And $f : f - v$: : 2 H : 2r; that is, $f : f - v$: : as the equinoctial diameter : to the polar diameter nearly.

Therefore, if the diameter and time of revolution be known; the arc deſcribed in a ſecond will be known, and v the verſed ſine of that arc. Alſo f will be known, by having the gravitating force upon the ſurface. And hence, the ratio of the diameters will be found.

COR. In the earth, the ratio of the axis to the equatorial diameter, will be found as 285 to 286. And in Jupiter as 11′ to 12. In the ſun the difference is quite inſenſible. In the reſt of the planets, there wants the proper data.

With regard to the ſeveral irregularities and inequalities which take place in the *lunar theory*, they are ſo many, and affected with ſuch variations, that I chooſe rather to refer to thoſe authors who have made them their peculiar ſtudy, and have written particularly on the ſubject, than enter into the minutias of a matter ſo perplexed and intricate that there are ſcarce two writers who are perfectly of one opinion The moſt diſtinguiſhed authors on this ſubject are Newton, Euler, De la Lande, Clairault and Mayer.

SECT. XIII.

OF COMETS.

Comets are ſo called from their having a long tail, ſomewhat reſembling the appearance of hair. Though this is not always the caſe; for ſome comets have appeared which were as well defined and as round as planets: but in general they have a luminous matter diffuſed around them, or projecting out from them, which to appearance very much reſembles the Aurora Borealis. When theſe appear, they come in a direct line towards the ſun, as if they were going to fall into his body; and after having diſappeared for ſome time in conſequence of their proximity to that luminary, they fly off again on the other ſide as faſt as they came, projecting a tail much greater and brighter in their receſs from him than when they advanced towards him; but, getting daily at a farther diſtance from us in the heavens, they continually loſe of their ſplendor, and at laſt totally diſappear. Their apparent magnitude is very different; ſometimes they appear only of the bigneſs of the fixed ſtars; at other times they will equal the diameter of Venus, and ſometimes even of the ſun or moon.

The true motion of comets was diſcovered from the obſervations made by Sir Iſaac Newton on the great comet of 1680. This deſcended almoſt perpendicularly towards the ſun, with a prodigious velocity; aſcending again with the ſame velocity retarded, as it had been before accelerated.

The many exact obſervations made on this comet enabled Sir Iſaac Newton to determine that they are a kind of planets which move in very eccentric ellipſis.

Dr. Halley collected all the obſervations he could on comets; and calculated the periodical times of 24 of them, on a ſuppoſition of their being parabolas but afterwards found that they agreed better with the ſuppoſition of their motion being performed in very eccentritic elliptical orbits. On this he calculated a table of their elements; from which it was manifeſt that they were not comprehended in the zodiac, ſome of them making an angle of upwards of 80° with the ecliptic.

By computations founded on theſe elements, the Doctor concluded that the comet of 1682 was the ſame which had appeared in 1607 and 1531: that it had a period of 75 or 76 years; and he ventured to foretel, that it would return about the year 1758.

The comet which appeared in 1661, was ſuppoſed to be the ſame with that of 1532, and to have a period of 129 years; and, from the equality of periods, and ſimilitude of appearances, it was concluded that the great comet of 1680 was the ſame which had appeared in 1106, in the time of Henry I. and the conſulate of Lampadius and Oreſtes, about the year 531, and in the year 44 B. C. before Julius Cæſar was murdered; conſequently its period muſt be about 575 years.

Since the time of Dr. Halley, other aſtronomers have calculated the elements of 25 other comets; all of which, excepting one of three which appeared in 1759, and which differs but little from that of 1531, 1607, and 1682, and is therefore accounted the ſame, differ very much from each other; ſo that we cannot help concluding them all to be different, and that the number of theſe bodies is very great.

Though the orbits of all comets are either parabolas or very eccentric ellipſes, yet there are vaſt differences among them; for the planes of ſome comets are almoſt perpendicular to others, and ſome of their ellipſes are much wider than others. The narroweſt ellipſes of any comet hitherto obſerved was that of 1680. There is alſo a great inequality in the motion of comets, their velocity being incomparably greater in their perihelion than in their aphelion.

Aſtronomers are now generally agreed, that comets are opaque bodies, enlightened by the ſun; and of this opinion was Sir Iſaac Newton, for the confirmation of which, he obſerves, that if a comet be ſeen in two parts of its orbit, at equal diſtances from the earth, but at unequal diſtances from the ſun, it always ſhines brighteſt in that neareſt the ſun.

Their diſtance may be known from their parallax, according to which Sir Iſaac found the diſtance of the comet 1577 to be abou

about 210 ſemidiameters of the earth, its apparent diameter being ſeven minutes: whence alſo he concluded that the true diameter of the comet was to that of the earth as 3 to 14.

Various conjectures have been formed reſpecting the tails of comets; though it is acknowledged by all, that they depend on the ſun ſomeway or other.

Sir Iſaac Newton was of opinion, that the tail of a comet is a very thin vapour which the head ſends out by reaſon of its heat: that it aſcends from the ſun juſt as ſmoke does from the earth: that as the aſcent of ſmoke is cauſed by the rarefactions of the air wherein it is entangled, cauſing ſuch air to aſcend and carry the ſmoke up with it, ſo the ſun's rays acting upon the comet or atmoſphere of the comet, do by rarefaction and refraction heat the ſame; that this heated atmoſphere heats, and by heating rarefies, the æther that is involved therein; and that the ſpecific gravity with which ſuch æther tends to the ſun, is ſo diminiſhed by its rarefaction, that it will now aſcend from him by its relative lightneſs, and carry with it the reflecting particles whereof the tail is compoſed.

The near approach of ſome comets to the ſun ſubjects them to intenſe and inconceivable degrees of heat. Newton calculated that the heat of the comet of 1680 muſt have been near 2000 times as great as that of red hot iron. The calculation is founded upon this principle, that the heat of the ſun falling upon any body at different diſtances is reciprocally as the ſquares of thoſe diſtances; but it may be obſerved, that the effect of the heat of the ſun upon all bodies near our earth depends very much on the conſtitution of thoſe bodies, and of the air that ſurrounds them.

Indeed, according to his calculation, the comet of 1680 muſt be for ever in a ſtate of violent ignition. He hath computed that a globe of red-hot iron of the ſame dimenſions with the earth, would ſcarce be cool in 50,000 years. If then the comet be ſuppoſed to cool 100 times faſter than red-hot iron, as its heat was 2000 times greater, it muſt require upwards of a million of years to cool it. In the ſhort period of 575 years, therefore its heat will be ſcarce diminiſhed; and, of conſequence, it muſt now be in a ſtate of ignition very little inferior to that of the ſun itſelf. Sir Iſaac Newton hath farther concluded, that this comet muſt be conſiderably retarded in every ſucceeding revolution by the atmoſphere of the ſun within which it enters; and thus muſt continually come nearer and nearer his body, till at laſt it falls into it. This, he thinks, may be one uſe of the comets, to furniſh fuel for the ſun, which otherwiſe would be in danger of waſting from the continual emiſſion of its light.

He adds, that for the conſervation of the water and moiſture of the planets, comets ſeem abſolutely requiſite; from whoſe condenſed vapours and exalation all the moiſture which is ſpent in vegetation and putrefaction, and turned into dry earth, &c. may be reſupplied and recruited; for all vegetables grow and increaſe wholly from fluids; and again, as to their greateſt part, turn by putrefaction into earth; an earthy ſlime being perpetually precipitated to the bottom of putrefying liquors. Hence the quantity of dry earth muſt continually increaſe, and the moiſture of the globe decreaſe, and be quite evaporated, if it have not a continual ſupply from ſome part or other of the univerſe. "And I ſuſpect (adds our great author), that the ſpirit, which makes the fineſt, ſubtileſt, and beſt part of our air, and which is abſolutely requiſite for the life and being of all things, comes principally from the comets."

Mr. Whiſton, from Flamſtead's meaſure of its apparent diameter, concluded the nucleus of the comet to be about ten times as big as the moon, or equal to a fourth part of the earth, and attributed the univerſal deluge in the time of Noah to the near approach thereof. His opinion was, that the earth paſſing through the atmoſphere of the comet, attracted therefrom great part of the water of the flood; that the nearneſs of the comet raiſed a great tide in the ſubterraneous waters, ſo that the outer cruſt of the earth was changed from a ſpherical to an oval figure; that this could not be done without making fiſſures, and cracks in it, through which the waters forced themſelves by the hollow of the earth being changed into a leſs capacious form; that along with the water thus ſqueezed upon the ſurface of the earth, much ſlime or mud would riſe; which, together with the groſſer part of the comet's atmoſphere, would, after the ſubſiding of the water, partly into the fiſſures and partly into the lower parts of the earth to form the ſea, cover all over the antediluvian earth, to a conſiderable depth.

The ſame comet he thought would probably, when coming near the earth, and heated in an immenſe degree in its perihelion, be the inſtrumental cauſe of that great cataſtrophe, the general conflagration foretold in the ſacred writings.

The analogy between the periodical times of the planets and their diſtances from the ſun, diſcovered by Kepler, takes place alſo in the comets. In conſequence of this, the mean diſtance of a comet from the ſun may be found by compairing its period with the time of the earth's revolution round the ſun. Thus the period of the comet that appeared in 1531, 1607, 1682, and 1759, being about 76 years, its mean diſtance from the ſun may be found by this proportion: As 1, the ſquare of one year, the earth's periodical time, is to 5776 the ſquare of 76, the comet's periodical time; ſo is 1,000,000, the cube of 100 the earth's mean diſtance from the ſun, to 5,776,000,000, the cube of the comet's mean diſtance. The cube root of this laſt number is 1794, the mean diſtance itſelf in ſuch parts as the mean diſtance of the earth from the ſun contains 100. If the perihelion diſtance of this comet, 58, be taken from 3588 double the mean diſtance, we ſhall have the aphelion diſtance, 3530, of ſuch parts as the diſtance of the earth contains 100; which is a little more than 35 times the diſtance of the earth from the ſun. By a like method, the aphelion diſtance of the comet of 1680 comes out of 138 times the mean diſtance of the earth from the ſun, ſuppoſing its period to be 575 years; ſo that this comet, in its aphelion, goes more than 14 times the diſtance from the ſun that Saturn does.

A TABLE of the ELEMENTS of the principal COMETS which have hitherto been duly obſerved.

Comet of A. D.	Place of Aſcending Node.			Inclination of Orbit.			Place of Perihelion.			Perihelion diſtance from ☉ the diſt. of ⊕, being 1.	Mean Time of the Perihelion.			Motion.
		°	′	″	°	′	″		°	′	″		d.	h.	m	
1264	♏	19	0	0	36	30	0	♑	21	0	0	.445	July	6	8	0 Direct
1337	♊	24	21	0	32	11	0	♉	7	59	0	.40666	June	2	6	25 Retro.
1472	♑	11	46	20	5	20	0	♉	15	33	30	.54273	Febr.	28	22	23 Retro.
1531	♉	19	25	0	17	56	0	♍	1	39	0	.567	Aug.	24	21	18 Retro.
1532	♊	20	27	0	32	36	0	♎	21	7	0	.5091	Oct.	19	22	12 Direct
1533	♌	5	44	0	35	49	0	♌	27	16	0	.2028	June	16	19	30 Retro.
1556	♏	25	42	0	32	6	30	♑	8	50	0	.4639	Apr.	21	20	3 Direct
1577	♈	25	52	0	74	32	45	♌	9	22	0	.18342	Oct.	26	18	45 Retro.
1580	♈	18	57	20	64	40	0	♎	19	5	50	.56628	Nov.	28	15	0 Direct
1585	♉	7	42	30	6	4	0	♈	8	51	0	1.09358	Sep.	27	19	20 Direct
1590	♏	15	30	40	29	40	40	♏	6	54	30	.57661	Jan.	29	3	45 Retro.
1593	♏	14	14	15	87	58	0	♏	26	19	0	.08911	July	8	13	39 Direct
1596	♒	12	12	30	55	12	0	♏	18	16	0	.51293	July	31	19	55 Retro.
1607	♉	20	21	0	17	2	0	♍	2	16	0	.5868	Oct.	16	3	50 Retro.
1618	♊	16	1	0	37	34	0	♈	2	14	0	.37975	Oct.	29	12	23 Direct
1652	♊	28	10	0	79	28	0	♈	28	18	40	.8475	Nov.	2	15	40 Direct
1661	♊	22	30	30	32	35	50	♎	25	58	40	.44851	Jan.	16	23	41 Direct
1664	♊	21	14	0	21	18	30	♌	10	41	25	1.02579	Nov.	24	11	52 Retro.
1665	♏	18	2	0	76	5	0	♊	11	54	30	.10649	Apr.	14	5	15 Retro.
1672	♑	27	30	30	83	22	10	♉	16	59	30	.69739	Feb.	20	8	37 Direct
1677	♏	26	49	10	79	3	15	♌	17	37	5	.28059	Apr.	26	0	37 Retro.
1678	♏	11	40	0	3	4	20	♍	27	46	0	1.23802	Aug.	16	14	3 Direct
1680	♑	2	2	0	60	56	0	♐	22	39	30	.00612	Dec.	8	0	6 Direct
1682	♉	21	16	30	17	56	0	♍	2	52	45	.58328	Sept.	4	7	5 Retro.
1683	♏	23	23	0	83	11	0	♊	25	29	30	.5602	July	3	2	5c Retro.
1684	♐	28	15	0	65	48	40	♏	28	52	0	.96015	May	29	10	16 Direct
1686	♓	20	34	40	31	21	40	♊	17	0	30	.325	Sept.	6	14	33 Direct
1698	♐	27	44	15	11	46	0	♑	0	51	15	.69129	Oct.	8	16	57 Direct
1699	♌	21	45	33	69	20	0	♏	2	31	6	.744	Jan.	3	8	23 Retro.
1702	♎	9	25	15	4	30	0	♌	18	41	3	.6459	March	2	14	12 Direct
1706	♈	13	11	40	55	14	10	♊	12	29	10	.42581	Jan.	19	4	23 Direct
1707	♉	22	46	35	88	36	0	♊	19	54	56	.85974	Nov	30	23	30 Direct
1718	♌	8	43	0	30	20	0	♌	1	30	0	1.02654	Jan.	3	23	39 Retro.
1723	♈	14	16	0	49	59	0	♉	12	52	20	.99863	Sept.	16	16	19 Retro.
1729	♍	10	32	37	76	58	4	♍	22	40	0	4.2614	June	14	10	57 Direct
1737	♏	16	22	0	18	20	45	♍	25	55	0	.22282	Jan.	19	8	21 Direct
1739	♈	27	25	14	55	42	44	♒	12	38	40	.67358	June	6	10	0 Retro.
1742	♎	5	38	29	66	59	14	♏	7	35	13	.96588	Jan.	28	4	39 Retro.
1742	♊	18	21	15	2	19	33	♒	2	41	45	.83501	Dec.	30	20	26 Direct
1744	♉	15	46	21	47	5	28	♎	17	10	0	.22249	Feb.	19	8	4 Direct
1747	♍	27	18	50	79	6	20	♑	7	2	0	2.1985	Feb.	20	7	11 Retro.
1748	♏	22	52	15	85	27	0	♏	5	0	50	.84067	Apr.	17	19	26 Retro.
1748	♉	4	39	43	56	59	3	♒	6	9	24	.65526	June	7	1	24 Direct
1757	♏	4	12	50	12	50	20	♌	2	58	0	.33754	Oct.	21	7	55 Direct
1759	♉	23	45	35	17	40	15	♍	3	8	10	.5849	Mar	12	13	50 Retro.
1759	♌	19	39	24	78	59	22	♉	23	24	20	.79851	Nov	27	2	19 Direct
1759	♊	18	56	19	4	37	23	♌	19	2	48	.96193	Dec.	16	12	41 Retro.
1762	♓	19	23	0	84	45	0	♒	15	14	0	1.0124	May	28	15	18 Direct

As the orbits of all comets are either parabolas or ellipſes (though probably they are all ellipſes); and as their elliptical orbits are ſo very eccentric, that they approach exceedingly near to parabolas, aſtronomers, for the eaſe of computation, generally make their calculations on comets, as if their orbits were actually parabolas.

On this ſuppoſition, Mr. Emerſon, in his Aſtronomy, has demonſtrated that the times in which different comets move through ſimilar parts of their orbits, are as the ſquare roots of the cubes of their perihelion diſtances; that if a comet's perihelion diſtance be equal to the mean diſtance between the ſun and earth, it will deſcribe a quadrant of its orbit in 109 days, 14 hours, 46 minutes, and 12 ſeconds; and that if p be put = the perihelion diſtance of any comet, the time of its moving from its perihelion to the 90° of its orbit, will be $109.615p\sqrt{p}$ days.

Mr. Emerſon as alſo ſhewn, that if PNO (Plate IV. *Figure* 26) be the orbit of a comet, S, the ſun, P the perihelion, N the place of the comet. And if the perihelion diſtance SP be put = p, comet's diſtance SN = y, coſine of true anomaly PSN = z, and v = verſed ſine of the ſupplement thereof. Alſo if 109.615 days, the time of a comet's deſcribing a quadrant whoſe perihelion diſtance is 1, = mean diſtance of the earth be put = t; and D = time of the perihelion; then will the diſtance $y = \frac{2p}{1+z} = \frac{2p}{v}$; the time from the perihelion, $D, = \frac{\overline{2p+y}\times t}{4}\sqrt{y+p}$; and the area $PSN = \frac{2p+y}{3}\times\sqrt{yy-pp}$. Alſo if c

be

be the coſine of half the true anomally, then the comets diſtance $y = \frac{p}{cc}$, radius being 1.

Note, the comet's orbit and the time of the perihelion are here ſuppoſed to be known.

Hence a table may be made for finding when a comet will be in any given part of its orbit, or, on the contrary, for finding in what point of its orbit it will be in any given time.

N. B. In Section VII. I have ſhewn how to determine the orbit of a planet, but there is no ſuch direct method for finding the orbit of a comet; and therefore Aſtronomers uſually feign an orbit at pleaſure, and examine how it agrees with the motions of the comet, as determined by obſervation; and if they find it differ therefrom, they aſſume another orbit, and ſo on by trial, till at laſt they meet with one that will give the comet's place, &c. at any propoſed time, according to obſervations; and thence they conclude that ſuch orbit is the true one.

M. de la Caille has ſhewn, that if t be put for the tangent of half any true anomally of a comet, moving in a parabolic orbit; a, for the time it is in going from the perihelion to 90°, and b, for the time in paſſing from the perihelion to any aſſigned point in its orbit; alſo the diſtance of the comet from the ſun in its perihelion being ſuppoſed 1, and the times a and b, being given, that the tangent of half the true anomally will be found by extracting the root of the following cubic equation, viz. $t^3 + 3t = \frac{4b}{a}$; and therefore by ART. XXV. of our New Syſtem of ALGEBRA, t will be found $= \sqrt[3]{\frac{2b}{a} + \sqrt{\frac{4b^2}{a^2} + 1}} - \frac{9}{\sqrt[3]{\frac{2b}{a} + \sqrt{\frac{4b^2}{a^2} + 1}}}$.

The degrees, &c. anſwering to the tangent t, being doubled, will give the true anomally; and when the comet is direct, that being added to or ſubtracted from the place of the comet in its perihelion, according as the comet is paſt or ſhort of the perihelion, will give its true heliocentric place in its orbit; or, if it is retrograde, the ſame muſt be ſubtracted from or added to the perihelion place, according as the comet's place precedes or ſucceeds the place of the perihelion.

In order to calculate the place of a comet at any time propoſed, as ſeen from the earth, obſerve the following directions.

1ſt. Having the perihelion diſtance of the comet, find the time in which it will go through 90° of its orbit, and from thence the true anomally, or angle from the perihelion, anſwering to the given time; then adding, or ſubtracting the ſame (as the caſe ſhall require) from the place of the perihelion, its true heliocentric place in its orbit will be had.

2d. Subtract the place of the aſcending node from the comet's true heliocentric place, and the remainder will be the argument of the comet's latitude; then ſay, as radius is to the coſine of the inclination of the comet's orbit, ſo is the tangent of the argument of latitude to the tangent of the comet's diſtance from the aſcending node meaſured in the ecliptic, which added to the true place of the comet's node, the ſum will be the comet's true heliocentric place reduced to the ecliptic; and as radius: ſine of argument of latitude :: ſine inclination of the comet's orbit: ſine of its latitude ſeen from the ſun.

3d. Calculate the ſun's diſtance from the earth and his true place from Aſtronomical Tables: from this ſubtract 6 ſigns, and the remainder will be the place of the earth, as ſeen from the ſun; then the difference between the comet's true heliocentric longitude in the ecliptic, and the longitude of the earth, will give the angle at the ſun between the earth and comet.

4th. Add the logarithm of the comet's perihelion diſtance to twice the logarithm of radius (or 20,0000000) and from the ſum ſubtract twice the coſine of half the comet's true anomally, and the remainder will be the logarithm of its true diſtance from the ſun.

5th. Say as radius: coſine of the comet's latitude ſeen from the ſun :: comet's real diſtance from the ſun, to its abridged diſtance, or diſtance meaſured upon the plane of the ecliptic.

6th. Then as the ſum of the comet's abridged diſtance, and of the earth's real diſtance from the ſun, is to their difference, ſo is the tangent of the complement of half the angle at the ſun (found by ART. III.) to the tangent of an arc, which added to this complement, if the comet's abridged diſtance exceed the earth's real diſtance from the ſun, or ſubtracted, if the comet's diſtance is leſs than the earth's, will give the angle at the earth, comprehended between the ſun's place and comet's geocentric place, and from thence may be deduced the comet's geocentric place; for the ſun's place + or — this angle, according as the comet is before or behind the ſun in the ecliptic, will give the comet's *true geocentric longitude*.

7th. As the ſine of the angle at the ſun (found by ART. III.) is to the ſine of the angle at the earth (found by ART. VI.) ſo is the tangent of the comet's latitude as ſeen from the ſun, to the tangent of its latitude as ſeen from the earth, or *geocentric latitude*.

SECT. XIV.

THE CAUSE OF ECLIPSES OF THE SUN AND MOON, WITH METHODS OF DETERMINING WHEN THEY HAPPEN, AND RULES FOR CALCULATING THE TIME OF THE MOON'S SOUTHING, RISING AND SETTING, &c.

THE earth and moon being opake bodies, and deriving their light from the ſun, do each of them caſt forth a ſhadow as it were behind them, or towards the oppoſite or contrary hemiſphere, to that in which the ſun appears.

And as light is propagated in right lines, and the earth and moon are nearly ſpherical, ſuch ſhadow will terminate in a point and occupy a conical ſpace. Now when either the moon or earth paſſes through the ſhadow of the other, it is thereby deprived of illumination from the ſun, and by degrees becomes inviſible to a ſpectator on the body from whence the ſhadow iſſues; and ſuch ſpectator will obſerve an eclipſe of that body which is paſſing through the ſhadow. Alſo a ſpectator on the earth or moon, when paſſing through the ſhadow of the other, will obſerve an eclipſe of the ſun, by reaſon of its being deprived of the ſun's light; ſo that in reality the eclipſe, in this caſe, is not an eclipſe of the ſun, but of the body itſelf.

To explain this more clearly, let AB (Plate IV. *Figure* 27.) be a luminous body, as the ſun, CD an opake ſpherical body expoſed to its light; and let AC and BD be drawn, interſecting each other in P, ſo will the cone CDP repreſent the ſhadow of CD. Now within this ſhadow, no light can come from the luminous body AB. Alſo let there be drawn BCE and ADF; then the ſpace ECPDF will be the penumbra, ariſing from the ſhadow of CD; into which ſpace ſome light comes from part of the body AB; thoſe parts of it which are neareſt the ſhadow being leſs illuminated than thoſe which are more remote, by reaſon that ſuch parts receive a leſs portion of rays from the illuminating body.

If any opake body, as G, be near the ſhadow CDP, then if part of it enters the ſhadow, ſuch part will be totally dark; and that part which remains in the penumbra, will have ſome faint light; thoſe places, however, which are the fartheſt from DP, having the moſt light. Conſequently the body G will then be eclipſed, either partially or totally.

If the centre of the body G paſs through the axis of the cone CDP, it will be centrally eclipſed; and if its diameter be leſs than the diameter of the conical ſhadow in that place, it will be totally eclipſed. Therefore, if AB be the ſun, CD the earth, moving in its orbit, and G the moon revolving about the earth; then, as the moon G advances towards an oppoſition of the ſun, or a full moon, it will come nearer to the ſhadow of the earth CDP; and if the moon is ſo near her nodes as to paſs through the ſhadow, ſhe will be eclipſed. If the moon's orbit was in the plane of the ecliptic, or earth's orbit, ſhe would be centrally eclipſed every full moon. Alſo when the moon by revolving in her orbit comes to the oppoſite ſide at H, where it is new moon, ſhe being then between the ſun AB and earth CD, will, in like manner, caſt a ſhadow upon the earth, and thereby cauſe an eclipſe of the earth, or an apparent eclipſe of the ſun. But the diameter of the moon being conſiderably leſs than the earth's diameter, and conſequently much more ſo is that of her ſhadow, at the diſtance of the earth, ſhe can never totally eclipſe the earth; ſo that in every eclipſe of the ſun (or earth) there will be many parts of the globe that will ſuffer no eclipſe at all, even though the ſun may be above the horizon. A ſpectator on any part where the ſhadow comes will be ſenſible of an eclipſe, if the ſun be then above the horizon of that place; alſo, as I have obſerved in regard to the moon, ſo here in reſpect of the earth, if the moon and earth were in one plane, there would be a central eclipſe of the ſun or earth at every conjunction of the ſun and moon, (or new moon); but that not being the caſe, an eclipſe of the ſun or moon can only happen when the moon at her conjunction or oppoſition is in or near to either of her nodes, or points where the plane of her orbit interſects the orbit of the earth.

As the earth is conſiderably greater than the moon, and even at the diſtance of the moon the diameter of its ſhadow is equal to thrice the moon's diameter; therefore, it frequently happens, that the moon becomes totally eclipſed, and continues to be ſo for ſome time.

Every eclipſe of the moon begins on the eaſtern and goes off on her weſtern ſide; for the moon's motion being ſwifter than the earth's, ſhe overtakes the ſhadow, and with her eaſtern limb enters into it on the weſt ſide, as ſhe proceeds eaſtward; but eclipſes of the ſun begin on the weſtern ſide, for the moon being then in the oppoſite part of her orbit, and overtaking the earth, the earth enters into her ſhadow on the weſtern ſide.

If the atmoſphere be ſerene, every eclipſe of the moon is viſible at the ſame inſtant, to all the inhabitants of that ſide of the globe to which ſhe is oppoſite; for as part of the moon's body at leaſt will enter the ſhadow, it muſt be, that every ſpectator to whom ſhe is viſible, will be ſenſible of the darkneſs which comes on that part; but with regard to eclipſes of the ſun, they do not happen to all places at the ſame inſtant; for the moon's ſhadow

passing over the earth eclipses different parts of it progressively, so that when it is ending at one place, it is beginning at another; and in some places there is no eclipse at all; and this even supposing the sun to be visible at each place all the while.

If, when the moon is in conjunction and near the node, her conical shadow does not reach the earth, but terminates at a less distance, then, since nothing but the penumbra falls upon the earth, there will be no total darkness on any part thereof; but to a spectator, situate at or near the point where the axis of the cone (produced) cuts the earth, the moon will appear with a bright ring surrounding her, which ring is the edge of the sun appearing all around the circle of the moon; the moon's apparent diameter being then less than the sun's. This is called an annular eclipse.

The dusky red light with which the moon sometimes appears when eclipsed, is owing to the refraction of the rays of light passing through the earth's atmosphere, and falling upon the moon.

No eclipse of the moon can happen, but when the distance of the centres of the moon and of the earth's penumbra is less than the sum of their semidiameters; for, if the distance be greater, the moon and penumbra cannot touch each other. Therefore, in lunar eclipses, the moon's latitude must be less than the sum of the semidiameters of the moon and penumbral shadow of the earth taken at the moon's orbit.

Also no eclipse of the sun (with respect to a particular place) can happen, unless the distance of the centres of the sun and moon be less than the sum of their semidiameters; but that there shall be none in any place, it is only necessary that the said distance be less than the above sum added to the moon's parallax.

Hence, in eclipses of the sun (taken generally) the moon's latitude must be less than the sum of the semidiameters of the sun and moon, and the moon's horizontal parallax; but that it may be visible in a certain place, the parallax must be excluded.

The Requisites belonging to an Eclipse of the Moon.

I. In an eclipse of the moon, half the angle of the cone of the earth's shadow, viz. $\frac{1}{2}\angle CPD = \angle CPO$ is equal to the sun's apparent semidiameter, less his horizontal parallax.

II. Half the angle of the earth's penumbral cone, or $\frac{1}{2}\angle CHD = \angle CHO$, is equal to the sum of the sun's apparent semidiameter, and his horizontal parallax; and consequently the said half angle is equal to half the angle of the dark cone (or $\frac{1}{2}$ CPD, or CPO) added to the sun's horizontal parallax.

III. The apparent semidiameter of the earth's dark shadow at the moon's orbit, is equal to the sum of the horizontal parallaxes of the sun and moon, less the sun's apparent semidiameter.

IV. The apparent semidiameter of the earth's penumbra at the moon's orbit, is equal to the sum of the horizontal parallaxes of the sun and moon, together with the sun's apparent semidiameter.

V. To find the length of the shadow OP, there are given in the triangle COP, the $\angle P$ = sun's apparent semidiameter, less his parallax, and CO the earth's radius, to find P⊙.

PROPOSITION I. *To find the* $\angle$ *that the Moon's Way makes with the Ecliptic.* (Plate IV. *Figure* 28.)

Here the inclination of the moon's orbit are supposed to be known, and the horary motions of the sun and moon.

Let NS be the ecliptic; NM the moon's orbit; and let S be the sun in the sun's eclipse, or the centre of the earth's shadow in an eclipse of the moon; and M the moon at the time of the syziges. Take NA to NS as the sun's horary motion to the moon's at that time and draw MA, the moon's apparent orbit; so will the angle MAS be the angle required.

For by the construction, in the time that the moon is in moving from N to M (that is through NS reckoned in the ecliptic) the sun moves through a space DS equal to NA. Therefore the sun is in D, when the moon is in the node at N. Let there be drawn DB parallel to SM, and MB parallel to SD; and join BN, which will be parallel to MA. Now since the moon makes the same latitude DB or SM in the same time whether the sun moves or stands still; and since SM his her latitude when the sun is at S, DB (=SM) will be her latitude, supposing the sun stationary at D without any motion towards S, and consequently NB will be her apparent way to an eye at D, through which she seems to move in the same time; or which is the same, AM will be her apparent way to an eye fixed at S; for the triangles AMS and NBD are equal, and $\angle MAS$ is the angle of her way with the ecliptic. By the theory of relative motions in bodies moving the same way, all the apparent motions are the same, as if one body stood still, and the other moved forward with a motion equal to the difference of their motions: and here ND or AS is the difference of their motions supposing S to be fixed. Hence the following proportions: as the moon's horary motion: sun's horary motion :: SN, the distance from the node, to AN. Then SA = SN—AN.

And as sine of SA : radius :: tangent of moon's latitude : tangent of $\angle A$ or the angle of the moon's way.

N. B. It is the apparent orbit AM that must be used in calculating the several particulars of an eclipse, because an observer considers not S as moving, and therefore only the relative motions are concerned.

PROPOSITION II. *To calculate an Eclipse of the Moon.* (Plate IV. *Figure* 29.)

I. Find the true time of the opposition, or full moon, when an eclipse is to happen, by astronomical tables, the precepts for which are generally given along with the tables; and let that time be reduced to apparent time, by increasing or diminishing the same, by the equation of time, as occasion requires.

II. From astronomical tables calculate the true places of the sun and moon when in opposition, as also the sun's mean anomaly, and the place of his apogee, together with the place of the moon's ascending node, the place of her apogee, and her latitude.

III. Let NS be a part of the ecliptic, NM the moon's orbit; S the centre of the earth's shadow, and M, the moon when in opposition. Take NA to NS as the sun's horary motion to the moon's, and draw AM for the way of the moon from the sun. Then in the right angled spherical triangle ASM, there are given AS (=NS—NA and dSM, the moon's latitude, to find the angle SMA.

IV. Let fall SP perpendicular to AM. Now since the arches SM, MP, and SP, are very small, they may be taken for right lines, and the triangle SMP for a plane triangle without any sensible error. Then having SM and angle SMP, MP and SP may be found; P, being the place of the moon in the middle of the eclipse. Likewise the time of the moon's moving through MP will be known by the horary motion, and from thence the time when she is at P, or the middle of the eclipse.

V. From astronomical tables find the sun and moon's apparent semidiameters, for the time of opposition, and their horizontal parallaxes.

VI. From any convenient scale of equal parts with the centre P and radius PB, (equal to the minutes contained in the moon's radius) describe the circle BCo, for the moon: and with the radius SD, (equal to the sum of the sun and moon's horizontal parallaxes, less the sun's semidiameter in minutes) describe the circle DEB, from the centre S, then this circle will represent the earth's dark shadow. Likewise from the same centre S, and with the radius SF (equal to the sum of the sun and moon's parallaxes added to the sun's semidiameter in minutes) describe the circle FQG, and it will represent the earth's penumbra. Then the several requisites may be found nearly by scale and compasses: or by calculation; thus: To find when the moon first touches the penumbra at L, there are given in the right angled triangle SPK, SP, and SK, (the sum of the radii SL and PB) to find PK; which being known, the time of the moon's passing through it will be known, by her horary motion from the sun.

And to find when the moon first enters the dark shadow at D, there are given SP, and SI (the sum of the radii SD and PB) of the right angled triangle SPI, to find PI, and consequently the time of half the duration in the shadow. Also to find the digits or 12th parts of the moon eclipsed, $Pn + Pe - SP = ne$, the part eclipsed, and $\frac{6\ ne}{Pe} =$ the number of digits eclipsed.

But in total eclipses of the Moon, the earth's shadow is often much wider than the moon, and then more than 12 digits are said to be eclipsed, and that, in proportion to such excess.

Now the times of passing through PI, PK, &c. being known, as also the time of the middle of the eclipse, at P, the beginning and ending thereof will be consequently known.

PROPOSITION III. *To find the Way of the Moon from the Sun, in a Solar Eclipse, supposing the Observer at rest.*

Let HZO, (Plate IV. *Figure* 30) be the meridian of the place, HO, the horizon; EC, the equinoctial; EL, the ecliptic; Z, the zenith; P, the pole; S and M the places of the sun and moon in conjunction; and PSD, the sun's meridian.

Then having found the sun's distance from the node NS, and the moon's latitude SM, &c. take NA to NS as the sun's horary motion to the moon's horary motion; and thence SA will be known; and having drawn MA, there will be given SA and SM of the spheric triangle ASM, right angled at S, to find $\angle SMA$; AM, being the moon's way from the sun.

But because the eye of the observer is in motion, through the earth's rotation, which gives an apparent motion to the moon, contrary to that of the observer, the quantity and direction of that motion must be found.

Now since the observer is carried eastward towards the point C, the apparent motion of the moon will be in the line CS; and to determine the position of CS in respect of AM, there are given LS and $\angle E$ of the right angled triangle EDS to find DS and $\angle ESD$ or ASP. And in the triangle ZPS there are given PS or complement of DS, the angle ZPS, (from the hour of the day) and ZP, the complement of the latitude, to find ZS, and angles PZS and ZSP. Then $\angle ZSP$, and $\angle ASP$, being known, $\angle ZSA$ will be known; and MSA being a right angle, ZSM will be known. Also in the right angled triangle CFS, there are given CF, the measure of the angle FZC or difference between the angle PZS and the right angle CZP, and SF, the complement of ZS, to find CS and $\angle CSF$ or BSZ; then $\angle BSZ$ and ZSM being known, $\angle BSM$ will be known; and $\angle SMA$ being known, the supplement thereof, SMB, is consequently known; and hence also $\angle SBM$.

To find the quantity of the motion. That along at M is already known; and with regard to the apparent motion along SB; the sine of 15° (the horary motion of a point in the equinoctial) is .259 to the radius 1. And if *h* be the moon's horizontal parallax, then the radius of the earth appears at the moon under the angle *h*, and therefore 15° of the equinoctial appears under the angle of .259 *h* = the horary motion of a point in the equinoctial viewed directly from the moon = the moon's apparent motion seen from that point in the equinoctial; but this motion must be diminished on two accounts; 1. because it is less in a parallel circle in proportion to the cosine of the latitude, and 2dly on account of the obliquity of the motion when not perpendicular to the rays of the sun, and this will be as the sine of CS, the sun's distance from the east or west points of the horizon. Therefore to find the quantity of this motion, to the log of .259*h*, add the cosine of the latitude, and the sine of CS. and the sum abating twice radius is the log of this apparent motion. Then this motion must be compounded with the motion along AMB, thus:

Let AS (Plate IV. *Figure* 31) be a portion of the ecliptic, SB the way of the apparent motion, MA the moon's way from the sun. Draw NM parallel to SB, and let MN be the horary motion along SB or MN, and MI the horary motion of the moon from the sun. Complete the parallelogram NMIQ, and draw the diagonal MQR, which is the direction of the motion compounded of the observer's and the moon's motions, and MQ is the total apparent motion, supposing the observer at rest.

Then in the plain triangle QMI, there are given MI and IQ (or MN) and ∠MIQ = MBS, to find ∠QMI, and side QM, or the absolute horary motion. Then the angles QMI and IMS, being known, ∠QMS is also known.

It must be observed, that if the sun be in the Eastern hemisphere, in which case the concave side of the Eastern hemisphere is here projected in (Plate IV. *Figure* 30) then the moon's motion from the sun is from M towards A, and the other apparent motion is from S towards B, or from M towards N. But if the sun is in the western hemisphere, this projection represents the convex side of the sphere, and then the moon moves from the sun in the direction AM, and the other apparent motion is from S towards C, being contrary.

PROPOSITION IV. *To calculate an Eclipse of the Sun for a particular Place given.*

I. By astronomical tables find the true time of the conjunction or new moon, and the places of the sun and moon at that time, with all the other requisites, adapted to the particular places.

II. Having found the way of the moon from the sun, as directed in the last Proposition, find, by the astronomical tables, the moon's horizontal parallax, her apparent diameter, and horary motion, as also the sun's apparent diameter, and his horary motion.

To avoid trouble, if the sphere be projected on a large scale, it will give the requisites with tolerable exactness, without calculation, by measuring the several angles and sides; and here it is best to project the concave side, for then every thing appears as it is in nature.

III. Find the moon's parallax of altitude, by making as rad. : cos. altitude : : moon's horizontal parallax : her parallax of altitude V *t* or M *m*. Also find her parallax of latitude M *n*, and longitude S *s* or *m n*, by PROB. XVII. SECT. VII, and from thence her apparent latitude and longitude will be known.

IV. Draw the line ASL for the ecliptic, and from a large scale of minutes erect SM perpendicular to AS, and equal to the apparent latitude; make the angle SMR, as found in the last Proposition; and draw NMR, for the moon's apparent path. From S let fall SP, perpendicular to MR, and SP will be the least distance of the centres of the sun and moon, or the middle of the eclipse. From the centre S with the radius equal to the minutes contained in the sun's semidiameter, describe the circle ABC for the sun; and from the centre P, with the radius equal to the moon's semidiameter, describe the circle AOCD for the moon. If these circles do not intersect, there will be no eclipse: but if they intersect, an eclipse must necessarily happen.

V. P is the place of the moon, in the middle of the eclipse. Make SI and SK = sum of the semidiameters of the sun and moon, and the moon's centre will be at I in the begining of the eclipse, and at K in the ending of it. Now, in the triangle PSI, there are given SI and SP to find PI = PK, which reduced to time by help of the moon's apparent horary motion, gives half the duration of the eclipse, and consequently the beginning and end will be known.

VI. To find the quantity *n o*, or the digits eclipsed, we have $n o = S n + P o - S P$, and $\frac{6 n o}{P o}$ = the number of digits.

N. B. The time found being mean time, must be reduced to the apparent time, by the equation of time. And if the given place be not that for which the tables are made, a proper allowance must be made for the difference of meridians.

PROPOSITION V. *To calculate the Time of the Moon's Southing.*

RULE. Subtract the sun's right ascension in time from the moon's right ascension in time at noon on the day preceding the time when the moon's southing is required, and the remainder will be the time preceding noon, of the moon's distance from the meridian, when the sun at noon is upon it. Find the increase of the moon's right ascension above the sun's, in the space of 24 hours. Then say as 24 hours is to the increase of the moon's right ascension in time, so is the distance of the moon's from the sun's right ascension in time on the noon of the preceding day, to the proportional increase of the moon's right ascension above that of the sun's in time, to be added to the moon's distance from the meridian at noon, for the true time of the moon's southing.

N. B. When the sun's right ascension is greater than the moon's, 24 hours must be added to the latter, that subtraction may be made of the first.

PROPOSITION VI. *To find the Time of the Moon's rising and setting.*

I. For the estimate time. RULE, Subtract the right ascension of the sun from the oblique ascension of the moon, in time, to which add or subtract 6 hours, according as the remainder is less or greater than 6 hours. From new to full moon, it is the setting that is to be found, but from full to new moon, the rising must be found.

For the true time. Take the sun's oblique ascension in time, (according to the given latitude) at the estimate time of the moon's rising, from the moon's oblique ascension at the same time; and add the time of sun-rise to the remainder, for the near time of the moon's rising that day. And to correct the time still nearer, repeat the operation by computing the oblique ascensions for the time last found.

In like manner, the time of the moon's setting is found by taking the oblique ascension of the sun from the oblique ascension of the moon, at the estimate time of setting; and by adding the time of the sun's setting on that day, to the remainder, which may be corrected as the former.

SECT. XV.

DR. HERSCHEL'S DESCRIPTION OF THE UNIVERSE.

IT was the opinion of former astronomers, that our sun, besides occupying the centre of the system which properly belongs to him, occupied also the centre of the universe; but Dr. Herschel is of a very different opinion.

With a Newtonian reflector of 20 feet focal length, and an aperture of 18 inches, he first began to survey the Via Lactea, and found that it completely resolved the whitish appearance into stars, which the telescopes he formerly used had not light enough to do. The portion he first observed was that about the hand and club of Orion, and found therein an astonishing multitude of stars, whose number he endeavoured to estimate by dividing them into what he calls fields of stars, and counting their number, and so computing from a mean of these, how many might be contained in a given portion of the milky-way. In the most vacant place to be met with in that neighbourhood he found 63 stars; other six fields contained 110, 60, 70, 90, 70, and 74 stars: a mean of all which gave 79 for the number of stars to each field: and thus he found, that by allowing 15 minutes for the diameter of his field of view, a belt of 15 degrees long and two broad, which he had often seen pass before his telescope in an hour's time, could not contain less than 50,000 stars, large enough to be distinctly numbered; besides which, he suspected twice as many more, which could be seen only now and then by faint glimpses for want of sufficient light.

The success he had with the milky-way soon induced him to turn his telescope to the nebulous parts of the heavens. Most of these yielded to his reflector, which plainly discovered them to be composed of stars, or at least to contain stars, and to show every other indication of consisting of them entirely. "The nebulæ, says Dr. Herschel, are arranged into strata, and run on to a great length; and some of them I have been able to pursue, and to guess pretty well at their form and direction. It is probable enough that they may surround the whole starry sphere of the heavens, not unlike the milky-way, which undoubtedly is nothing but a stratum of fixed stars: one of these nebulous beds, is so rich, that, in passing through a section of it in the time of only 36 minutes, I have detected no less than 31 nebulæ, all distinctly visible upon a fine blue sky. Their situation and shape, as well as condition, seem to denote the greatest variety imaginable. In another stratum, or perhaps a different branch of the former, I have often seen double and treble nebulæ variously arranged; large ones with small, seeming attendants; narrow, but much extended lucid nebulæ or bright dashes; some of the shape of a fan, resembling an electric brush issuing from a lucid point; others of the cometic shape, with a seeming nucleus in the centre, or like cloudy stars, surrounded with a nebulous atmosphere: a different sort again containing a nebulosity of the milky kind, while others shine with a fainter mottled kind of light, which denotes their being resolvable into stars.

"It is very probable that the great stratum called the *milky-way*, is that in which the sun is placed, though perhaps not in the very centre of its thickness. We gather this from the appearance of the galaxy, which seems to encompass the whole heavens, as it certainly must do if the sun is within the same.

"Thus in *Figure* 32. an eye at S within the stratum *a b*, will see the stars in the direction of its length *ab*, or height *c d*, with all

all thoſe in the intermediate ſituation, projected into the lucid circle ABCD; while thoſe in the ſides *m e*, *n w*, will be ſeen ſcattered over the remaining part of the heavens at MVNW.

"If the eye were placed ſomewhere without the ſtratum, at no very great diſtance, the appearance of the ſtars within it would aſſume the form of one of the leſſer circles of the ſphere, which would be more or leſs contracted to the diſtance of the eye; and if this diſtance were exceedingly increaſed, the whole ſtratum might at laſt be drawn together into a lucid ſpot of any ſhape, according to the poſition, length, and height of the ſtratum.

"Let us now ſuppoſe, that a branch or ſmaller ſtratum ſhould run out from the former in a certain direction, and let it alſo be contained between two parallel planes extended indefinitely onwards, but ſo that the eye may be placed in the great ſtratum ſomewhere before the ſeparation, and not far from the place where the ſtrata are ſtill united; then will this ſecond ſtratum not be projected into a bright circle like the former, but will be ſeen as a lucid branch proceeding from the firſt, and returning to it again at a certain diſtance leſs than a ſemicircle. Thus, in the ſame figure, the ſtars in the ſmall ſtratum *p g* will be projected into a bright arc at PRRP, which, after its ſeparation from the circle CBD, unites with it again at P.

"What has been inſtanced in parallel planes may eaſily be applied to ſtrata irregularly bounded, and running in various directions; for their projection will of conſequence vary according to the quantities of the variations in the ſtrata and the diſtance of the eye from the ſame. And thus any kind of curvatures, as well as various degrees of brightneſs, may be produced in the projections.

"From appearances then we may infer, that the ſun is moſt likely placed in one of the great ſtrata of the fixed ſtars, and very probably not far from the place where ſome ſmaller ſtratum branches out from it.

"Various methods may be taken to come to a knowledge of the ſun's place in the ſidereal ſtratum, one of which I have already begun to put in practice. I call it *gauging the heavens*, or the *ſtar-guage*. It conſiſts in repeatedly taking the number of ſtars in ten fields of view of my reflector very near each other; and by adding their ſums, and cutting off one decimal on the right, a mean of the contents of the heavens in all the parts which are thus gauged are obtained. Thus it appears, that the number of ſtars increaſes very much as we approach the milky way; for in the parallel from 92 to 94 degrees north polar diſtance, and right aſcenſion 15 h. 10′, the ſtar-gauge runs up from 9.4 ſtars in the field to 18.6 in about an hour and an half; whereas in the parallel from 78 to 80 degrees north polar diſtance, and R. A. 11, 12, 13, and 14 hours, it very ſeldom riſes above 4. We are, however, to remember, that, with different inſtruments, the account of the gauges will be very different, eſpecially on our ſuppoſition of the ſun in a ſtratum of ſtars. For let *ab*, Plate IV. *Figure* 33. be the ſtratum, and ſuppoſe the ſmall circle *g h l k* to repreſent the ſpace into which, by the light and power of a given teleſcope, we are enabled to penetrate, and let GHLK be the extent of another portion which we are enabled to viſit by means of a larger aperture and power; it is evident, that the gauges with the latter inſtrument will differ very much in their account of ſtars contained at MN and at KG or LH, when with the former they will hardly be affected with the change from *m n* to *k g* or *l k*.

"The ſituation of the ſun in the ſidereal ſtratum will be found by conſidering in what manner the ſtar-gauge agrees with the length of a ray revolving in ſeveral directions about an aſſumed point, and cut off by the bounds of the ſtratum. Thus, in *Figure* 34. let S be the place of an obſerver; S r r r, *S r r r*, lines in the plane r S r, *r S r*, drawn from S within the ſtratum to one of the boundaries here repreſented by the plane AB. Then ſince, neither the ſituation of S. nor the form of the limiting ſurface AB, is known, we are to aſſume a point, and apply to it lines proportional to the ſeveral gauges that have been obtained, and at ſuch angles from each other as they may point out; then will the termination of theſe lines delineate the boundary of the ſtratum, and conſequently manifeſt the ſituation of the ſun within the ſame.

"In my late obſervations on nebulæ, I ſoon found, that I generally detected them in certain directions rather than in others: that the ſpaces preceding them were generally quite deprived of their ſtars, ſo as often to afford many fields without a ſingle ſtar in it: that the nebulæ generally appeared ſome time after among ſtars of a certain conſiderable ſize, and but ſeldom among very ſmall ſtars: that when I came to one nebula, I generally found ſeveral more in the neighbourhood: that afterwards a conſiderable time paſſed before I came to another parcel. Theſe events being often repeated in different altitudes of my inſtrument, and ſome of them at conſiderable diſtances from each other, it occurred to me that the intermediate ſpaces between the ſweeps might alſo contain nebulæ; and finding this to hold good more than once, I ventured to give notice to my aſſiſtant at the clock, that 'I found myſelf on nebulous ground.' But how far theſe circumſtances of vacant places preceding and following the nebulous ſtrata, and their being as it were contained in a bed of ſtars ſparingly ſcattered between them, may hold good in more diſtant portions of the heavens, and which I have not yet been able to viſit in any regular manner, I ought by no means to hazard a conjecture."

By a continued ſeries of obſervations, Dr. Herſchel became confirmed in his judgment; and in a ſucceeding paper has given a ſketch of his opinions concerning the interior conſtruction of the heavens. "That the milky way, ſays he, is a moſt extenſive ſtratum of ſtars of various ſizes, admits no longer of the leaſt doubt; and that our ſun is one of the heavenly bodies belonging to it, is as evident. I have now viewed and gauged this ſhining zone in almoſt every direction, and find it compoſed of ſhining ſtars, whoſe number, by the account of thoſe gauges, conſtantly increaſes and decreaſes in proportion to its apparent brightneſs to the naked eye. But in order to develope the ideas of the univerſe that have been ſuggeſted by my late obſervations, it will be beſt to take the ſubject from a point of view at a conſiderable diſtance both of ſpace and time.

"Let us then ſuppoſe numberleſs ſtars of various ſizes ſcattered over an indefinite portion of ſpace, in ſuch a manner as to be almoſt equally diſtributed through the whole. The laws of attraction, which no doubt extend to the remoteſt regions of the fixed ſtars, will operate in ſuch a manner as moſt probably to produce the following remarkable effects.

"I. It will frequently happen, that a ſtar, being conſiderably larger than its neighbouring ones, will attract them more than they will be attracted by others that are immediately around them; by which means they will be in time, as it were, condenſed about a centre; or, in other words, form themſelves into a cluſter of ſtars of almoſt a globular figure, more or leſs regularly ſo according to the ſize and original diſtance of the ſurrounding ſtars.

"II. The next caſe, which will happen almoſt as frequently as the former, is where a few ſtars, though not ſuperior in ſize to the reſt, may chance to be rather nearer each other than the ſurrounding ones; for here alſo will be formed a prevailing attraction in the combined centre of gravity of them all, which will occaſion the neighbouring ſtars to draw together; not, indeed, ſo as to form a regular globular figure, but, however, in ſuch a manner as to be condenſed towards the common centre of gravity of the whole irregular cluſter. And this conſtruction admits of the utmoſt variety of ſhapes, according to the number and ſituation of the ſtars which firſt gave riſe to the condenſation of the reſt.

"III. From the compoſition and repeated conjunction of both the foregoing forms, a third may be derived, when many large ſtars, or combined ſmall ones, are ſituated in long extended regular or crooked rows, hooks, or branches; for they will alſo draw the ſurrounding ones ſo as to produce figures of condenſed ſtars coarſely ſimilar to the former, which gave riſe to theſe condenſations.

"IV. Likewiſe, when a cluſter of ſtars is forming in one part of a ſpace, there may be another collecting in a different, but perhaps not far diſtant, quarter, which may occaſion a mutual approach towards their common centre of gravity.

"V. In the laſt place, as a natural conſequence of the former caſes, there will be great cavities or vacancies formed by the retreat of the ſtars towards the various centres which attract them; ſo that, upon the whole, there is evidently a field of the greateſt variety for the mutual and combined attractions of the heavenly bodies to exert themſelves in.

"From this theoretical view of the heavens, which has been taken from a point not leſs diſtant in time than in ſpace, we will now retreat to our own retired ſtation, in one of the planet's attending a ſtar in its great combination with numberleſs others: and in order to inveſtigate what will be the appearances from this contracted ſituation, let us begin with the naked eye. The ſtars of the firſt magnitude, being in all probability the neareſt, will furniſh us with a ſtep to begin our ſcale. Setting off, therefore, with the diſtance of Sirius or Arcturus, for inſtance, as unity, we will at preſent ſuppoſe, that thoſe of the ſecond magnitude are at double, thoſe of the third at treble, the diſtance, &c. Taking it for granted then, that a ſtar of the ſeventh magnitude (the ſmalleſt ſuppoſed viſible with the naked eye) is about ſeven times as far as one of the firſt, it follows, that an obſerver who is incloſed in a globular cluſter of ſtars, and not far from the centre, will never be able with the naked eye to ſee to the end of it; for ſince, according to the above eſtimations, he can only extend his view to about ſeven times the diſtance of Sirius, it cannot be expected that his eyes ſhould reach the borders of a cluſter which has perhaps not leſs than 50 ſtars in depth every where around him. The whole univerſe to him, therefore, will be compriſed in a ſet of conſtellations richly ornamented with ſcattered ſtars of all ſizes. Or if the united brightneſs of a neighbouring cluſter of ſtars ſhould, in a remarkable clear night, reach his ſight, it will put on the appearance of a ſmall, faint, whitiſh, nebulous cloud, not to be perceived without the greateſt attention. Let us ſuppoſe him placed in a much extended ſtratum, or branching cluſter of millions of ſtars, ſuch as may fall under the third form of nebulæ already conſidered. Here alſo the heavens will not only be richly ſcattered over with brilliant conſtellations, but a ſhining zone or milky way will be perceived to

ſurround

Hadleys Sextant and various improved Quadrants;

See Astronomy, Section 16, & Navigation, Part 3, Sec. 5.

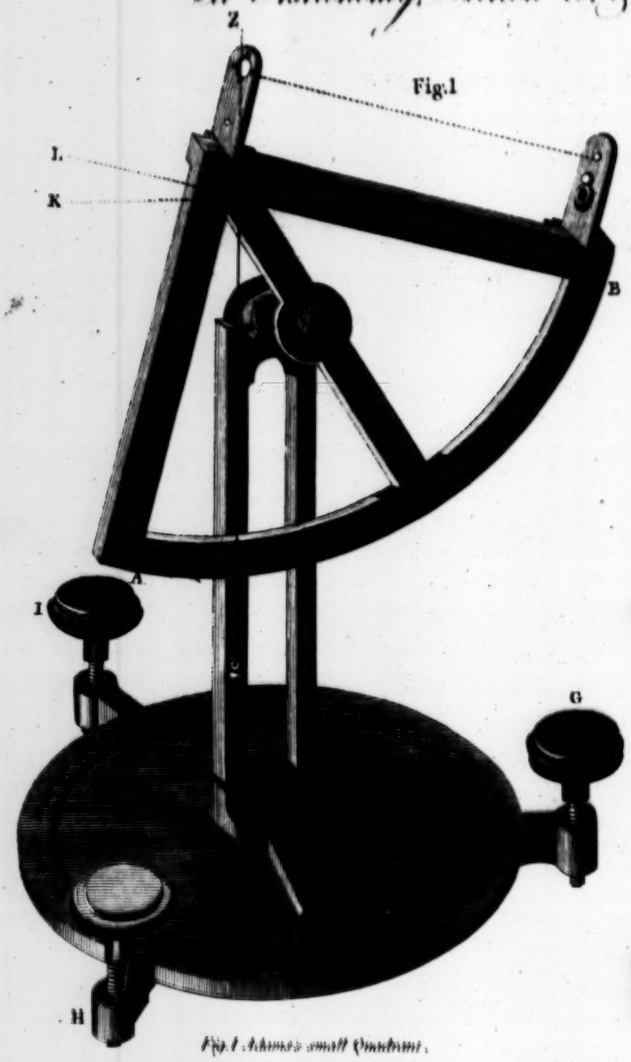


Fig. 1 Adams's small Quadrant.

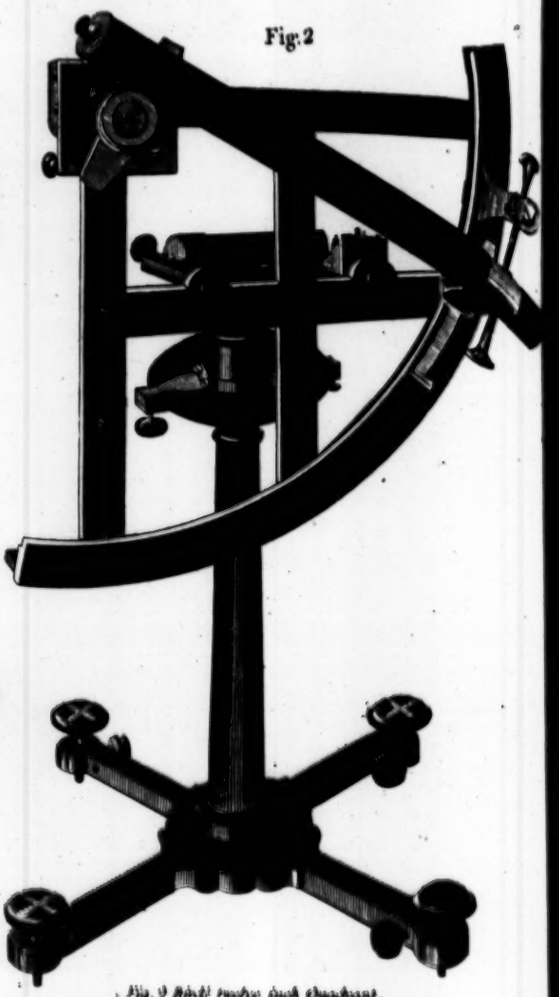


Fig. 2 Birds twelve inch Quadrant.

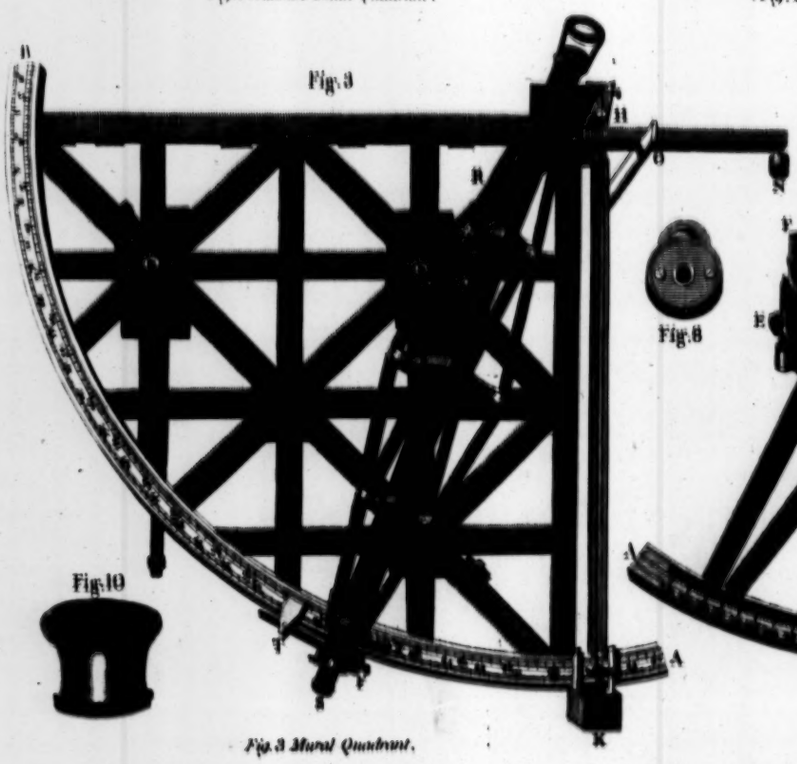


Fig. 3 Mural Quadrant.

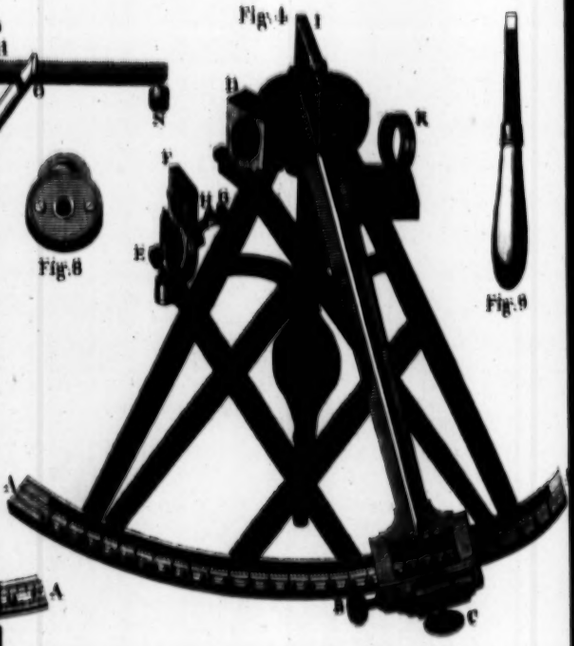


Fig. 4 Hadley's Sextant.

Fig.5

Fig.6

Fig.7

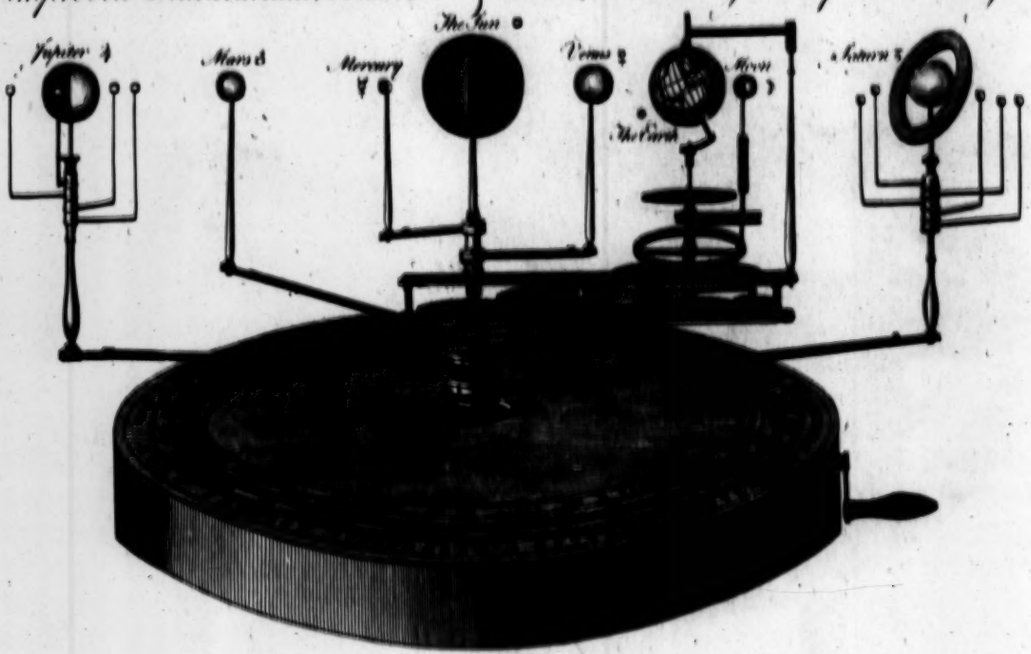
Fig.10

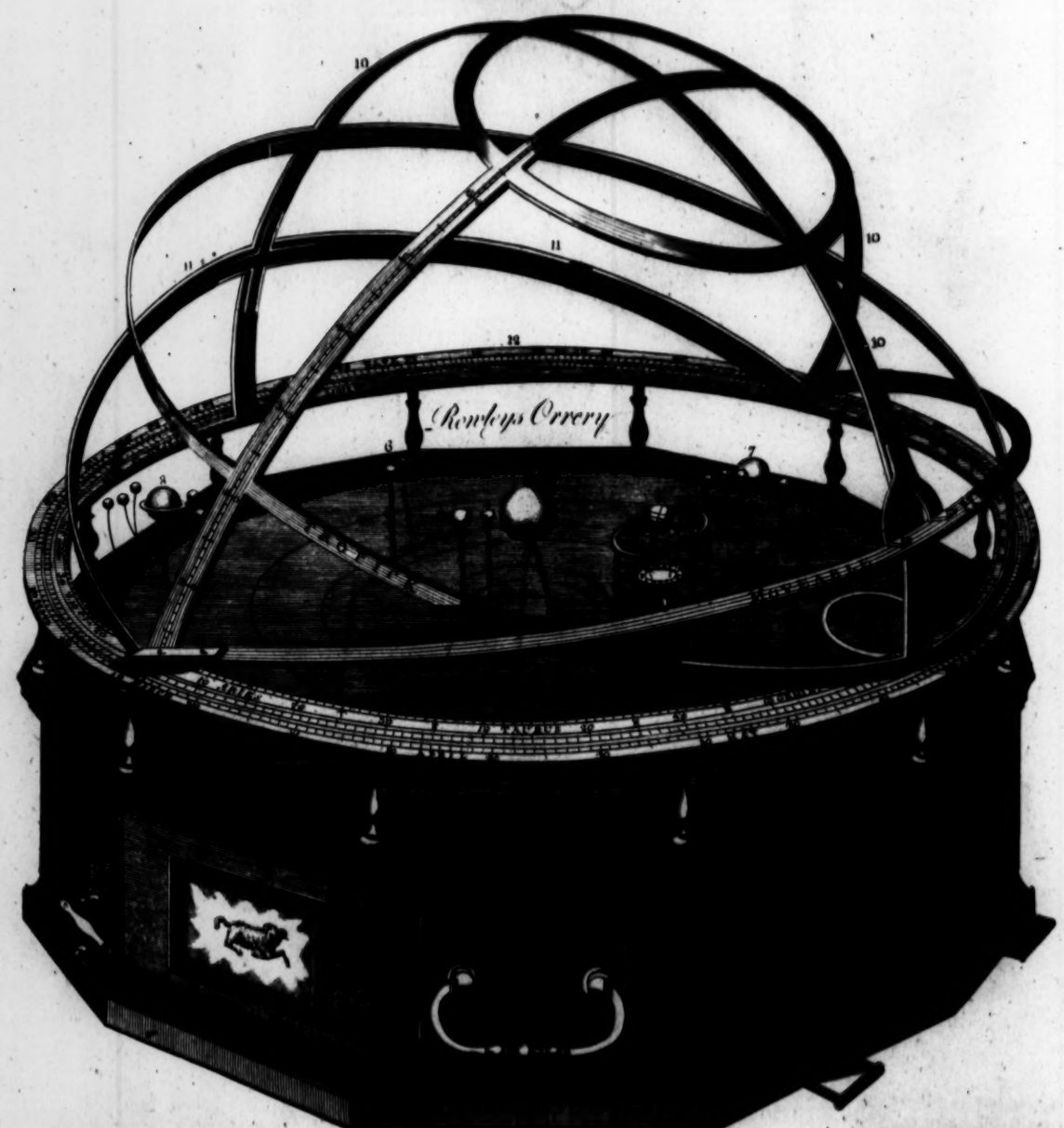
Fig.8

Fig.9

Engraved for Halls Encyclopaedia & Printed for C. Cooke, No. 17 Paternoster Row, Aug. 1795.

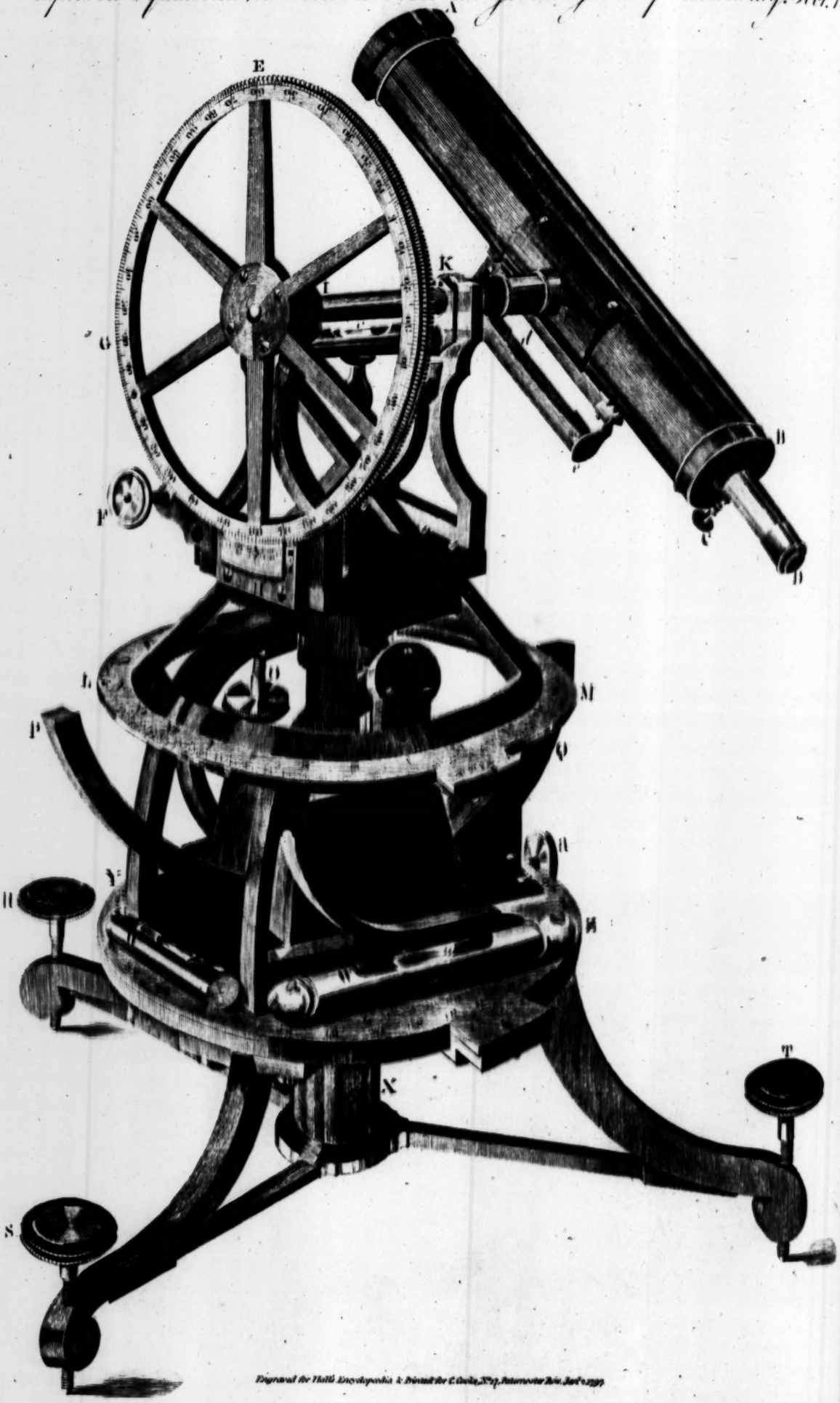
An improved Planetarium, Tellurian, & Lunarium, &c. &c. System of Astronomy, &c. &c.





Engraved for Dobbs Encyclopedia, & Printed for C. Dilly, Ave Maria Lane, June 1st 1797.

Improved Equatorial, or Portable Observatory: See System of Astronomy: Sect. 16. Plate 6.



Engraved for Hall's Encyclopædia & Printed for C. Cooke, No. 17, Paternoster Row, Jan. 1797.

ſurround the whole ſphere of the heavens, owing to the combined light of thoſe ſtars which are too ſmall, that is, too remote to be ſeen. Our obſerver's ſight will be ſo confined, that he will imagine this ſingle collection of ſtars, though he does not even perceive the thouſandth part of them, to be the whole contents of the heavens. But allowing him now the uſe of a common teleſcope, he begins to perceive that all the milkineſs of the bright path which ſurrounds the ſphere is affected by ſtars. He perceives, that thoſe objects which had been called nebulæ, are evidently nothing but cluſters of ſtars. Their number encreaſes upon him; and when he reſolves one nebula into ſtars, he diſcovers ten new ones which he cannot reſolve. He then forms the idea of immenſe ſtrata of fixed ſtars, of cluſters of ſtars and of nebulæ; till, going on with ſuch intereſting obſervations, he ſtill perceives, that all theſe appearances muſt naturally ariſe from the confined ſituation in which he is placed.

Dr. Herſchel then propoſes the following

PROBLEM.

"The ſtars being ſuppoſed nearly equally ſcattered, and their number, in a field of view of a known angular diameter, being given, to determine the length of the viſual ray.

"Here, the arrangement of the ſtars not being fixed upon, we muſt endeavour to find which way they may be placed ſo as to fill a given ſpace moſt equally. Suppoſe a rectangular cone cut into ſruſtula by many equidiſtant planes perpendicular to the axis; then, if one ſtar be placed at the vertex and another in the axis at the firſt interſection, ſix ſtars may be ſet around it ſo as to be equally diſtant from one another, and from the central ſtar. Theſe poſitions being carried on in the ſame manner, we ſhall have every ſtar within the cone ſurrounded by eight others at an equal diſtance from that ſtar taken as a centre. *Figure* 35 contains four ſections of ſuch a cone diſtinguiſhed by alternate ſhades; which will be ſufficient to explain what ſort of arrangement I would point out.

"The ſeries of the number of ſtars contained in the ſeveral ſections will be 1, 7, 19, 37, 61, 91, &c. which, continued to n terms, the ſum of it, by the differential method, will be $na + n.\frac{n-1}{2}b' + n.\frac{n-1}{2}.\frac{n-2}{3}d''$, &c. where a is the firſt term, b', b'', d'', &c. the firſt, ſecond, and third differences. Then, ſince $a=1$, $b'=6$, $b''=6$, $d''=0$, the ſum of the ſeries will be n^3. Let S be the given number of ſtars; i the diameter of the baſe of the field of view; and B the diameter of the great rectangular cone; then by trigonometry we ſhall have $B=\frac{\text{Radius}}{\text{Tang. } \frac{1}{2} \text{ field}}$. Now, ſince the field of view of a teleſcope is a cone, we ſhall have its ſolidity to that of the great cone of the ſtars formed by the above conſtruction, as the ſquare of the diameter of the baſe of the field of view to the ſquare of the diameter of the great cone, the height of both being the ſame; and the ſtars in each cone being in the ratio of the ſolidity, as being equally ſcattered, we have $n=i\sqrt{BiS}$; and the length of the viſual ray $=n-1$; which was to be determined." Another ſolution of this problem, on the ſuppoſition of another arrangement of ſtars, is given; but Dr. Herſchel prefers the former.

From the data now laid down, Dr. Herſchel next endeavours to prove that the earth is "the planet of a ſtar belonging to a compound nebula of the third form." "I ſhall now, (ſays he) proceed to ſhow, that the ſtupendous ſidereal ſyſtem we inhabit, this extenſive ſtratum, and its ſecondary branch, conſiſting of many millions of ſtars, is in all probability a detached nebula. In order to go upon grounds that ſeem to me to be capable of great certainty, they being no leſs than an actual ſurvey of the boundaries of our ſidereal ſyſtem, which I have plainly perceived as far as I have yet gone round it, every where terminated, and in moſt places very narrowly too, it will be proper to ſhow the length of my ſounding line, if I may ſo call it, that it may appear whether it was ſufficiently long for the purpoſe.

"In the moſt crowded parts of the milky-way, I have had fields of view that contained no fewer than 588 ſtars, and theſe were continued for many minutes; ſo that in one quarter of an hour's time there paſſed no leſs than 116,000 ſtars through the field of view of my teleſcope. Now if we compute the length of the viſual ray, by putting $S=588$, and the diameter of the field of view 15 minutes, we ſhall find $n=\sqrt{BiS}=498$; ſo that it appears the length of what I have called my ſounding line, or $n-1$, was not probably leſs than 497 times the diſtance of Sirius from the ſun.

"It may ſeem inaccurate that we ſhould found an argument on the ſtars being equally ſcattered, when, in all probability, there may not be any two of them in the heavens whoſe mutual diſtance ſhall be equal to that of any other two given ſtars: but it ſhould be conſidered, that when we take all the ſtars collectively, there will be a mean diſtance which may be aſſumed as the general one; and an argument founded on ſuch a ſuppoſition will have in its favour the greateſt probability of not being far ſhort of truth.

"If ſome other high gauge be ſelected from the table, ſuch as 472 or 344, the length of the viſual ray will be found 461 and 415. And although in conſequence of what has been ſaid, a certain degree of doubt may be left about the arrangement and ſcattering of the ſtars, yet when it is recollected, that in thoſe parts of the milky-way, where theſe high gauges were taken, the ſtars were neither ſo ſmall nor ſo crowded, as they muſt have been, on a ſuppoſition of a much farther continuance of them, when certainly a milky or nebulous appearance muſt have come on, I need not fear to have over-rated the extent of my viſual ray; and indeed every thing that can be ſaid to ſhorten it will only contract the limits of our nebulæ, as it has in moſt places been of ſufficient length to go far beyond the bounds of it. Thus in the ſides of our ſtratum, oppoſite to our ſituation in it, where the gauges often run below 5, or nebulæ cannot extend to 100 times the diſtance of Sirius; and the ſame teleſcope which could ſhow 588 ſtars in a field of view of 15 minutes, muſt certainly have preſented me alſo with the ſtars in theſe ſituations, had they been there. If we ſhould anſwer this by obſerving, that they might be at too great a diſtance to be perceived, it will be allowing that there muſt at leaſt be a vacancy amounting to the length of a viſual ray, not ſhort of 400 times the diſtance of Sirius; and this is amply ſufficient to make our nebula a detached one. It is true, that it would not be conſiſtent confidently to affirm that we were on an iſland, unleſs we had found ourſelves every where bounded by the ocean; and therefore I ſhall go no farther than the gauges will authoriſe: but conſidering the little depth of the ſtratum in all thoſe places which have been actually gauged, to which muſt be added all the intermediate parts that have been viewed and found to be much like the reſt, there is but little room to expect a connection between our nebula and any of the neighbouring ones. A teleſcope, with a much larger aperture than my preſent one, graſping together a greater quantity of light, and thereby enabling us to ſee farther into ſpace, will be the ſureſt means of completing and eſtabliſhing the arguments that have been uſed: for if our nebula is not abſolutely a detached one, I am firmly perſuaded that an inſtrument may be made large enough to diſcover the places where the ſtars continue onwards. A very bright milky nebuloſity muſt there undoubtly come on, ſince the ſtars in a field of view will increaſe in the ratio of n^3 greater than that of the cube of the viſual ray.

Thus, if 588 ſtars, in a given field of view, are to be ſeen by a ray of 497 times the diſtance of Sirius, when this is lengthened to 1000, which is but little more than double the former, the number of ſtars in the ſame field of view will be no leſs than 4774: for when the viſual ray r is given, the number of ſtars S, will be $=\frac{n^3}{B^3}$ where $n=r+1$; and a teleſcope with a threefold power of extending into ſpace, or with a ray of 1500, which I think may eaſily be conſtructed, will give us 16098 ſtars. Nor would theſe be ſo cloſe, but that a good power applied to ſuch an inſtrument might eaſily diſtinguiſh them; for they need not, if arranged in regular ſquares, approach nearer to each other than 6′.37: but the milky nebuloſity I have mentioned, would be produced by the numberleſs ſtars beyond them, which, in one reſpect, the viſual ray might alſo be ſaid to reach. To make this appear, we muſt return to the naked eye, which, as we have before eſtimated, can only ſee the ſtars of the ſeventh magnitude, ſo as to diſtinguiſh them: but it is nevertheleſs very evident, that the united luſtre of millions of ſtars, ſuch as I ſuppoſe the nebula in Andromeda to be, will reach our ſight in the ſhape of a very ſmall faint nebuloſity; ſince the nebula of which I ſpeak may eaſily be ſeen in a fine evening. In the ſame manner my preſent teleſcope, as I have argued, has not only a viſual ray that will reach the ſtars at 497 times the diſtance of Sirius, ſo as to diſtinguiſh them, and probably much farther, but alſo a power of ſhowing the united luſtre of the accumulated ſtars that compoſe a milky nebuloſity at a diſtance far exceeding the former limits: ſo that from theſe conſiderations it appears again highly probable, that my preſent teleſcope, not ſhewing ſuch a nebuloſity in the milky-way, goes already far beyond its extent; and conſequently much more would an inſtrument, ſuch as I have mentioned, remove all doubt on the ſubject, both by ſhowing the ſtars in the continuation of the ſtratum, and by expoſing a very ſtrong milky nebuloſity beyond them, that could no longer be miſtaken for the dark ground of the heavens.

Dr Herſchel offers ſome thoughts on the origin of the nebulous ſtrata of the heavens and their antiquity. "If it were poſſible," ſays he, "to diſtinguiſh between the parts of an indefinitely extended whole, the nebula we inhabit might be ſaid to be one that has fewer marks of antiquity than any of the reſt. To explain this idea perhaps more clearly, we ſhould recollect, that the condenſation of cluſters of ſtars has been aſcribed to a gradual approach; and whoever reflects on the number of ages that muſt have paſſed before ſome of the cluſters that are to be found in my intended catalogue of them could be ſo far condenſed as we find them at preſent, will not wonder if I aſcribe a certain air of youth and vigour to many very regularly ſcattered regions of our ſidereal ſtratum. There are, moreover, many places in it, in which, if we may judge from appearances, there is the greateſt reaſon to believe, that the ſtars are drawing towards ſecondary centres, and will in time ſeparate into cluſters, ſo as to occaſion many ſubdiviſions. Hence we may

may ſurmiſe, that when a nebulous ſtratum conſiſts chiefly of nebulæ of the firſt and ſecond forms, it probably owes its origin to what may be called the decay of a great compound nebula of the third form; and that the ſubdiviſions which happened to it in length of time, occaſioned all the ſmall nebulæ which ſprung from it to lie in a certain range, according as they were detached from the primary one. In like manner, our ſyſtem, after numbers of ages, may very poſſibly become divided ſo as to give riſe to a ſtratum of two or three hundred nebulæ; for it would not be difficult to point out ſo many beginning or gathering cluſters in it.

"Some parts of our ſyſtem ſeem already to have ſuſtained greater ravages of time than others: for inſtance, in the body of the Scorpion is an opening or hole, which is probably owing to this cauſe. It is at leaſt four degrees broad; but its height I have not yet aſcertained."

Thus, then, according to Dr. Herſchel, the univerſe conſiſts of nebulæ, or innumerable collections of innumerable ſtars, each individual of which is a ſun not only equal, but much ſuperior to ours.

Though in the above extracts from Dr. Herſchel's papers, the words *condenſation*, *cluſters*, &c. of ſtars, frequently occur, we are by no means from thence to imagine that any of the celeſtial bodies in our nebulæ are nearer to one another than we are to Sirius, whoſe diſtance is ſuppoſed not to be leſs than 400,000 times that of the ſun from us, or 38 millions of millions of miles. The whole extent of the nebula being in ſome places near 500 times as great, muſt be ſuch, that the light of a ſtar placed at its extreme boundary, ſuppoſing it to fly with the velocity of 12 millions of miles every minute, muſt have taken near 3000 years to reach us. Dr. Herſchel, however, is by no means of opinion, that our nebula is the moſt conſiderable in the univerſe.

"My opinion, ſays the doctor, of their ſize is grounded on the following obſervations: There are many round nebulæ or the firſt form, of about five or ſix minutes in diameter, the ſtars of which I can ſee very diſtinctly; and on comparing them with the viſual ray calculated from ſome of my long gauges, I ſuppoſe by the appearance of the ſmall ſtars in thoſe gauges, that the centres of theſe round nebulæ may be 600 times the diſtance of Sirius from us." He then goes on to tell us, that the ſtars in ſuch nebulæ are probably twice as much condenſed as thoſe of our ſyſtem; otherwiſe the centre of it would not be leſs than 6000 times the diſtance of Sirius from us; and that it is poſſibly much under-rated by ſuppoſing it only 600 times the diſtance of that ſtar.

In the courſe of Dr. Herſchel's obſervations and inquiries concerning the ſtructure of the heavens, an objection occurred, that if the different ſyſtems were formed by the mutual attractions of the ſtars, the whole would be in danger of deſtruction by the falling of them one upon another. A ſufficient anſwer to this, he thinks, is, that if we can really prove the ſyſtem of the univerſe to be what he has ſaid, there is no doubt but that the great author of it has amply provided for the preſervation of the whole, though it ſhould not appear to us in what manner this is effected. Several circumſtances, however, he is of opinion, manifeſtly tend to a general preſervation; as, in the firſt place, the indefinite extent of the ſidereal heavens, which muſt produce a balance that will effectually ſecure all the great parts of the whole from approaching to each other. "There remains then, ſays he, only to ſee how the particular ſtars belonging to ſeparate cluſters are prevented from ruſhing on to their centres of attraction." This he ſuppoſes may be done by projectile forces; "the admiſſion of which will prove ſuch a barrier againſt the ſeeming deſtructive power of attraction, as to ſecure from it all the ſtars belonging to a cluſter, if not for ever, at leaſt for millions of ages. Beſides, we ought perhaps to look upon ſuch cluſters, and the deſtruction of a ſtar now and then in ſome thouſand of ages, as the very means by which the whole is preſerved and renewed. Theſe cluſters may be the laboratories of the univerſe, wherein the moſt ſalutary remedies for the decay of the whole are prepared.

SECT. XVI.

OF ASTRONOMICAL INSTRUMENTS.

DESCRIPTION OF THE UNIVERSAL EQUATORIAL, *As conſtructed by Mr.* George Adams, *of Fleet Street.*

PLATE I. FIGURE I.

THE principal parts of this inſtrument are the azimuth, or horizontal circle YZ, *a* the nut to turn it. LM, the hour circle; ABD, the teleſcope; and *de*, its level; C, a ſcrew for adjuſting the hairs; the declination circle EKG, and its pinion F; the nonius to this circle is marked H; IK the axis for the teleſcope; *c* a ſmall level to this axis. O is the nut by which the hour circle is turned round; R, S, T, the adjuſting ſcrews that ſupport the inſtrument; X the axis of the azimuth circle; V the nonius thereto, and W, W, two ſpirit levels; PYQ the latitude arch.

The reader will obtain a perfect idea of the various uſes to which this inſtrument may be applied by the following Problems.

PROBLEM I. *To take the Meridian Altitude of the Sun, Moon, or Star, &c.*

Make the polar axis perpendicular to the horizon, and when the ſun is coming near to the meridian, elevate the teleſcope till the centre of the ſun is exactly in the centre of the croſs wires; then follow the ſun, by moving both the equatorial and declination circles, if neceſſary, till he is at his greateſt altitude; the nonius of the declination circle will then give you his meridian altitude.

PROBLEM II. *To find the Meridian by one Obſervation only.*

To do this, elevate the equatorial (or hour) circle to the co-latitude of the place, and ſet the declination circle to the ſun's declination for the day and hour of the day required; then move the azimuth and hour circles, both at the ſame time, either in the ſame direction, or the contrary, till you bring the centre of the croſs wires in the teleſcope exactly to cover the centre of the ſun: that being done, the index of the hour will give the apparent, or ſolar time at the inſtant of obſervation. Thus you get the time, though the ſun be at a diſtance from the meridian; then turn the hour circle till the index points preciſely at 12 o'clock, and lower the teleſcope to the horizon in order to obſerve ſome point there, in the centre of your glaſs, and that point is your meridian mark found by one obſervation only. The beſt time of the day for this operation of finding your meridian, is three or four hours before, or three or four hours after twelve at noon.

PROBLEM III. *To obſerve a Star or Planet in Broad Day-light, at any Time when it is above the Horizon.*

N. B. The table of right aſcenſions, declinations, &c. of the principal fixed ſtars, gives you the times of their tranſits over the meridian.

Elevate the equatorial circle to the co-latitude of the place, and ſet the nonius of the declination circle to the ſtar's declination; look into the table for the time of its tranſit immediately preceding your obſervation: then take the interval of time ſince that tranſit to the time of your obſervation as given by the clock, and and add to it the ſtar's acceleration, correſponding to that interval of time, this ſum is the hour to which you muſt ſet the hour index of the equatorial circle, and the ſtar will then appear in the teleſcope.

PROBLEM IV. *To find the Right Aſcenſion, and Declination of a fixed Star, Planet, Comet, or the Moon, by an Obſervation made with the Equatorial.*

The equatorial circle being elevated as before to the complement of the latitude of the place, move the declination and equatorial circulations, till the moon, ſtar, or comet, is in the centre of the croſs wires in the teleſcope; the nonius of the declination circle, will give you the hour of the ſtar, &c. then your regulator or clock will give you the ſun's time, or hour of the day. Take the difference between the ſun's time, and the ſtar's time; and if the ſtar's time is leſs than the ſun's time, add that difference, to the ſun's right aſcenſion at the time of obſervation, the ſum (rejecting 24 hours, if it exceeds that number) is the right aſcenſion of the ſtar, &c. Again, if the ſtar's time exceeds the ſun's time, ſubtract the difference from the ſun's right aſcenſion; the remainder (adding 24 hours, to the ſun's right aſcenſion, if neceſſary) is the right aſcenſion of the ſtar, &c.

PROBLEM V. *To find the Longitude at Land.*

Obſerve the difference of the right aſcenſion of two celeſtial bodies; for inſtance, of the moon, and a known fixed ſtar; at any given time, either on, or out of the meridian, and from that difference, infer the moon's right aſcenſion, at the moment of obſervation; that being obtained, find what is the preciſe time, at any place whoſe longitude is well aſcertained; for inſtance, at Greenwich, when the moon has that right aſcenſion, which you have now obſerved; the difference between that time at Greenwich, and the time with you, is the difference of longitude, in time, between Greenwich, and your place of obſervation, which is Eaſt of Greenwich, if the time with you be later than the time at Greenwich, and is Weſt of Greenwich, if the time with you be earlier than that of Greenwich.

OF THE PLANETARIUM, TELLURIAN, AND LUNARIAN.

The Planetarium (Plate II. *Figure* 1.) is an inſtrument made by Mr. Adams, of Fleet Street, London, who has paid conſiderable attention to this deſcription of machines, in order to reduce them to their greateſt degree of ſimplicity and perfection. It repreſents in a general manner, by various parts of its machinery, all the motions and phænomena of the planetary ſyſtem. This machine conſiſts of, the Sun (in the centre), with the planets, Mercury, Venus, the Earth and Moon, Mars, Jupiter and his four moons, Saturn and his five moons; and to it is occaſionally applied an extra long arm for the Georgian planet and his two moons. To the earth and moon is applied a frame, containing only four wheels and two pinions, which ſerve to preſerve the earth's axis in its proper parallelism in its motion round the ſun, and to give the moon her due revolution about the earth at the ſame time. Theſe wheels are connected with the wheel work in a round box below, and the whole is ſet in motion by a winch. The arm that carries round the moon, points out her age and phaſes for any ſituation in her orbit, as alſo her geocentric place in

in the ecliptic, in ſigns and degrees. The moon's orbit is repreſented by a flat rim; the two joints upon which it turns, denoting her nodes. This orbit is made to incline to any deſired angle. The earth of this inſtrument is uſually made of a three-inch or 1¼ globe, papered, &c. for the purpoſe; and by means of the terminating wire that goes over it, points out the changes of the ſeaſons, and the different lengths of days and nights more conſpicuously. This machine is alſo made to repreſent the Ptolemaic Syſtem, or ſuch as is vulgarly received; which places the earth in the centre, and the planets and ſun revolving about it. (It is done by an auxiliary ſmall ſun and an earth, which change their places in the inſtrument.) At the ſame time, it affords a moſt manifeſt confutation of it: for it is plainly obſerved in this conſtruction, (1.) That the planets Mercury and Venus, being both within the orbit of the ſun, cannot at any time be ſeen to go behind it; whereas in nature we obſerved them as often to go behind as before the ſun in the heavens. (2.) It ſhows, that as the planets move in circular orbits about the central earth, they ought at all times to be of the ſame apparent magnitude; whereas, on the contrary, we obſerve their apparent magnitude in the heavens to be very variable, and ſo far different, that, for inſtance, Mars will ſometimes appear as big as Jupiter nearly, and at other times you will ſcarcely know him from a fixed ſtar. (3.) It ſhows that any of the planets might be ſeen at all diſtances from the ſun in the heavens; or, in other words, that when the ſun is ſetting, Mercury or Venus may be ſeen not only in the ſouth but even in the eaſt; which circumſtances were never yet obſerved. (4.) You ſee by this planetarium that the motions of the planets ſhould always be regular and uniformly the ſame; whereas, on the contrary, we obſerve them always to move with a variable velocity, ſometimes faſter, then ſlower, and ſometimes not at all. (5.) By the machine you ſee the planets move all the ſame way, viz. from weſt to eaſt continually: but in the heavens we ſee them move ſometimes direct from weſt to eaſt, ſometimes retrogade from eaſt to weſt, and at other times to be ſtationary. All which phænomena plainly prove this ſyſtem to be a falſe and abſurd hypotheſis.

The truth of the Copernican or Solar Syſtem of the world is hereby moſt clearly repreſented. For taking the earth from the centre, and placing thereon the uſual large braſs ball for the ſun, and reſtoring the earth to its proper ſituation among the planets, then every thing will be right and agree exactly with celeſtial obſervations. You will obſerve Mercury never to be more than a certain angular diſtance, 21°, and Venus 47°, from the ſun. That the planets, eſpecially Mars, will be ſometimes much nearer to the earth than at others, and therefore muſt appear larger at one time than at another. And that they cannot appear at the earth to move with an uniform velocity; for when neareſt they appear to move faſteſt, and ſlower when moſt remote. You will alſo obſerve their motions to be ſometimes direct, and ſometimes retrograde, when after a time they become ſtationary. Which particulars all correſpond exactly with obſervations, and fully prove the truth of this excellent ſyſtem.

Wherefore by this machine you at once ſee all the planets in motion about the ſun, with the ſame reſpective velocities and periods of revolution which they have in the heavens; the wheel-work being calculated to a minute of time, from the lateſt diſcoveries.

The diurnal rotation of the earth about its axis, the different ſeaſons of the year, and the different lengths of days and nights, are likewiſe here completely exhibited.

In ſhort by this inſtrument every phænomenon in nature is repreſented as it actually appears in the heavens.

ROWLEY'S GRAND ORRERY.

The machine repreſented by (Plate II. *Figure* 2.) is the Grand Orrery, firſt made in this kingdom by Mr. Rowley for king George I. The frame of it, which contains the wheel-work &c. and regulates the whole, is made of ebony, and about four feet in diameter; the outſide thereof is adorned with 12 pilaſters. Between theſe the 12 ſigns of the zodiac are neatly painted with gilded frames. Above the frame is a broad ring ſupported with 12 pillars. This ring repreſents the plane of the ecliptic; upon which are two circles of degrees, and between theſe the names and characters of the 12 ſigns. Near the outſide is a circle of months and days, exactly correſponding to the ſun's place at noon each day throughout the year. Above the ecliptic ſtand ſome of the principal circles of the ſphere, agreeable to their reſpective ſituations in the heavens: viz. N° 10. are the two colures, divided into degrees and half degrees, N° 11. is one half of the equinoctial circle, making an angle of 23½ degrees. The tropic of Cancer and the arctic circle are each fixed parallel at their proper diſtance from the equinoctial. On the northern half of the ecliptic is a braſs ſemicircle, moveable upon two points fixed in ♈ and ♎. This ſemicircle ſerves as a moveable horizon to be put to any degree of latitude upon the north part of the meridian, and the whole machine may be ſet to any latitude without diſturbing any of the internal motions, by two ſtrong hinges, (N° 13) fixed to the bottom frame upon which the inſtrument moves, and a ſtrong braſs arch, having holes at every degree, through which a ſtrong pin is put at every elevation. This arch and the two hinges ſupport the whole machine when it is lifted up according to any latitude; and the arch at other times lies conveniently under the bottom frame. When the machine is ſet to any latitude (which is eaſily done by two men, each taking hold of two handles conveniently fixed for the purpoſe), ſet the moveable horizon to the ſame degree upon the meridian, and hence you may form an idea of the reſpective altitude or depreſſion of the planets both primary and ſecondary. The ſun (N° 1.) ſtands in the middle of the whole ſyſtem upon a wire, making an angle with the ecliptic of about 82 degrees. Next the ſun is a ſmall ball (2.), repreſenting Mercury. Next to Mercury is Venus (3.), repreſented by a larger ball. The earth is repreſented (N° 4.) by an ivory ball, having ſome circles and a map ſketched upon it. The wire which ſupports the earth makes an angle with the ecliptic of 66½ degrees, the inclination of the earth's axis to the ecliptic. Near the bottom of the earth's axis is a dial plate (N° 9.), having an index pointing to the hours of the day as the earth turns round its axis. Round the earth is a ring ſupported by two ſmall pillars, repreſenting the orbit of the moon; and the diviſions upon it anſwer to the moon's latitude. The motion of this ring repreſents the motion of the moon's orbit according to that of the nodes. Within this ring is the moon (N° 5), having a black cap or caſe, by which his motion repreſents the phaſes of the moon according to her age. Without the orbits of the earth and moon in Mars (N° 6.). The next in order to Mars is Jupiter and his four moons (N° 7.). Each of theſe moons is ſupported by a wire fixed in a ſocket which turns about the pillar ſupporting Jupiter. Theſe ſatellites may be turned by the hand to any poſition, and yet when the machine is put into motion they will all move in their proper times. The outermoſt of all is Saturn, his five moons, and his ring (N° 8.). Theſe moons are ſupported and contrived ſimilar to thoſe of Jupiter. The machine is put into motion by turning a ſmall winch (N° 14.); and the whole ſyſtem is alſo moved by this winch, and by pulling out and puſhing in a ſmall cylindrical pin above the handle. When it is puſhed in, all the planets, both primary and ſecondary, will move according to their reſpective periods by turning the handle. When it is drawn out, the motion of the ſatellites of Jupiter and Saturn will be ſtopped, while all the reſt move without interruption. There is alſo a braſs lamp having two convex glaſſes to be put in room of the ſun; and alſo a ſmaller earth and moon, made ſomewhat in proportion to their diſtance from each other, which may be put on at pleaſure. The lamp turns round at the ſame time with the earth, and the glaſſes of it caſt a ſtrong light upon her.

And when the ſmaller earth and moon are placed on, it will be eaſy to ſhow when either of them will be eclipſed. When this machine is intended to be uſed, the planets muſt be duly placed by means of an ephemeris, and you may place a ſmall black patch or bit of wafer upon the middle of the ſun.

Right againſt the firſt degree of ♈, you may alſo place patches upon Venus, Mars, and Jupiter, right againſt ſome noted point in the ecliptic. Put in the handle, and puſh in the pin which is above it. One turn of this handle anſwers to a revolution of the balls which repreſents the earth about its axis; and conſequently to 24 hours of time, as ſhewn by the hour-index (9.), which is marked and placed at the foot of the wire on which the ball of the earth is fixed. Again, when the index has moved the ſpace of ten hours; Jupiter makes one revolution round its axis, and ſo of the reſt. By theſe means the revolutions of the planets, and their motions round their own axis, will be repreſented to the eye. By obſerving the motions of the ſpots upon the ſurface of the ſun and of the planets in the heavens, their diurnal motions were firſt diſcovered, after the ſame manner as we in this machine obſerve the motions of their repreſentatives by that of the marks placed upon them.

ADAMS'S SMALL QUADRANT.

PLATE V. FIGURE I.

This is a very ſimple and uſeful inſtrument of this kind. ABC is the quadrant mounted on an axis and pedeſtal: (by means of the axis, it may be immediately placed in any vertical poſition, and the pedeſtal being moveable in the axis of the circle EF, ſerves to place it in the direction of any azimuth, or towards any point of the compaſs.) The limb AB is divided into degrees and halves, numbered from A; and upon the radius BC are fixed two ſights, of which B is perforated with a ſmall hole, and is provided with a dark glaſs, to defend the eye from the ſun's light; and the other ſight C has a larger hole, furniſhed with croſs wires, and alſo a ſmaller, which is of uſe to take the ſun's altitude by the projection of the bright image of that luminary upon the oppoſite ſight. From the center C hangs a plumb line CP. The horizontal circle FE is divided into four quadrants of 90 degrees; and an arm E, connected with the pedeſtal, moves along the limb, and conſequently ſhews the poſition of the place of the quadrant, as will hereafter be more minutely explained. Laſtly, the ſcrews G, H, I, render it very eaſy to ſet the whole inſtrument ſteadily and accurately in its proper poſition, notwithſtanding any irregularity in the table or ſtand it may be placed upon.

The rationale of this inſtrument is very clear and obvious. It is uſed to meaſure the angular diſtance of any body, or appearance, either from the zenith or point immediately above our heads, or from the horizon or level. The plumb line CP, if continued upwards

wards from C, would be directed to the zenith Z; and the line CL, ſuppoſed to be drawn from the centre of the quadrant to an object L, will form an angle LCZ, which is the zenith diſtance, and is equal to the angle BCP, formed between the oppoſite parts of the ſame lines. We ſee, therefore, that the degrees on the arc, comprehended on the limb of the quadrant, between the plumb line and the extremities next the eye, meaſure the angle of zenith diſtance.

Again, the line CK (forming a right angle with the perpendicular CZ) is level, or horizontal; the angle LCK muſt therefore be the altitude or elevation of L above the horizon: and this laſt angle muſt be equal to the angle meaſured between the plumb line and the end A fartheſt from the eye; becauſe both theſe are equal to the quantity which would be left, after taking the zenith diſtance from a right angle, or the whole quadrant.

FIGURE II.

BIRD'S TWELVE INCH QUADRANT.

The Method of adopting this Quadrant.

For performing this, there are three principal parts to be adjuſted, 1. The pillar is to be ſet perpendicular to the horizon. 2. One ſide of the quadrant is to be ſet perpendicular. 3. The axis of the teleſcope, or line of ſight, is to be made parallel to the horizontal radius of the quadrant.

I. *To ſet the Pillar perpendicular.*

Set the braſs pedeſtal on a firm ſurpport. Then hang the quadrant on the pillar, and by the ſpirit-level and ſcrews in the feet, the pillar may be ſet perpendicular in the following manner: Turn the quadrant till the upper ſide is parallel to two oppoſite feet, and with one hand unſcrew that ſcrew of the foot towards which the buble inclines, and, at the ſame time, with the other hand ſcrew in the oppoſite ſcrew, till the buble reſts equally between the two marks, or ſcratches, on the glaſs tube; then turn the quadrant, horizontally, half round; and if the buble does not reſt exactly between the ſcratches as before, by unſcrewing that ſcrew towards which the buble inclines, and at the ſame ſcrewing in the other, make the buble move over half the ſpace in the tube by which they differ, and remember toward which end it inclines. Then turn the quadrant one quarter round, till its upper ſide is parallel to the other two feet; and if the buble does not reſt in the ſame place, with reſpect to the ſcratches, as it did before, make it do ſo by the ſcrews in the feet; and then bring it equally between the ſcratches, by lowering that end of the tube toward which the buble ſtood, or raiſing the other end. For doing this, there are three ſcrews at each end of the tube. To lower one end, ſlacken the right and left, or puſhing ſcrews, and ſcrew in the middle ſcrew, till the buble reſts equally between the two ſcratches: then the pillar and level are right, or nearly ſo. To prove if they are exact, or to make them ſo, if they are not; begin the ſame proceſs over again, by firſt turning the quadrant half round, and if the buble reſts not equally between the ſcratches, move it half the difference by the ſcrews in the feet; and then quarter round, and adjuſting the level firſt ſo far by the ſcrews in the feet, and next by raiſing or lowering one end of the tube as before directed; till you get the buble to ſtand in the ſame part of the glaſs when the quadrant is turned half round and quarter round; and the pillar and level will then be right.

II. *To make one Side of the Quadrant perpendicular.*

This is done by making the plumb-line hang firſt over the fine point at the arrow-head, on the center plate; and next to cover the other fine point on the arch below.

It is made to hang over the upper point, by ſcrewing the elaſtic bit of braſs (over which the wire of the plummet goes) out, or in, by its upper ſcrew-nail. It is made to hang over the lower point, by the adjuſting ſcrew within the quadrant, which is turned by a round brotched braſs-button on its head.

The plummet ſhould be made to hang in a ſmall cup, or veſſel, filled with water, to make it more ſteady, and reſt ſooner; and if the veſſel is faſtened by an arm to the pillar of the pedeſtal; ſo as to move round along with the quadrant, it will be the more convenient.

The plumb-line ſhould be made to hang very near the plane of the quadrant, at the lower arrow, but not to touch it: which is done by preſſing with the hand the elaſtic bit of braſs before mentioned, a little backward or forward.

III. *To adjuſt the Teleſcope, or to make its Axis horizontal, when the Index is at 90 Degrees.*

Set the index to 90, keeping the plummet and level right: then direct the teleſcope to ſome diſtant object above a mile off, (but the farther the better) till you ſee a remarkable part of it exactly at the horizontal wire: then take off the quadrant from the pillar, by unſcrewing the two large iron ſcrews; and invert the quadrant, by ſcrewing it on again with the arc uppermoſt: then ſcrew to the arc of the quadrant a crooked bit of braſs, with a notch in it, as near the arrow as you can, and hang the plummet over that bit of braſs, moving it on one ſide or the other, till the line covers the point on the arc; and if it does not then cover the point on the centre plate alſo, make it do ſo by the ſcrews in the feet; then look through the teleſcope; and if the horizontal wire cuts the ſame part of the object it did before inverſion, the teleſcope is right. If the object appears higher or lower, the wire in the teleſcope muſt be moved half the difference, by the two ſteel ſcrews near the eye end of the teleſcope: if the object appears higher than the horizontal wire, eaſe the lower ſcrew, and ſcrew in the upper one; if the object appears below, eaſe the upper ſcrew, and ſcrew in the lower one; till the horizontal wire cuts the diſtant object at half the difference it did before inverting it: then it is adjuſted for obſervation.

The wire in the teleſcope that is applied to the limb of the ſun, in taking its altitude, ought to be exactly horizontal when the plane of the quadrant is perpendicular. To find if it is ſo: adjuſt the quadrant by the level and plummet, as before directed; then point the teleſcope to ſome ſmall diſtinct object at a diſtance, as the top of a rock, a chimney-head, &c. and remark a particular part of it which the wire croſſes: turn the quadrant a little about gently, towards one ſide; and if all parts of the wire paſs over the ſame part of the object, the wire is truly horizontal. But if one end of the wire croſſes the object higher, or lower, than the other, preſs the two ſmall ſcrews that govern the wire between your finger and thumb, and at the ſame time turn them ſide wiſe, but in oppoſite directions, till, upon looking again, and turning the quadrant, you find all parts of the wire paſs over the ſame part of the object; then it is truly horizontal.

MURAL QUADRANT.

FIGURE III.

Repreſents the inſtrument as fixed to a wall. It is of copper, and of about 5 feet radius. The frame is formed of flat bars, and ſtrengthened by edge bars affixed underneath perpendicularly to them. The radii HB, HA, being divided each into four equal parts, ſerves to find out the points D and E, by which the quadrant is freely ſuſpended on its props or iron ſupports that are faſtened ſecurely in the wall.

One of the ſupports E is repreſented ſeparately in *e* on one ſide of the quadrant. It is moveable by means of a long ſlender rod EF or *ef*, which goes into a hollow ſcrew in order to reſtore the inſtrument to its ſituation when it is diſcovered to be a little deranged. In order to prevent the unſteadineſs of ſo great a machine there ſhould be placed behind the limb four copper ears with double cocks, I, K, I, K. There are others along the radii HA, and HB. Each of theſe cocks contain two ſcrews, into which is faſtened the ears that are fixed behind the quadrant.

Over the wall or ſtone which ſupports the inſtrument, and at the ſame height as the centre, is placed horizontally the axis PO. This axis turns on two pivots P. On this axis is fixed at right angles another branch ON, loaded at its extremity with a weight N, capable of equipoiſing with its weight that of the teleſcope LM; whilſt the axis, by its extremity neareſt the quadrant, carries the wooden frame PRM, which is faſtened to the teleſcope in M.

The lower extremity (V) of the teleſcope is furniſhed with two ſmall wheels, which take the limb of the quadrant on its two ſides.

When the teleſcope is to be ſtopped at a certain poſition, the copper hand T is to be made uſe of. It is fixed by a ſetting ſcrew, which faſtens it to the limb. Then, in turning the regulating ſcrew, the teleſcope will be advanced; which is continued until the ſtar or other object, whoſe altitude is obſerving, be on the horizontal fine thread in the teleſcope. Then on the plate X, ſupporting the teleſcope, and carrying a vernier or nonius, will be ſeen the number of degrees and minutes, &c. that the angular height of the object obſerved is equal to.

FIGURE IV.

HADLEY'S SEXTANT.

For a deſcription of which the reader is referred to the Syſtem of NAVIGATION.

In forming this Syſtem, I have had recourſe to every valuable work on this ſubject; the principal of which are the Treatiſes of Dr. Gregory, Keil, Dr. Halley, M. De la Caille, Dr. Long, Robertſon, Heath, Emerſon, De la Lande, &c. together with the Improvements of Dr. Herſchel, &c. collected from the Tranſactions of the Royal Society, and a variety of other miſcellaneous publications.

It has been my ſtudy to render this Syſtem full and comprehenſive, ſo that, with due attention, a perſon may attain a competent knowledge of Aſtronomy, without any other Treatiſe; and by purchaſing a good ſet of Aſtronomical Tables, he will be thoroughly qualified for making actual Calculations of the Motions of the celeſtial Bodies, ſuch as calculating the places of the Sun, Moon, and Planets, for any propoſed time; their conjunctions and oppoſitions with each other; predicting Eclipſes, &c.

I cannot diſmiſs this ſubject, without expreſſing myſelf indebted to Mr. ADAMS, *(Mathematical and Aſtronomical Inſtrument Maker, in Fleet-ſtreet) for the loan of his inſtruments to have drawings made from; as it is a point of no ſmall conſequence to practitioners in Aſtronomy, that they ſhould have the moſt neceſſary, and thoſe the moſt accurate, Inſtruments that can be made.*

The Uſes of the Globes are given under the article GLOBE, *in the order of the Alphabet; alſo other matters relating to Aſtronomy in the* Syſtem of NAVIGATION, *and under their reſpective Heads in different parts of the* ENCYCLOPÆDIA.

T. BANKES.

ASTROPE-WELLS, near Banbury, in Oxfordſhire, are recommended as excellent in female obſtructions, the gravel, hypochondriac and ſimilar diſorders. The water is briſk, ſpirituous, pleaſant taſted, chalybeate, and is alſo gently purgative. It ſhould be drank from three to five quarts in the forenoon.

ASYMPTOTE, in geometry, a line which continually approaches nearer to another; but, though continued infinitely, will never meet with it: Of theſe are many kinds. In ſtrictneſs, however, the term Aſymptotes is appropriated to right lines, which approach nearer and nearer to ſome curves of which they are ſaid to be Aſymptotes; but if they and their curves are indefinitely continued, they will never meet. See the Syſtem, Part I. which compriſes CONIC SECTIONS, Sect. III.

ATHANASIAN CREED; a formulary, or confeſſion of faith, long ſuppoſed to have been drawn up by Athanaſius biſhop of Alexandria, in the fourth century, to juſtify himſelf againſt the calumnies of his Arian enemies. But it is now generally allowed among the learned not have been his. Dr. Waterland aſcribes it to Hilary biſhop of Arles, for the following among other reaſons: 1. Becauſe Honoratus of Marſeilles, the writer of his life, tells us, that he compoſed an Expoſition of the Creed; a properer title for the Athanaſian, than that of Creed ſimply which it now bears. 2. Hilary was a great admirer and follower of St. Auſtin; and the whole compoſition of this creed is in a manner upon St. Auſtin's plan, both with reſpect to the Trinity and incarnation. 3. It is agreeable to the ſtyle of Hilary, as far as we can judge from the little that is left of his works. Upon the whole, he concludes, that Hilary biſhop of Arles, about the year 430, compoſed The Expoſition of Faith, which now bears the name of the Athanaſian Creed, for the uſe of the Gallican clergy, and particularly thoſe of the dioceſe of Arles: That, about the year 570, it became famous enough to be commented upon; but that all this while, and for ſeveral years lower, it had not yet acquired the name of Athanaſian, but was ſimply ſtyled The Catholic Faith: That, before 670, Athanaſius's admired name came in to recommend and adorn it, being in itſelf an excellent ſyſtem of the Athanaſian principles of the Trinity and incarnation, in oppoſition chiefly to the Arians, Macedonians, and Apollinarians. This is the hypotheſis of the learned author of the Critical Hiſtory of the Athanaſian Creed.

As to the reception of this creed in the Chriſtian churches, we find, that it obtained in France in the time of Hincmar, or about 850; that it was received in Spain about 100 years later than in France, and in Germany much about the ſame time As to our own coun ry, we have clear and poſitive proofs of this creed being ſung alternately in our churches in the tenth century. It was in common uſe in ſome parts of Italy, particularly in the dioceſe of Verona, about the year 960, and was received at Rome about the year 1014. As to the Greek and oriental churches, it has been queſtioned whether any of them ever received this creed at all; though ſome very conſiderable writers are of a contrary perſuaſion. It appears then, that the reception of this creed has been both general and ancient; and may vie with any, in that reſpect, except the Nicene, or Conſtantinopolitan, the only general creed common to all the churches.

As to the matter of this creed, it is given as a ſummary of the true orthodox faith, and a condemnation of all hereſies ancient and modern. Unhappily, however, it has proved a fruitful ſource of unprofitable controverſy and unchriſtian animoſity even down to the preſent time. See TRINITY and TRINITARIANS.

ATHANOR. Chymiſts have diſtinguiſhed by this name a furnace ſo conſtructed that it can always maintain an equal heat, and which ſhall laſt a long time without addition of freſh fuel. The body of the athanor has nothing in it particular, and is conſtructed like ordinary furnaces. But at one of its ſides, or its middle, there is an upright hollow tower, which communicates with the fire-place by one or more ſloping openings. This tower ought to have a lid which exactly cloſes its upper opening.

When the athanor is to be uſed, as much lighted coal is put in the fire-place as is judged neceſſary, and the tower is filled to the top with unlighted fuel. The tower is then to be exactly cloſed with its lid. As faſt as the coal in the fire-place is conſumed, that in the tower falls down and ſupplies its place. As the coal contained in the tower has no free communication with the external air, it cannot burn till it falls into the fire-place.

The athanor being much celebrated and uſed by ancient chymiſts, it has been particularly deſcribed by many authors, and was formerly found in all the laboratories. At preſent this furnace is much leſs employed, and is even neglected. The reaſon of this is, that all the ancient chymiſts were in ſearch of the art of making gold; and being excited by this powerful deſire, and confidence of ſucceſs, they ſpared no trouble nor expence to accompliſh this deſign. They undertook, without heſitation, operations which required great length of time and unremitted heat. Whereas now, theſe alluring hopes having vaniſhed, the cultivators of chymiſtry have no other view than to extend and perfect the theory of this eſſential part of natural philoſophy. This motive, although undoubtedly much nobler than the former, ſeems, however, to be leſs powerful over moſt men. For now, all long and laborious operations whence chymiſtry might receive great advantages, are neglected, as being tireſome and diſguſtful. There is, in fact, a conſiderable difference betwixt the hope of explaining a philoſophical phenomenon, and that of obtaining an ingot of gold capable of producing many others. Hence the inſtruments employed in long operations, and particularly the athanor, are now much neglected; and alſo becauſe the fuel in the tower is apt to ſtick there or fall down at once in too great quantity. The lamp-furnace, which is a true athanor, may be ſucceſsfully employed in operations which do not require much heat. For deſcription of the moſt a proved Athanor, ſee the Syſtem of Chymiſtry, under the article CHYMICAL APPARATUS. For repreſentation, ſee the Plate annexed, Fig. 6.

ATHEIST, a perſon who does not believe the exiſtence of a Deity. Many people, both ancient and modern, have pretended to atheiſm, or have been reckoned atheiſts by the world; but it is juſtly queſtioned whether any man ſeriouſly adopted ſuch a principle. Theſe pretenſions, therefore, muſt be founded on pride or affectation. In general, a man is ſaid to be an atheiſt, who owns no being ſuperior to nature, that is, to men, and the other ſenſible beings in the world. In this ſenſe, Spinoſa may be ſaid to be an atheiſt, and it is an impropriety to rank him, as the learned commonly do, among deiſts; ſince he allows of no other God beſide nature, or the univerſe, of which mankind makes a part; and there is no atheiſt but allows of the exiſtence of the world, and of his own exiſtence in particular.

Plato diſtinguiſhes three kinds of atheiſts. Some, who deny, abſolutely, that there are any gods; others, who allow the exiſtence of gods, but maintain that they do not concern themſelves with human affairs, and ſo deny a Providence; and others, who believe there are gods, but think they are eaſily appeaſed, and that they may remit the greateſt crimes for the ſmalleſt ſupplication. Some diſtinguiſh ſpeculative atheiſts, or thoſe who are ſo from principle, and theory—from practical atheiſts, whoſe wicked lives lead them to believe, or rather to wiſh, that there were no God.

Atheiſm, as abſurd and unreaſonable as it is, has had its martyrs. Lucilio Vanini, an Italian, native of Naples, publicly taught atheiſm in France, about the beginning of the 17th century; and, being convicted of it at Toulouſe, was condemned to be death. Being preſſed to make public acknowledgment of his crime, and to aſk pardon of God, the king, and juſtice, he anſwered, he did not believe there was a God; that he never offended the king; and, as for juſtice, he wiſhed it to the devil. He confeſſed that he was one of twelve, who parted in company from Naples to ſpread their doctrine in all parts of Europe. His tongue was firſt cut out, and then his body burnt, April 9, 1619.

Cicero repreſents it is a probable opinion, that they who apply themſelves to the ſtudy of philoſophy believe there are no gods. This muſt, doubtleſs, be meant of the academic philoſophy, to which Cicero himſelf was attached, and which doubted of every thing. On the contrary, the Newtonian philoſophers are continually recurring to a Deity, whom they always find at the end of their chain of natural cauſes. Some foreigners have even charged them with making too much uſe of the notion of a God in philoſophy, contrary to the rule of Horace:

Nec Deus interſit, niſi dignus vindice nodus.

Among us, the philoſophers have been the principal advocates for the exiſtence of a Deity. Witneſs the writings of Sir Iſaac Newton, Boyle, Ray, Cheyne, Nieuwentyt, &c. To which may be added many others, who, though of the clergy (as was alſo Ray), yet have diſtinguiſhed themſelves by their philoſophical pieces in behalf of the exiſtence of a God; e. gr. Derham, Bentley, Whiſton, Samuel and John Clarke, Fenelon, &c. So true is that ſayirg of Lord Bacon, that though a ſmattering of philoſophy may lead a man into atheiſm, a deep draught will certainly bring him back again to the belief of a God and Providence.

ATLAS, in Geography, a celebrated mountain in Africa, which is ſo high, that it ſeems to bear the heavens. Hence the fable, in Atlas, the king of this country, is ſaid to bear the heavens on his ſhoulders; thus he is repreſented in the famous ſtatue at the Farneſe palace at Rome.

ATLAS, in Anatomy, the name of the firſt *vertebra* of the neck, which ſupports the head. For a particualr deſcription, ſee the Syſtem, Part I. Sec. III. Art. I. and Plate I. and Fig. 2.

ATMOSPHERE, a word generally uſed to ſignify the whole maſs of fluid conſiſting of air, aqueous and other vapours, electric fluid, &c. ſurrounding the earth to a conſiderable height. It gravitates towards its centre, on its ſurface, is carried along with it round the ſun, and partakes of all its motions both annual and diurnal. The farther or higher ſpaces, though perhaps not wholly deſtitute of air, are ſuppoſed to be poſſeſſed by a finer ſubſtitute called Ether, and are hence called Etherial regions. The word is formed of ἀτμος, vapour, and σφαιρα, a ſphere. See ETHER

The Binder is deſired to obſerve, that this Sheet (5 A—1) *is to be placed before Sheet* (5 A—2), *it being an additional Sheet introduced to enlarge the article* Atmoſphere *in this New Edition of this Work.*

and HEAVENS. A late eminent author conſiders the atmoſphere as a large chymical veſſel, wherein the matter of all the kinds of ſublunary bodies as copiouſly floating; and thus expoſed to the continual action of that immenſe ſurface of the ſun; whence proceed innumerable operations, ſublimations, ſeparations, compoſitions, digeſtions, fermentations, putrefactions. For the nature, conſtitution, and different ſpecies of the air, with their ingredients, properties, phænomena and uſes, ſee the Syſtem of AEROLOGY throughout: ſee alſo the article AIR and the Syſtem of ELECTRICITY.

The compoſition of that part of our atmoſphere properly called air, was till lately very much unknown. In former times it was ſuppoſed to be a ſimple, homogeneous, and elementary fluid. The experiments of Dr. Prieſtley diſcovered, that the pureſt kind of air, which he called Dephlogiſticated or vital air; (but which is called by Chaptal Oxygene Gas) and by which term we have diſtinguiſhed it in our Syſtem of Chymiſtry, was in reality a compound, and might be artificially produced in various ways. His firſt conjectures concerning its component parts were, that it conſiſted of earth, nitrous acid, and phlogiſton. Subſequent experiments rendered theſe conjectures dubious; and at laſt it was ſuppoſed that dephlogiſticated air is a pure elementary ſubſtance, the viviſying principle to animals, and the acidifying principle throughout all nature. This dephlogiſticated air, however, is but a ſmall part of the compoſition of our atmoſphere. According to the moſt accurate computations, the air we uſually breathe is compoſed of only one-fourth of this dephlogiſticated air, or perhaps leſs; the other three or four parts conſiſting of what Dr. Prieſtley calls Phlogiſticated air, and Lavoiſier mephitiſed or mephitic air, atmoſpherical mephitics, &c. but Chaptal calls it Nitrogene Gas; which term we have alſo adopted in our Syſtem of Chymiſtry. This by itſelf is abſolutely noxious, and exceedingly poiſonous to animals: though it ſeems only to be negatively ſo; for when mixed in a certain proportion with dephlogiſticated air, it may be breathed with ſafety, which could not be if it contained any ingredient abſolutely unfriendly to the human conſtitution. The other part, viz. the pure dephlogiſticated air, ſeems to ſtand much in the ſame relation to plants that phlogiſticated air does to animals; that is, it would prove poiſonous, and deſtroy them if they were to depend upon it entirely for their ſubſiſtence; but as they derive their nouriſhment partly from the air and partly from the ſoil, it thence happens, that the plants which are ſet to grow in dephlogiſticated air do not die inſtantly, as animals do in the phlogiſticated kind, but remain for ſome time weak and ſickly. See the Syſtem of AEROLOGY, Sect. III. and IV.

The other component parts of our atmoſphere are ſo various, and of ſuch heterogeneous natures, that they do not admit of any kind of definition or analyſis, one only excepted, named, the electric fluid. This we know pervades the whole, but appears to be much more copious in the upper than in the lower atmoſpherical regions. See ELECTRICITY. To meaſure the abſolute quality of this fluid, either in the atmoſphere or any other ſubſtance, is impoſſible. All that we can know on this ſubject is, that the electric fluid pervades the atmoſphere; that it appears to be more abundant in the ſuperior than the inferior regions; that it ſeems to be the immediate bond of connection between the atmoſphere and the water which is ſuſpended in it; and that by its various operations, the phenomena of hail, rain, ſnow, lightning, and various other kinds of meteors, are occaſioned. See RAIN, HAIL, SNOW, &c.

Various attempts have been made to aſcertain the height to which the atmoſphere is extended all round the earth. Theſe commenced ſoon after it was diſcovered, by means of the Torricellian tube, that air is a gravitating ſubſtance. Thus it alſo became known, that a column of air, whoſe baſe is a ſquare inch, and the height that of the whole atmoſphere, weighs 15 pounds; and that the weight of air is to that of mercury as 1 to 10,800: whence it follows, that if the weight of the atmoſphere be ſufficient to raiſe a column of mercury to the height of 30 inches, the height of the aerial column muſt be 10,800 times as much, and conſequently a little more than five miles high.

It was not, however, at any time ſuppoſed, that this calculation could be juſt; for as the air is an elaſtic fluid, the upper parts muſt expand to an immenſe bulk, and thus render the calculation above related exceedingly erroneous. By experiments made in different countries, it has been found, that the ſpaces which any portion of air takes up, are reciprocally proportional to the weights with which it is compreſſed. Allowances were therefore to be made in calculating the height of the atmoſphere. If we ſuppoſe the height of the whole divided into innumerable equal parts, the denſity of each of which is as its quantity; and the weight of the whole incumbent atmoſphere being alſo as its quantity; it is evident, that the weight of the incumbent air is every where as the quantity contained in the ſubjacent part; which makes a difference between the weights of each two contiguous parts of air. By a theorem in geometry, where the differences of magnitudes are geometrically proportional to the magnitudes themſelves, theſe magnitudes are in continual arithmetical proportion; therefore, if, according to the ſuppoſition, the altitude of the air, by the addition of new parts into which it is divided, do continually increaſe in arithmetical proportion, its denſity will be diminiſhed, or (which is the ſame thing, its gravity decreaſed) in continual geometrical proportion.

It is now eaſy, from ſuch a theſis, by making two or three barometrical obſervations, and determining the denſity of the atmoſphere at two or three different ſtations, to determine its abſolute height, or its rarity at any aſſignable height. Calculations accordingly were made upon this plan; but it having been found that the barometrical obſervations by no means correſponded with the denſity which, by other experiments, the air ought to have had, it was ſuſpected that the upper parts of the atmoſpherical regions were not ſubject to the ſame laws with the lower ones. Philoſophers therefore had recourſe to another method for determining the altitude of the atmoſphere, viz. by a calculation of the height from which the light of the ſun is refracted, ſo as to become viſible to us before he himſelf is ſeen in the heavens. By this method it was determined, that at the height of 45 miles the atmoſphere had no power of refraction; and conſequently beyond that diſtance was either a mere vacuum, or the next thing to it, and not to be regarded.

This theory ſoon became very generally received, and the height of the atmoſphere was ſpoken of as familiarly as the height of a mountain, and reckoned to be as well aſcertained, if not more ſo, than the heights of moſt mountains are. Very great objections, however, which have never yet been removed, ariſe from the appearances of ſome meteors, like large globes of fire, not unfrequently to be ſeen at vaſt heights above the earth (ſee METEOR). A very remarkable one of this kind was obſerved by Dr. Halley in the month of March 1719, whoſe altitude he computed to have been between 69 and 73½ Engliſh miles; its diameter 2800 yards, or upwards of a mile and a half; and its velocity about 350 miles in a minute. Others, apparently of the ſame kind; but whoſe altitude and velocity were ſtill greater, have been obſerved: particularly that very remarkable one, Auguſt 18th 1783, whoſe diſtance from the earth could not be leſs than 90 miles, and its diameter not leſs than the former; at the ſame time, that its velocity was certainly not leſs than 1000 miles in a minute. Fire-balls, in appearance ſimilar to theſe, though vaſtly inferior in ſize, have been ſometimes obſerved at the ſurface of the earth. Of this kind Dr. Prieſtley mentions one ſeen on board the Montague, 4th November 1749, which appeared as big as a large mill-ſtone, and broke with a violent exploſion.

From analogical reaſoning, it ſeems very probable, that the meteors which appear at ſuch great heights in the air are not eſſentially different from thoſe which, like the fire-ball juſt mentioned, are met with on the ſurface of the earth. The perplexing circumſtances with regard to the former are, that at the great heights abovementioned, the atmoſphere ought not to have any denſity ſufficient to ſupport flame, or to propagate ſound; yet theſe meteors are commonly ſucceeded by one or more exploſions, nay are ſometimes ſaid to be accompanied with a hiſſing noiſe as they paſs over our heads. The meteor of 1719 was not only very bright, inſomuch that for a ſhort ſpace it turned night into day, but was attended with an exploſion heard over all the iſland of Britain, occaſioning a violent concuſſion in the atmoſphere, and ſeeming to ſhake the earth itſelf. That of 1783 alſo, though much higher than the former, was ſucceeded by exploſions; and, according to the teſtimony of ſeveral people, a hiſſing noiſe was heard as it paſſed. Dr. Halley acknowledged that he was unable to reconcile theſe circumſtances with the received theory of the height of the atmoſphere; as, in the regions in which this meteor moved, the air ought to have been 300,000 times more rare than what we breathe, and the next thing to a perfect vacuum.

In the meteor of 1783, the difficulty is ſtill greater, as it appears to have been 20 miles farther up in the air. Dr. Halley offers a conjecture, indeed, that the vaſt magnitude of ſuch bodies might compenſate for the thinneſs of the medium in which they moved. Whether or not this was the caſe, cannot indeed be aſcertained, as we have ſo few data to go upon; but the greateſt difficulty is to account for the brightneſs of the light. Appearances of this kind are indeed with great probability attributed to electricity, but the difficulty is not thus removed. Though the electrical fire pervades with great eaſe the vacuum of a common air-pump, yet it does not in that caſe appear in bright well defined ſparks, as in the open air, but rather in long ſtreams reſembling the aurora borealis. From ſome late experiments indeed, Mr. Morgan concludes, that the electrical fluid cannot penetrate a perfect vacuum. If this is the caſe, it ſhows that the regions we ſpeak of are not ſuch a perfect vacuum as can be artificially made; but whether it is or not, the extreme brightneſs of the light ſhows that a fluid was preſent in thoſe regions, capable of confining and condenſing the electric matter as much as the air does at the ſurface of the ground; for the brightneſs of theſe meteors, conſidering their diſtance, cannot be ſuppoſed inferior to that of the brighteſt flaſhes of lightning.

This

This being the caſe, it appears reaſonable to conclude, that what is called the denſity of the air does not altogether keep pace with its gravity. The latter indeed muſt in a great meaſure be affected by the vapours, but above all by the quantity of the baſis of fixed or dephlogiſticated air contained in it: for Mr. Kirwan has diſcovered that the baſis of fixed air, when deprived of its elaſtic principle, is not greatly inferior to gold in ſpecific gravity; and we cannot ſuppoſe that of dephlogiſticated air to be much leſs. It is poſſible, therefore, that pure air, could it be deprived of all the water it contains, might have very little gravity; and as there is great reaſon to believe that the baſis of dephlogiſticated air is only one of the conſtituent parts of water, we ſee an evident reaſon why the air ought to become lighter, and likewiſe leſs fit for reſpiration, the higher up we go, though there is a poſſibility that its denſity, or power of ſupporting flame, may continue unaltered.

There are not yet, however, a ſufficient number of facts to enable us to determine this queſtion; though ſuch as have been diſcovered ſeem rather to favour the above conjecture. Dr. Boerhaave was of opinion that the gravity of the air depended entirely on the water it contained; and, by means of alkaline ſalts, he was enabled to extract as much water from a quantity of air as was very nearly equivalent to its weight. By the calcination of metals we may extract as much of the baſis of dephlogiſticated air from a quantity of atmoſpherical air as is equivalent to the weight of air loſt. Were it poſſible, therefore, to extract the whole of this, as well as all other vapours, and to preſerve only the elaſtic principle, it is highly probable that its gravity would entirely ceaſe. It has been found by thoſe who have aſcended with aeroſtatic machines, or to the tops of high mountains, that the dephlogiſticated air is found to be contained in ſmaller quantities in the atmoſphere of theſe elevated regions than on the lower grounds. It is alſo found, that in ſuch ſituations the air is much drier, and parts with water with much more difficulty, than on the ordinary ſurface. Salt of tartar, for inſtance, which at the foot of a mountain will very ſoon run into a liquid, remains for a long time expoſed to the air on the top of it, without ſhowing the leaſt tendency to deliqueſce. Nevertheleſs, it hath never been obſerved that fires did not burn as intenſely on the tops of the higheſt mountains as on the plains. The matter indeed was put to the trial in the great eruption of Veſuvius in 1779, where, though the lava ſpouted up to the height of three miles above the level of the ſea, the uppermoſt parts all the while were to appearance as much inflamed as the loweſt.

The high degree of electricity, always exiſting in the upper regions of the atmoſphere, muſt of neceſſity have a very conſiderable influence on the gravity of any heterogeneous particles floating in it. When we conſider the effects of the electric fluid upon light bodies at the ſurface of the earth, it will readily be admitted, that in thoſe regions where this fluid is very abundant, the gravity of the atmoſphere may be much diminiſhed without affecting its denſity. We know that it is the nature of any electriſied ſubſtance to attract light bodies; and that, by proper management, they may even be ſuſpended in the air, without either moving up or down for a conſiderable time. If this is the caſe with light terreſtrial bodies, it cannot be thought very improbable that the aerial particles themſelves, i. e. thoſe which we call the baſis of dephlogiſticated air, and of aqueous or other vapour diffuſed among them, ſhould be thus affected in the regions where electricity is ſo abundant. From this cauſe, therefore, alſo the gravity of the atmoſphere may be affected without any alteration at all being made in its denſity; and hence may ariſe anomalies in the barometer hitherto not taken notice of. For experiments and obſervations on Atmoſpherical Electricity, ſee the Syſtem of ELECTRICITY, Sect. II. Art. 6.

It appears, therefore, that the abſolute height of the atmoſphere is not yet determined. The beginning and ending of twiliight indeed ſhow, that the height at which the atmoſphere begins to refract the ſun's light is about 44 or 45 Engliſh miles. But this may, not improbably, be only the height to which the aqueous vapours are carried: for it cannot be thought any unreaſonable ſuppoſition, that light is refracted only by means of the aqueous vapour contained in the atmoſphere; and that where this ceaſes, it is ſtill capable of ſupporting the electric fire at leaſt, as bright and ſtrong as at the ſurface. That it does extend much higher, is evident from the meteors already mentioned: for all theſe are undoubtedly carried along with the atmoſphere; otherwiſe that of 1783, which was ſeen for about a minute, muſt have been left 1000 miles to the weſtward, by the earth flying out below it in its annual courſe round the ſun.

It has already been mentioned, that the preſſure of the atmoſphere, when in its mean ſtate, is equivalent to a weight of 15 pounds on every ſquare inch. Hence Dr. Cotes computed, that the preſſure of the whole ambient fluid upon the earth's ſurface is equivalent to that of a globe of lead 60 miles in diameter. Hence alſo it appears, that the preſſure upon a human body muſt be very conſiderable; for as every ſquare inch of ſurface ſuſtains a preſſure of 15 pounds, every ſquare foot, as containing 144 inches, muſt ſuſtain a preſſure of 2160; and if we ſuppoſe a man's body to contain 15 ſquare feet of ſurface, which is pretty near the truth, he muſt ſuſtain a weight of 32,400 pounds, or 16 tun, for his ordinary load. By this enormous preſſure we ſhould undoubtedly be cruſhed in a moment, were not all parts of our bodies filled either with air or ſome other elaſtic fluid, the ſpring of which is juſt ſufficient to counterbalance the weight of the atmoſphere. But whatever this fluid may be, we are ſure that it is juſt able to counteract the atmoſpherical gravity and no more; for if any conſiderable preſſure be ſuperadded to that of the air, as by going into deep water, or the like, it is always ſeverely felt, let it be ever ſo equable. If the preſſure of the atmoſphere is taken off from any part of the human body, the hand, for inſtance, when put in an open receiver from whence the air is afterwards extracted, the weight of the atmoſphere then diſcovers itſelf, and we imagine the hand ſtrongly ſucked down into the glaſs. See PNEUMATICS.

In countries at ſome diſtance from the equator, the preſſure of the atmoſphere varies conſiderably, and thus produces conſiderable changes on many terreſtrial bodies. On the human body the quantity of preſſure ſometimes varies near a whole tun; and when it is thus ſo much diminiſhed, moſt people find ſomething of a liſtleſſneſs and inactivity about them. It is ſurpriſing, however, that the ſpring of the internal fluid, already mentioned, which acts as a counterpoiſe to the atmoſpherical gravity, ſhould in all caſes ſeem to keep pace with it when the preſſure is naturally diminiſhed, and even when it is artificially augmented, though not when the preſſure is artificially diminiſhed. Thus in that kind of weather when the preſſure of the air is leaſt, we never perceive our veins to ſwell, or are ſenſible of any inward expanſion in our bodies. On the contrary, the circulation is languid, and we ſeem rather to be oppreſſed by a weight. Even in going up to the tops of mountains, where the preſſure of the atmoſphere is diminiſhed more than three times what it uſually is on the plain, no ſuch appearances are obſerved. Some travellers indeed have affirmed, that, on the tops of very high mountains, the air is ſo light as to occaſion a great difficulty of reſpiration, and even violent retching and vomiting of blood. It does not appear, however, that theſe aſſertions are well founded. Mr. Brydone found no inconvenience of this kind on the top of mount Ætna; nor is any ſuch thing mentioned by Mr. Houel, who alſo aſcended this mountain. Sir William Hamilton indeed ſays, that he did feel a difficulty of reſpiration, independent of any ſulphureous ſteam. But, on the top of a volcano, the reſpiration may be affected by ſo many different cauſes, that it is perhaps impoſſible to aſſign the true one. The French mathematicians, when on the top of a very high peak of the Andes, did not make any complaint of this kind, though they lived there for ſome time. On the contrary, they found the wind ſo extremely violent, that they were ſcarce able to withſtand its force; which ſeems an argument for at leaſt equal denſity of the atmoſphere in the ſuperior as in the inferior regions. Dr. Heberden, who aſcended to the top of Teneriffe, a higher mountain than Ætna, makes no mention of any difficulty of reſpiration. M. Sauſſure, however, in his journey to the top of mount Blanc, the higheſt of the Alps, felt very great uneaſineſs in his way. His reſpiration was not only extremely difficult, but his pulſe became quick, and he was ſeized with all the ſymptoms of a fever. His ſtrength was alſo exhauſted to ſuch a degree, that he ſeemed to require four times as long a ſpace to perform ſome experiments on the top of the mountain as he would have done at the foot of it. It muſt be obſerved, however, that theſe ſymptoms did not begin to appear till he had aſcended two miles and a half perpendicular above the level of the ſea. The mountain is only about a quarter of a mile higher; and in this ſhort ſpace he was reduced to the ſituation juſt mentioned. But it is improbable that ſo ſmall a difference, even at the end of his journey, ſhould have produced ſuch violent effects, had not ſome other cauſe concurred. A cauſe of this kind he himſelf mentions, viz. that the atmoſphere at the top of the mountain was ſo much impregnated with fixed air, that lime-water, expoſed to it, quickly became covered with a pellicle occaſioned by the abſorption of that fluid. Now it is known, that fixed air is extremely pernicious to animals, and would bring on ſymptoms ſimilar to thoſe abovementioned. There is no reaſon, therefore, to have recourſe to the rarity of the atmoſphere for ſolving a phenomenon which may more naturally be accounted for otherwiſe.

When the preſſure of the atmoſphere is augmented, by deſcending, in the diving-bell, to conſiderable depths in the ſea, it does not appear that any inconvenience follows from its increaſe. Thoſe who ſit in the diving-bell are not ſenſible of any preſſure as long as they remain in the air, though they feel it very ſenſibly in going into the water: yet it is certain, that the preſſure in both caſes is the ſame; for the whole preſſure of the atmoſphere, as well as of the water, is ſuſtained by the air in the diving-bell, and conſequently communicated to thoſe who ſit in it. But though artificial compreſſion of the air, as well as natural rarefaction, can thus be borne, it is otherwiſe with artificial rarefaction. Animals in an air-pump ſhow uneaſineſs from the

very firſt, and cannot live for any time in an atmoſphere rarefied artificially even as much as it appeared to be from the barometer on the top of mount Blanc

It is not eaſy to aſſign the true reaſon of the variations of gravity in the atmoſphere. Certain it is, however, that they take place only in a very ſmall degree within the tropics; and ſeem there to depend on the heat of the ſun, as the barometer conſtantly ſinks near half an inch every day, and riſes again to its former ſtation in the night-time. In the temperate zones the barometer ranges from 28 to near 31 inches, by its various altitudes ſhowing the changes that are about to take place in the weather. If we could know, therefore, the latent cauſes by which the weather is influenced, we ſhould likewiſe certainly know thoſe by which the gravity of the atmoſphere is affected. Theſe are particularly explained under the articles RAIN, HAIL, SNOW, WINDS, &c.; but in general they may be reduced to two, viz. an emiſſion of latent heat from the vapour contained in the atmoſphere, or of electric fluid from the ſame, or from the earth. To one or both of theſe cauſes, therefore, may we aſcribe the variations of the gravity of the atmoſphere; and we ſee that they both tend to produce the ſame effect with the ſolar heat in the tropical climates, viz. to rarify the air, by mixing with it or ſetting looſe a non-gravitating fluid, which did not act in ſuch large proportion in any particular place before. No doubt, the action of the latent heat and electric fluid is the ſame in the torrid as in the temperate zones: but in the torrid zone the ſolar heat and exceſſive evaporation counteract them; ſo that whatever quantities may be diſcharged by the exceſſive deluges of rain, &c. which fall in thoſe countries, they are inſtantly abſorbed by the abundant fluid, and are quickly ready to be diſcharged again; while, in the temperate zones, the air becomes ſenſibly lighter, as well as warmer by them, for ſome time before they can be abſorbed again.

The variations of heat and cold to which the atmoſphere is ſubject, have been the ſubject of much ſpeculation. In general they ſeem to depend entirely upon the light of the ſun reflected into the atmoſphere from the earth; and where this reflection is deficient, even though the light ſhould be preſent ever ſo much, the moſt violent degrees of cold are found to take place. Hence, on the tops of mountains, the cold is generally exceſſive, though by reaſon of the clearneſs of the atmoſphere the light of the ſun falls upon them in greater quantity than it can do on equal ſpace on the plain. In long winding paſſages alſo, ſuch as the caverns of Ætna and Veſuvius, where the air has room to circulate freely, without any acceſs of the ſun, the cold is ſcarce tolerable; whence the uſe of theſe for cooling liquors, preſerving meat, &c.

The coldneſs of the atmoſphere on the tops of mountains has been aſcribed by M. Lambert and De Luc, to the igneous fluid, or elementary fire, being more rare in thoſe elevated ſituations than on the plains. M. Lambert is of opinion that it is rarified above by the action of the air, and that below it is condenſed by its own proper weight. He conſiders fire as a fluid in motion, the parts of which are ſeparable, and which is rarified when its velocity is accelerated. He does not decide with regard to the identity of fire and light, though he ſeems inclined to believe it. M. de Luc compares elementary fire to a continuous fluid, whoſe parts are condenſed by being mutually compreſſed. He denies that fire and light are the ſame; and maintains that the latter is incapable, by itſelf, of ſetting fire to bodies, though it does ſo by putting in motion the igneous fluid they contain; and that it acts with more force near the earth than at a diſtance from its ſurface, by reaſon of this fluid, which he calls an heavy and elaſtic one, being more condenſed there than at a greater height.

Mr. Sauſſure, in treating of this ſubject in his account of the Alps, does not conſider fire as a fluid ſo free and detached as to be able either to aſcend with rapidity by its ſpecific levity, or to condenſe itſelf ſenſibly by its proper weight. He ſuppoſes it to be united to bodies by ſo ſtrict an affinity, that all its motions are determined, or at leaſt powerfully modified, by that affinity. As ſoon therefore as fire, diſengaged by the combuſtion or by any other cauſe, endeavours to diffuſe itſelf, all the bodies that come within the ſphere of its activity endeavour to attract it; and they abſorb ſuch quantities of it as are in the direct ratio of their affinities with it, or in the inverſe ratio of what is neceſſary for their equilibrium with the ſurrounding bodies. Now it does not appear that in this diſtribution, the ſituation of places with regard to the horizon, has any other influence than what they receive from the different currents produced by the dilatation of the air, and by the levity which that dilatation produces. The aſcent of flame, ſmoke, &c. or of air heated in any way, perſuaded the ancients that fire is poſſeſſed of abſolute levity, by which it had a tendency to mount upwards. "But theſe effects (ſays he) are owing either to the levity of the fluid which conſtitutes flame, or to that of air dilated by heat; and not to the levity of the igneous fluid. I am, however, ſufficiently convinced, that this fluid is incomparably lighter than air, though I do not believe that it poſſeſſes the power of aſcending in our atmoſphere by virtue of its levity alone.

The celebrated Bouguer has demonſtrated, by principles the moſt ſimple, and moſt univerſally adopted, that it is not neceſſary, in order to account for the diminution of heat on mountains, to have recourſe to hypotheſes that are at beſt doubtful. The following is his explanation of what was felt on the mountains of Peru.

"It was proper, in order to explain this ſubject, to inſiſt on the ſhort duration of the ſun's rays, which cannot ſtrike the different ſides of mountains but for a few hours, and even this not always. A horizontal plain, when the ſun is clear, is expoſed at mid-day to the perpendicular and undiminiſhed action of theſe rays, while they fall but obliquely on a plain not much inclined, or on the ſides of a high pile of ſteep rocks. But let us conceive for a moment an inſulated point, half the height of the atmoſphere, at a diſtance from all mountains, as well as from the clouds which float in the air. The more a medium is tranſparent, the leſs heat it ought to receive by the immediate action of the ſun. The free paſſage which a very tranſparent body allows to the rays of light, ſhows that its ſmall particles are hardly touched by them. Indeed what impreſſion could they make on it when they paſs through almoſt without obſtruction? Light, when it conſiſts of parallel rays, does not by paſſing a foot of free atmoſpheric air, near the earth, loſe an hundred thouſandth part of its force. From this we may judge how few rays are weakened, or can act on this fluid, in their paſſage through a ſtratum of the diameter not of an inch or a line, but of a particle. Yet the ſubtilty and tranſparency are ſtill greater at great heights, as was obvious on the Cordilleras, when we looked at diſtant objects. Laſtly, the groſſer air is heated below by the contact or neighbourhood of bodies of greater denſity than itſelf, which it ſurrounds, and on which it reſts; and the heat may be communicated by little and little to a certain diſtance. The inferior parts of the atmoſphere by this means contract daily a very conſiderable degree of heat, and may receive it in proportion to its denſity or bulk. But it is evident that the ſame thing cannot happen at the diſtance of a league and an half or two leagues above the ſurface of the earth, although the light there may be ſomething more active. The air and the wind therefore muſt at this height be extremely cold, and colder in proportion to the elevation.

"Beſides, the heat neceſſary to life is not merely that which we receive every inſtant from the ſun. The momentary degree of this heat correſponds to a very ſmall of part of that which all the bodies around us have imbibed, and by which ours is chiefly regulated. The action of the ſun only ſerves to maintain nearly in the ſame ſtate the ſum of the total heat, by repairing through the day the loſs it ſuſtains through the night, and at all times. If the addition be greater than the loſs, the total heat will increaſe, as it happens in ſummer, and it will continue to accumulate in a certain degree; but for the reaſons already given, this accumulation cannot be very great on the top of a mountain, where the ſummit, which riſes high, is never of great bulk. The loweſt ſtate of the thermometer in every place is always in proportion to the heat acquired by the ſoil; and that heat being very ſmall on the top of a mountain, the quantity added to it by the ſun during the day muſt be comparatively greater; and the accumulated heat will be more in a condition to receive increaſe in proportion to its diſtance from the degree which it cannot paſs.

"Another particular obſervable on all the high places of the Cordilleras, and which depends on the ſame cauſe, is, that when we leave the ſhade, and expoſe ourſelves to the ſunſhine, we feel a much greater difference than we do here in our fine days when the weather is temperate. Every thing contributes at Quito to make the ſun exceedingly powerful: a ſingle ſtep from an expoſed place to the ſhade gives the ſenſation of cold: this would not be the caſe if the quantity of heat acquired by the ſoil were more conſiderable. We now alſo ſee why the ſame thermometer, put firſt into the ſhade and then in the ſun, does not undergo the ſame changes at all times and in all places. In the morning, upon Pichincha, this inſtrument is generally a few degrees below the freezing point, which may be reckoned the natural temperature of the place; but when during the day we expoſe it to the ſun, it is eaſy to imagine the effect muſt be great, and much more than double in whatever way it is meaſured."

This theory is adopted by Mr. Sauſſure, who adds the following fact to prove that the action of the ſun's rays, conſidered abſtractedly, and independent of any extrinſic ſource of cold, is as great on mountains as on plains; viz. that the power of burning leſſes and mirrors is the ſame at all heights. To aſcertain this fact, our author procured a burning-glaſs ſo weak that at Geneva it would juſt ſet fire to tinder. This he carried, with ſome of the ſame tinder, to the top of the mountain Saleve (a height of 3000 feet); where it not only produced the ſame effect, but apparently with greater facility than on the plain. Being perſuaded then, that the principal ſource of cold on the tops of high mountains is their being perpetually ſurrounded with an atmoſphere which cannot be much heated either by the rays of the ſun on account of its tranſparency, or by the reflection of them from the

earth

earth by reaſon of its diſtance, he wiſhed to know, whether the direct ſolar rays on the top of a high mountain had the ſame power as on the plain, while the body on which they acted was placed in ſuch a manner as to be unaffected by the ſurrounding air. For this purpoſe he inſtituted a ſet of experiments, from which he drew the following concluſions, viz. That a difference of 777 toiſes in height, diminiſhes the heat which the rays of the ſun are able to communicate to a body expoſed to the external air, 14° of the thermometer; that it diminiſhes the heat of a body partially expoſed, only 6°; and that it augments by 1° the heat of a third body completely defended from the air.

Hence it appears that the atmoſphere, though ſo eſſentially neceſſary to the ſupport of fire, is ſome how or other the greateſt antagoniſt of heat, and moſt effectually counteracts the operation of the ſolar rays in producing it. This power it ſeems to exert at all diſtances, at the ſurface as well as in the higher regions. From ſome experiments made by M. Pictet, it appears, that even in places expoſed to the rays of the ſun, the heat, at five feet diſtance from the ground, is greater only by one or two degrees than at 50 feet above the ſurface, though the ground was at that time 15 or 20° warmer than the air immediately in contact with it. Inconſiderable as this difference is, however, it does not hold as we go higher up: for if it did, the cold on the top of the mountain of Saleve, which is 3000 feet above the level of the lake of Geneva, would be 60° greater than at the foot of it; whereas in reality it is only 10. In the night-time the caſe is reverſed; for the ſtratum of air, at five feet from the ground, was found by Mr. Pictet to be colder than that at 50. Beſides this, different ſtrata of the atmoſphere are found to poſſeſs very different and variable degrees of cold, without any regard to their ſituation high up or low down. In the year 1780, Dr. Wilſon of Glaſgow found a very remarkable cold exiſting cloſe to the ſurface of the ground; ſo that the thermometer, when laid on the ſurface of the ſnow, ſunk many degrees lower than one ſuſpended 24 feet above it. It has been likewiſe obſerved, that in clear weather, though the ſurface of the earth be then moſt liable to be heated by the ſun, yet after that is ſet, and during the night, the air is coldeſt near the ground, and particularly in the valleys. Experiments on this ſubject were made for a whole year by Mr. James Sex, who has given an account of them in the 78th volume of the Philoſophical Tranſactions.

From theſe experiments Mr. Sex concludes, that a greater diminution of heat frequently takes place near the earth in the night-time than at any altitude in the atmoſphere within the limits of his inquiry, that is, 220 feet from the ground; and at ſuch times the greateſt degrees of cold are always met with neareſt the ſurface of the earth. There is a conſtant and regular operation of nature, under certain circumſtances and diſpoſitions of the atmoſphere, and takes place at all ſeaſons of the year; and this difference never happens in any conſiderable degree but when the air is ſtill, and the ſky perfectly unclouded. The moiſteſt vapour, as dews and fogs, did not at all impede, but rather promote, the refrigeration. In very ſevere froſts, when the air frequently depoſites a quantity of frozen vapour, it is commonly found greateſt; but the exceſs of heat, which in the day-time was found at the lower ſtation in ſummer, diminiſhed in winter almoſt to nothing. It has been obſerved, that a thermometer, included in a receiver, always ſinks when the air begins to be rarified. This has been thought to ariſe, not from any degree of cold thus produced, but from the ſudden expanſion of the bulb of the thermometer in conſequence of the removal of the atmoſpherical preſſure: but from ſome late experiments related, Phil. Tranſ. vol. 78. by Mr. Darwin, it appears that the atmoſphere always becomes warm by compreſſion, and cold by dilatation from a compreſſed ſtate.

From this phenomenon, as well as the experiments, Mr. Darwin thinks "there is good reaſon to conclude, that in all circumſtances where air is mechanically expanded, it becomes capable of attracting the fluid matter of heat from other bodies in contact with it.

"Now, (continues he) as the vaſt region of air which ſurrounds our globe is perpetually moving along its ſurface, climbing up the ſides of mountains, and deſcending into the valleys; as it paſſes along, it muſt be perpetually varying the degree of heat according to the elevation of the country it traverſes: for, in riſing to the ſummits of mountains, it becomes expanded, having ſo much of the preſſure of the ſuperincumbent atmoſphere taken away; and when thus expanded, it attracts or abſorbs heat from the mountains in contiguity with it; and, when it deſcends into the valleys, and is compreſſed into leſs compaſs, it again gives out the heat it has acquired to the bodies it comes in contact with. The ſame thing muſt happen to the higher regions of the atmoſphere, which are regions of perpetual froſt, as has lately been diſcovered by the aerial navigators. When large diſtricts of air, from the lower part of the atmoſphere, are raiſed two or three miles high, they become ſo much expanded by the great diminution of the preſſure over them, and thence become ſo cold, that hail or ſnow is produced by the precipitation of the vapour: and as there is, in theſe high regions of the atmoſphere, nothing elſe for the expanded air to acquire heat from after it has parted with its vapour, the ſame degree of cold continues, till the air, on deſcending to the earth, acquires its former ſtate of condenſation and of warmth.

"The Andes, almoſt under the line, reſts its baſe on burning ſands; about its middle height is a moſt pleaſant and temperate climate covering an extenſive plain, on which is built the city of Quito; while its forehead is encircled with eternal ſnow, perhaps coeval with the mountain. Yet, according to the accounts of Don Ulloa, theſe three diſcordant climates ſeldom encroach much on each other's territories. The hot winds below, if they aſcend, become cooled by their expanſion; and hence they cannot affect the ſnow upon the ſummit; and the cold winds that ſweep the ſummit, become condenſed as they deſcend, and of temperate warmth before they reach the fertile plains of Quito."

Notwithſtanding all theſe explanations, however, ſeveral very conſiderable difficulties remain with regard to the heat and cold of the atmoſphere. That warm air ſhould always aſcend; and thus, when the ſource of heat is taken away by the abſence of the ſun, that the ſtratum of atmoſphere lying immediately next to the earth ſhould be ſomewhat colder than that which lies a little farther up; is not at all to be wondered at. We have an example ſomewhat ſimilar to this in the potter's kiln; where, after the veſſels have been intenſely heated for ſome time, and the fire is then withdrawn, the cooling always begins at the bottom, and thoſe which ſtand lowermoſt will often be quite black, while all the upper part of the furnace and the veſſels next to it, are of a bright red. It doth not, however, appear, why ſuch degrees of cold ſhould take place at the ſurface of the earth as we ſometimes meet with. It is, beſides, no uncommon thing to meet with large ſtrata in the upper regions of the atmoſphere, remarkable for their cold, while others are warmer than thoſe at the ſurface; as we have been aſſured of by the teſtimony of ſeveral aerial navigators. It is alſo difficult to ſee why the air which has once aſcended, and become rarified to an extreme degree, ſhould afterwards deſcend among a denſer fluid of ſuperior gravity, though indeed the atmoſpherical currents by which this fluid is continually agitated may have conſiderable effect in this way. See the article WIND. See alſo HEAT, COLD, CONGELATION, CONDENSATION, &c. For the quantity of water contained in the Atmoſphere, ſee the articles HYGROMETER, CLOUDS, VAPOUR, &c. For the cauſe of the elaſticity of the Atmoſphere, ſee ELASTICITY; ſee alſo HAIL, RAIN, SNOW, &c.

The uſes of the atmoſphere are ſo many and ſo various that it is impoſſible to enumerate them. One of the moſt eſſential is its power of giving life to vegetables, and ſupporting that of all animated beings. For the latter purpoſe, however, it is not in all places equally proper: we ſhall therefore conclude this article with ſome remarks on

The Salubrity of the ATMOSPHERE.—The air on the tops of mountains is generally more ſalubrious than that in pits. Denſe air indeed is always more proper for reſpiration than ſuch as is more rare; yet the air on mountains, though much more rare, is more free from phlogiſtic vapours than that of pits. Hence it has been found, that people can live very well on the tops of mountains, where the barometer ſinks to 15 or 16 inches. M. de Sauſſure, in his journey upon the Alps, having obſerved the air at the foot, on the middle, and on the ſummits of various mountains, obſerves, that the air of the very low plains ſeems to be the leſs ſalubrious; that the air of very high mountains is neither very pure, nor, upon the whole, ſeems ſo fit for the lives of men, as that of a certain height above the level of the ſea, which he eſtimates to be about 200 or 300 toiſes, that is, about 430 or 650 yards.

The air of a bed-room at various times, viz. at night, and in the morning after ſleeping in it, has been examined by various perſons; and it has been generally found, that after ſleeping in it the air is leſs pure than at any other time. The air of privies, even in calm weather, has not been found to be ſo much phlogiſticated as might have been expected, notwithſtanding its diſagreeable ſmell. From this and other obſervations, it is thought that the exhalations of human excrements are very little if at all injurious, except when they become putrid, or proceed from a diſeaſed body; in which caſe they infect the air very quickly.

Dr. Ingenhouſz, ſoon after he left London, ſent an account of his experiments made in the year 1779 upon the purity of the air at ſea and other parts; which account was read at the Royal Society the 24th of April 1780, and is inſerted in the lxxth vol. of the Phil. Tranſ. His firſt obſervations were made on board a veſſel in the mouth of the Thames, between Sheerneſs and Margate, where he found that the air was purer than any other ſort of common air he had met with before. He found that the ſea-air taken farther from the land, viz. between the Engliſh coaſt and Oſtend, was not ſo pure as that tried before; yet this inferior

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purity ſeems not to take place always. The Doctor's general obſervations, deduced from his numerous experiments, are, "That the air at ſea, and cloſe to it, is in general purer, and fitter for animal life, than the air on the land, though it ſeems to be ſubject to ſome inconſiſtency in its degree of purity with that of the land: that probably the air will be found in general much purer far from the land than near the ſhore, the former being never ſubject to be mixed with land air." The Doctor in the ſame paper tranſcribes a journal of experiments, ſhowing the degree of purity of the atmoſphere in various places, and under different circumſtances.

The method uſed in thoſe experiments, was to introduce one meaſure of common air into the eudiometer-tube, and then one meaſure of nitrous air. The moment that theſe two ſorts of elaſtic fluids came into contact, he agitated the tube in the water-trough, and then meaſured the diminution, expreſſing it by hundredth parts of a meaſure; thus, when he ſays that ſuch air was found to be 130, it ſignifies, that after mixing one meaſure of it with one of nitrous air, the whole mixed and diminiſhed quantity was 130 hundredths of a meaſure, viz. one meaſure and 30 hundredths of a meaſure more.

His apparatus was a very portable one, made by Mr. Martin, which in reality is the eudiometer-tube and meaſure as uſed by Mr. Fontana before he made his laſt improvement. "The whole of this apparatus (ſays Dr. Ingenhouſz) was packed up in a box about ten inches long, five broad, and three and a half high. The glaſs-tube or great meaſure, which was 16 inches long, and divided into two ſeparate pieces, lay in a ſmall compaſs, and could be put together by braſs ſcrews adapted to the divided extremities. Inſtead of a water-trough, ſuch as is uſed commonly, he made uſe of a ſmall round wooden tub, &c.

The Abbé Fontana, who has made a great number of very accurate experiments upon this ſubject, gives his opinion in the following words: "I have not the leaſt heſitation in aſſerting, that the experiments made to aſcertain the ſalubrity of the atmoſpherical air in various places in different countries and ſituations, mentioned by ſeveral authors, are not to be depended upon; becauſe the method they uſed was far from being exact*, the elements or ingredients for the experiment were unknown and uncertain, and the reſults very different from one another."

"When all the errors are corrected, it will be found that the difference between the air of one country and that of another, at different times, is much leſs than what is commonly believed; and that the great differences found by various obſervers are owing to the fallacious effects of uncertain methods. This I advance from experience; for I was in the ſame error. I found very great differences between the reſults of the experiments of this nature which ought to have been ſimilar; which diverſities I attributed to myſelf, rather than to the method I then uſed. At Paris I examined the air of different places at the ſame time, and eſpecially of thoſe ſituations where it was moſt probable to meet with infected air, becauſe thoſe places abounded with putrid ſubſtances and impure exhalations; but the differences I obſerved were very ſmall, and much leſs than what could have been ſuſpected, for they hardly arrived to one-fiftieth of the air in the tube. Having taken the air of the hill called Mount Valerian, at the height of about 500 feet above the level of Paris, and compared it with the air of Paris taken at the ſame time, and treated alike, I found the former to be hardly one-thirtieth better than the latter.

"In London I have obſerved almoſt the ſame. The air of Iſlington and that of London ſuffered an equal diminution by the mixture of nitrous air; yet the air of Iſlington is eſteemed to be much better. I have examined the air of London taken at different heights (for inſtance, in the ſtreet, at the ſecond floor, and at the top of the adjoining houſes), and have found it to be of the ſame quality. Having taken the air at the iron gallery of St. Paul's cupola, at the height of 313 feet above the ground, and likewiſe the air of the ſtone gallery, which is 202 feet below the other; and having compared theſe two quantities of air with that of the ſtreet adjoining, I found that there was ſcarce any ſenſible difference between them, although taken at ſuch different heights.

"In this experiment a circumſtance is to be conſidered, which muſt have contributed to render the above-mentioned differences more ſenſible: this is, the agitation of the air of the cupola; for there was felt a pretty briſk wind upon it, which I obſerved to be ſtronger and ſtronger the higher I aſcended; whereas in the ſtreet, and indeed in all the ſtreets I paſſed through, there was no ſenſible wind to be felt. This experiment was made at four in the afternoon, the weather being clear. The quickſilver in the barometer at that time was 28,6 inches high, and Fahrenheit's thermometer ſtood at 54°."

A few lines after, Mr. Fontana proceeds thus:—"From this we clearly ſee, how little the experiments hitherto publiſhed about the differences of common air are to be depended upon. In general, I find that the air changes from one time to another; ſo that the differences between them are far greater than thoſe of the airs of different countries or different heights. For inſtance, I have found that the air of London in the months of September, October, and November, 1778, when treated with the nitrous air, gave II,I, 1,90, and II,II, 2,25, which is a mean reſult of many experiments that differed very little from each other. The 26th day of November laſt, I found the air for the firſt time much better, for it gave II,I, 1,80, and II,II, 2,20; but the 14th of February 1779, the air gave II,I, 1,69, and II,II, 2,21; from whence it appears, that the air of this 14th of February was better than it had been ſix months before. There can be no doubt of the accuracy of the experiments, becauſe I compared the air taken at different times with that which I had firſt uſed in the month of September, and which I had preſerved in dry glaſs-bottles accurately ſtopped."

This difference in the purity of the air at different times, Mr. Fontana farther remarks, is much greater than the difference between the air of the different places obſerved by him: notwithſtanding this great change, as he obſerved, and as he was informed by various perſons, no particular change of health in the generality of people, or facility of breathing, was perceived.

Mr. Fontana concludes with obſerving, that "Nature is not ſo partial as we commonly believe. She has not only given us an air almoſt equally good every where at every time, but has allowed us a certain latitude, or a power of living and being in health in qualities of air which differ to a certain degree. By this I do not mean to deny the exiſtence of certain kinds of noxious air in ſome particular places; but only ſay, that in general the air is good every where, and that the ſmall differences are not to be feared ſo much as ſome people would make us believe. Nor do I mean to ſpeak here of thoſe vapours and other bodies which are accidentally joined to the common air in particular places, but do not change its nature and intrinſical property. This ſtate of the air cannot be known by the teſt of nitrous air; and thoſe vapours are to be conſidered in the ſame manner as we ſhould conſider ſo many particles of arſenic ſwimming in the atmoſphere. In this caſe it is the arſenic, and not the degenerated air, that would kill the animals who ventured to breathe it."

Hence, it is ſo far from being a wonder, that we ſometimes ſuffer in our health by a change of weather, that it is the greateſt wonder that we do not ſuffer oftener and more by ſuch changes. For when we conſider, that our bodies are ſometimes preſſed upon by near a ton and a half weight more than at another, and that the variation of the additional preſſure of many pounds, is often very ſudden; it is ſurpriſing that every ſuch change does not entirely break the frame of our bodies to pieces. In effect, the veſſels of our bodies being much ſtraitened, by an increaſed preſſure, would ſtagnate the blood, and the circulation would quite ceaſe, if nature had not wiſely contrived, that, when the reſiſtance to the circulating blood is greateſt, the *impetus* by which the heart contracts ſhould be ſo too. For, upon an increaſe of the weight of the air, the lungs will be more forcibly expanded, and thereby the blood will be more intimately broken and divided, ſo that it becomes fitter for the more fluid ſecretions, ſuch as that of the nervous fluid; by which the HEART will be more ſtrongly contracted. And the blood's motion towards the ſurface of the body being obſtructed, it will paſs in greater quantity to the brain, where the preſſure of the air is taken off by the *cranium*; upon which account alſo, more ſpirits will be ſeparated, and the heart on that account too be more enabled to carry on the circulation, through all paſſable canals; whilſt ſome others, towards the ſurface, are obſtructed.

The moſt conſiderable alteration made in the blood, upon the air's greater or leſſer preſſure on the ſurface of our bodies, is its rendering the blood more or leſs compact, and making it croud into a leſs, or expand into a greater ſpace, in the veſſels which it enters.—For the air contained in the blood always keeps itſelf *in æquilibrio* with the external air that preſſes upon our bodies; and this it does by a conſtant *niſus* to unbend itſelf, which is always proportionable to the compreſſing weight by which it was bent: ſo that if the compreſſion of weight of the circumambient air be ever ſo little abated, the air contained within the blood unfolds its ſpring, and forces the blood to take up a larger ſpace than it did before. The reaſon, we are not ſenſible of this preſſure is explained in the following manner by Borellus, De Mot. nat. a grav. fac. prop. 29, &c. After ſaying that ſand, perfectly rammed in a hard veſſel, is not capable, by any means, of being penetrated or parted, not even by a wedge; and likewiſe that water, contained in a bladder compreſſed equally on all ſides, cannot yield or give way in any part. The ſame is farther confirmed by Mr. Boyle; who, including a young frog in a veſſel half full of water, and intruding ſo much air as that the water might ſuſtain eight times the weight it otherwiſe would; yet the animalcule, notwithſtanding the great tenderneſs of its ſkin, did not ſeem to be at all effected thereby. For the effects of the removal of the preſſure of the atmoſphere, ſee the deſcription of the uſes of the Air-pump, in the Syſtem of PNEUMATICS, Sect. II.—For

* It is plain that Dr. Ingenhouſz's method is not implied in this remark: ſince the Doctor's experiments were made long after, and the method uſed by him was properly that of Mr. Fontana.

For the cauſe of the variations in the weight and preſſure of the atmoſphere, ſee BAROMETER.

ATOM, in Philoſophy, a part or particle of matter, ſo minute as to be indiviſible. The word is formed of the privative α, and τεμνω, I divide.

ATOMS are properly the *minima naturæ*, the laſt or ultimate particles into which bodies are diviſible; and are conceived as the firſt rudiments, or component parts of all phyſical magnitude; or the pre-exiſtent and incorruptible matter whereof bodies were formed. The notion of atoms ariſes hence, that matter is not diviſible in *infinitum*. And hence the Peripatetics are led to deny the reality of atoms, together with that of mathematical points: an atom, ſay they, either has parts, or it has none: if it hath none, it is a mere mathematical point: if it hath, then do theſe parts alſo conſiſt of others, and ſo on to infinity. But this is to recede from the genuine character of atoms, which are not eſteemed indiviſible, becauſe of their want of bigneſs, or parts (for all phyſical magnitude muſt have three dimenſions, length, breadth, and thickneſs, and all extenſion is diviſible); but they are indiviſible on account of their ſolidity, hardneſs, and impenetrability, which preclude all diviſion, and leave no vacancy for the admiſſion of any foreign force to ſeparate or diſunite them.

As atoms are the firſt matter, it is neceſſary they ſhould be indiſſolvable, in order to their being incorruptible.—Sir Iſaac Newton adds, that it is alſo required they be immutable, in order to the world's continuing in the ſame ſtate, and bodies being of the ſame nature now as formerly. Hence the ancients were alſo led to maintain atoms eternal: becauſe what is immutable, muſt be eternal.

They alſo added gravity; and, in conſequence thereof, motion to their atoms: and farther, obſerving that atoms thus falling perpendicularly, could not join or unite together; they ſuperadded a fortuitous or ſide motion, and furniſhed them with certain hooked parts, in order to enable them to catch and hang the better together.—And from a caſual and fortuitous jumble of theſe atoms, they ſuppoſe the whole univerſe to be formed.

ATONY, in Medicine, &c. a want of tone or tenſion; or a relaxation of the ſolids of a human body; occaſioning a loſs of ſtrength faintings, &c. See ATROPHY, &c. The word is compounded of the privative α, and τονος, *tone*, of τεινω, *tendo*, I ſtretch.

ATRABILIS, Black Bile, or Melancholy. According to the ancients it hath a twofold origin: 1ſt, From the groſſer parts of the blood, and this they called the melancholy humour. 2d, From yellow bile being highly concocted. Dr. Percival, in his Eſſays Med. and Exp. ſuggeſts, that it is the gall rendered acrid by a ſtagnation in the gall-bladder, and rendered viſcid by the abſorption of its fluid parts. Bile in this ſtate diſcharged into the *duodenum*, occaſions univerſal diſturbance and diſorder until it is evacuated; it occaſions violent vomiting, or purging, or both; and previous to this the pulſe is quick, the head aches, a delirium comes on, a hiccough, intenſe thirſt, inward heat, and a fetid breath. A celebrated modern anatomiſt thinks it is blood which, having lodged ſome time in the inteſtinal canal, has acquired blackneſs and putridity. Is it not more probable that, in general, it is no other than gall become acrid by ſtagnation of the *veſica fellea*, and rendered viſcid by the abſorption of its fluid parts? When diſcharged into the *duodenum* in this ſtate, it occaſions univerſal diſorder, till evacuated by vomiting or purging. Eſſ. vol. ii. p. 110. See BILE.

ATROPHY, a diſeaſe, wherein the body, or ſome of its parts, do not receive the neceſſary nutriment, but dwindle or waſte inceſſantly. The word is compounded of the privative α, and τρεφω, I nouriſh, q. d. privation of nouriſhment. An Atrophy is either nervous, or the effect of evacuations. A nervous Atrophy or conſumption, is that which owes its original to a bad and morbid ſtate of the ſpirits; and to the weakneſs or deſtruction of the tone of the nerves; from whence an imbecility, and an univerſal conſumption in the whole habit of the body, ultimately proceeding from a want of due aſſimilation of the nutritious juice: ſo from the beginning of the diſeaſe, there is to be found a want of appetite, and a bad digeſtion in the ſtomach, from an imperfect elaboration and volatilization of the chyle. Which ſort of Atrophy may juſtly be reckoned one of the fatal ſymptoms of the ſcurvy. An Atrophy from inanition, is that which derives its original from a preternatural defect or ſubtraction of the nutritious juice, and that long and habitual; which differs according to the variety of the outlets formed in the body, either by nature or art, by which this precious liquor either has, or may run off and be waſted. There is alſo a ſpecies of ſymptomatical conſumption, which though it immediately proceeds from a preternatural and ill ſtate of the blood and ſpirits, yet has a mediate dependence upon ſome other preceding diſeaſe, which impreſſed that morbid diſpoſition on the ſpirits and humours.

Signs of ATROPHY. An Atrophy is known by a general langour both of body and mind; a depraved and unhealthy look of the face; a light and unſettled ſleep; an uncertain appetite, ſometimes voracious, ſometimes nauſeating all things, but uſually moſt deſirous of cold foods; a ſtraitneſs of the breaſt, and an uneaſineſs after eating; great internal heat, and dryneſs of the tongue. The bowels are uſually lubricous and moiſt, and throw out the food half undigeſted; in ſome caſes, however, they are obſerved to be dry and coſtive. The urine often appears to be a chylous matter: the abdomen is tumid and hard in the firſt ſtages of the diſeaſe, but afterwards it becomes more flaccid, and then on feeling it there may be ſeveral nodes and lumps perceived. The body by degrees waſtes away, and there is a continual feveriſhneſs and thirſt, and that eſpecially in the night-time: and theſe ſymptoms often increaſe to that violence, as plainly to reſemble, a hectic, and bring an equal loſs of ſtrength and ſpirits. Sometimes the Atrophy ariſes from worms, and then the whole face is always pale; the noſtrils are full of a mucous matter, and ſometimes become excoriated; the appetite is voracious, and the patient feels an inſufferable reſtleſſneſs when hungry, which goes off, and generally becomes inclined to ſleep after a full meal. When this is the caſe in young ſubjects, the rickets and ſwellings about the joints uſually ſucceed the other ſymptoms, and crookedneſs of the legs, gibboſity of the back, and various diſtortions of the ſpine follow it: theſe often put an end to the Atrophy; but as they continue and become laſting deformities, they are a very unhappy remedy.

Perſons ſubject to ATROPHIES. Children, while young, are very ſubject to this diſeaſe, and often fall into it from improper food: the uſe of heavy and fæculent malt liquors, and of acids, which coagulate the milk, that uſually makes a large part of their nutriment. The ſuppreſſion of their ſweats is another frequent cauſe of Atrophies, eſpecially when occaſioned by large draughts of cold liquors when they are hot in the night, and ſometimes by an improper uſe of aſtringents to ſtop thoſe *diarrhœas* to which they are frequently ſubject. Youths more grown up are often thrown into an Atrophy by eating voraciouſly of crude, thick, heavy, and obſtruent diet, or from the drinking ſpirituous liquors: ſometimes from their having been injudiciouſly treated in fevers, and ſometimes from their being violently infeſted with worms in their bowels. Men in more mature age uſually fall into it after being debilitated by other illneſſes, and by the remains of the cauſes of thoſe illneſſes being left in the body; and by nothing oftener are reduced to this diſtempered ſtate, than by inordinate *hæmorrhages*. Perſons who are ſcrophulous, or have infarctions of the external glands, are alſo uſually at one time or other afflicted with this infarction of the internal ones, and few eſcape it that labour under any other violent concretions of the internal parts.

Prognoſtics of the ATROPHY. A recent Atrophy is not difficult of cure; and even the moſt inveterate one, though ſtubborn enough, is always much leſs dangerous and difficult of cure than an hectic. The more complicated this diſeaſe is, the more difficult it always is in the cure; and it is hence that grown perſons are not ſo eaſily or ſo often cured as children, becauſe with them it is uſually complicated with many other diſorders; and, in general, that Atrophy which is brought on by *hæmorrhages*, or by ill-treated illneſſes, is much more difficult of cure than that which ariſes from a wrong diet. And, finally, in Atrophies ariſing from worms, when they are deſtroyed, the diſeaſe uſually ceaſes.

Method of cure. All ſymptomatical conſumptions are evidently incurable, unleſs a particular reſpect be firſt had to the diſtempers upon which they depend; but if theſe are once removed by art, this kind of conſumption ceaſes of conſequence; and therefore the cure of this conſumption is to be ſought for in the cure of thoſe diſtempers which are the cauſes of it.

The firſt thing to be done in general is, to thoroughly abſterge and cleanſe the *primæ viæ* by gentle purges, among which nothing is ſo proper as calomel, aſſiſted by ſyrup of rhubarb, or the like; and theſe purgatives are afterwards to be repeated at different intervals, during the courſe of the cure. After the firſt purges, reſolvent and attenuating medicines are to be given; and, finally, the preparations of ſteel, decoctions of *arum* and pimpernel root, with ground-ivy, are very beneficial, as is alſo the juice of ground-ivy given alone; and the reſolvent ſalts, as tartar of vitriol, nitre, and the like, with ſome of the aperient tinctures of ſteel. An Atrophy differs from a hectic in this, that there is in it only an infarction of the meſenteric glands, whereas in the other caſe they are generally ulcerated; and in degree the difference alſo is manifeſt, all the ſymptoms being more violent in the hectic than in the ſimple Atrophy. It ſhould alſo be diſtinguiſhed from leanneſs, the rickets, and that weakneſs and conſumption of children, who pine away only for want of a due ſupply from the breaſt. Dr. Thomas Short, in his New Obſervations, Moral, Natural, Medical, &c. recommends milk and cyder in the Atrophy.

ATTACHMENT, in the law of England, implies the taking or apprehending a perſon by virtue of a writ or precept. It is diſtinguiſhed from an Arreſt, by proceeding out of a higher court by precept or writ; whereas the latter proceeds out of an inferior court by precept only. An arreſt lies only on the body of a man; whereas an attachment lies often on the goods only, and ſometimes on the body and goods. An attachment by writ differs from diſtreſs, in not extending to lands as the latter does; nor does a diſtreſs touch the body, as an attachment does.

ATTAINDER,

ATTAINDER, in law. When ſentence of death, the moſt terrible and higheſt judgment in our laws, is pronounced, the immediate inſeparable conſequence by the common law is attainder. For when it is now clear beyond all diſpute, that the criminal is no longer fit to live upon the earth, but is to be exterminated as a monſter and a bane to human ſociety, the law ſets a note of infamy upon him, puts him out of its protection, and takes no farther care of him than barely to ſee him executed. He is then called *attaint*, *attinctus*, ſtained, or blackened. He is no longer of any credit or reputation; he cannot be a witneſs in any court; neither is he capable of performing the functions of another man: for, by an anticipation of his puniſhment, he is already dead in law. This is after judgment: for there is great difference between a man convicted, and attainted; though they are frequently through inaccuracy confounded together. After conviction only, a man is liable to none of theſe diſabilities: for there is ſtill in contemplation of law a poſſibility of his innocence. Something may be offered in arreſt of judgment: the indictment may be erroneous, which will render his guilt uncertain, and thereupon the preſent conviction may be quaſhed: he may obtain a pardon, or be allowed the benefit of clergy; both which ſuppoſe ſome latent ſparks of merit, which plead in extenuation of his fault. But when judgment is once pronounced, both law and fact conſpire to prove him completely guilty; and there is not the remoteſt poſſibility left of any thing to be ſaid in his favour. Upon judgment, therefore, of death, and not before, the attainder of a criminal commences: or upon ſuch circumſtances as are equivalent to judgment of death; as judgment of outlawry on a capital crime, pronounced for abſconding or fleeing from juſtice, which tacitly confeſſes the guilt: And therefore, upon judgment either of outlawry, or of death, for treaſon or felony, a man ſhall be ſaid to be attainted. A perſon attainted of high treaſon forfeits all his lands, tenements, and hereditaments; his blood is corrupted, and he and his poſterity rendered baſe; and this corruption of blood cannot be taken off but by act of parliament. Attainders may be reverſed or falſified; (i. e. proved to be falſe) by writ of error, or by plea. If by writ of error, it muſt be by the king's leave, &c.; and when by plea, it may be by denying the treaſon, pleading a pardon by act of parliament, &c. Perſons may be attainted by act of parliament.—Acts of attainder of criminals have been paſſed in ſeveral reigns, on the diſcovery of plots and rebellions, from the reign of king Charles II. when an act was made for the attainder of ſeveral perſons guilty of the murder of king Charles I. Among acts of this nature, that for attainting Sir John Fenwick, for conſpiring againſt king William, is the moſt remarkable; it being made to attaint and convict him of high treaſon on the oath of one witneſs, juſt after a law had been enacted, "That no perſon ſhould be tried or attainted of high treaſon where corruption of blood is incurred, but by the oath of two lawful witneſſes, unleſs the party confeſs, ſtand mute, &c. Stat. 7 and 8 W. III. cap. 3.

Bill of ATTAINDER, is a bill brought into parliament for attainting, condemning, and executing a perſon for high treaſon.

ATTAINT, is a writ that lies after judgment againſt a jury of twelve men that have given falſe verdict in any court of record, in an action real or perſonal, where the debt or damages amount to above 40s. Stat. 5 and 34 Ed. III. c. 7. It is called attaint, becauſe the party that obtains it endeavours thereby to ſtain or taint the credit of the jury with perjury, by whoſe verdict he is grieved. The jury who are to try this falſe verdict muſt be twenty-four, and are called the grand jury; for the law wills not that the oath of one jury of twelve men ſhould be attainted or ſet aſide by an equal number, nor by leſs indeed than double the former. And he that brings the attaint can give no other evidence to the grand jury, than what was originally given to the petit. For as their verdict is now trying, and the queſtion is whether or no they did right upon the evidence that appeared to them, the law adjudged it the higheſt abſurdity to produce any ſubſequent proof upon ſuch trial, and to condemn the prior juriſdiction for not believing evidence which they never knew. But thoſe againſt whom it is brought are allowed, in the affirmance of the firſt verdict, to produce new matter: becauſe the petit jury may have formed their verdict upon evidence of their own knowledge, which never appeared in court; and becauſe very terrible was the judgment which the common law inflicted upon them, if the grand jury found their verdict a falſe one. The judgment was, 1. That they ſhould loſe their *liberam legem*, and become for ever infamous. 2. That they ſhould forfeit all their goods and chattels. 3. That their lands and tenements ſhould be ſeiſed into the king's hands. 4. That their wives and children ſhould be thrown out of doors. 5. That their houſes ſhould be raſed and thrown down. 6. That their trees ſhould be rooted up. 7. That their meadows ſhould be ploughed. 8. That their bodies ſhould be caſt into jail. 9. That the party ſhould be reſtored to all that he loſt by reaſon of the unjuſt verdict. But as the ſeverity of this puniſhment had its uſual effect, in preventing the law from being executed, therefore by the ſtatute 11 Hen. VII. c. 24. revived by 23 Hen. VIII. c. 3. and made perpetual by 13 Eliz. c. 25. it is allowed to be brought after the death of the party, and a more moderate puniſhment was inflicted upon attainted jurors, viz. perpetual infamy, and if the cauſe of action were above 40l. value, a forfeiture of 20l. a-piece by the jurors; or, if under 40l. then 5l. a-piece; to be divided between the king and the party injured. So that a man may now bring an attaint either upon the ſtatute or at common law, at his election; and in both of them may reverſe the former judgment.

ATTENUANTS, or ATTENUATING medicines, are ſuch as ſubtilize and break the humours into finer parts; and thus diſpoſe them for motion, circulation, excretion, &c. Attenuants ſtand oppoſed to *incraſſants*, or thickners, medicines which condenſe, inſpiſſate, &c. Theſe medicines are of the utmoſt importance in the practice of phyſic, as a little reflection upon their natures, qualities, and manner of operation, will eaſily convince us. To this claſs belong the roots of *arum*, *aſarabacca*, *acorus*, elecampane, and florentine *orris*; the leaves of brook-lime, ſcurvy-graſs, water-creſs, Indian creſſes, dittander, fumitory, marſh-trefoil, ſmall centaury; all the ſpecies of garlic, onion, and leek, and the wood and bark of guaiacum; among the ſpices, pepper and ginger; among the ſeeds, thoſe of muſtard, ſcurvy-graſs, and creſſes; among the gums, galbanum, ammoniacum, myrrh, and benjamin. Among the chymical preparations, the moſt powerful attenuants are calomel, æthiops, flour of brimſtone, the fixed alkaline ſalts, the ſalts of the purging waters, vitriolated tartar, regenerated tartar, and ſolution of crabs eyes, nitre, and ſal ammoniac; the volatile ſalt and the urinous ſpirit of ſal ammoniac alſo; to which may be added, oxymel of ſquills, and the acid tincture of antimony. Medicated ſprings alſo belong to this claſs of medicines, becauſe they, beſide their diluting and aperient natures, are alſo highly attenuating. Infuſions in form of tea, from the quantity of warm water they conſiſt of, are alſo very efficacious attenuants, and are very powerful in the diſuniting coaleſcent molecules. Of this claſs alſo are ſweet whey, and a multitude of other leſs uſed and leſs powerful medicines. Of theſe, ſome act upon the fluids, and others upon the ſolid parts of the human body. Thoſe which act upon the fluids, by mere contact, are very few in number, being only the watery diluents which are of ſingular efficacy in colliquating the viſcid and glutinous humours. All the other medicines mentioned as attenuants act only on the ſolids, by increaſing their tone, augmenting their ſtrength, heightening their contractile force, and adding to the elaſticity and ſyſtolic motion of the veſſels; by which means they preſs and impel more vigorouſly their contained fluids, and by that means divide and break them, by driving them forcibly through ſmall paſſages. Attenuating and inciding medicines are of very extenſive uſe in phyſic, and come under different denominations, according to the different effects they produce. Thus, when tenacious and viſcid juices not only ſtagnate in the cavities of the veſſels, but obſtruct the minute ducts of the viſcera and emunctories, theſe medicines, by their inciding and attenuating quality, diſcharge the humours, and remove the obſtructions; for which reaſon they are not improperly called aperients; and they deſerve alſo, in theſe caſes, the names of antiſcorbutics, and ſweetners of the blood. Attenuants produce ſo great a variety of effects, that it is proper we ſhould be well acquainted with their ſeveral kinds, as appropiated to the ſeveral diſorders, and know which will prove moſt ſerviceable in each. The diſſolving and attenuating of viſcid crudities in the ſtomach and *primæ viæ*, is well anſwered by the roots of *arum*, *acorus*, pepper, ginger, and the like; as alſo by *ſal ammoniac*, vitriolated tartar, and fixed alkaline ſalts, and the ſimple or dulcified ſpirit of ſalt. When crude and unconcocted humours are to be evacuated by ſtool, this intention is very well anſwered by the neutral ſalts, as the ſalts of the purging water, and the *ſal polycreſtum*, with a ſufficient quantity of a watery vehicle. When viſcid humours, occaſioning diſorders of the breaſt, are to be attenuated and expectorated, the intention is moſt effectually anſwered by the elecampane and orris root; and by *gum ammoniacum*, myrrh, or benjamin, and balſam of Peru; or by regenerated tartar, oxymel of ſquills, a ſolution of crabs eyes in diſtilled vinegar, and the ſyrup of tobacco and the like. When the maſs of blood is tainted by thick and tenacious ſordes, and the emunctories are by that means obſtructed, and the humours contaminated by a ſaline ſulphureous and ſcorbutic dyſcracy, the moſt efficacious of the attenuants, are the horſe-radiſh, ſcurvy-graſs, water and garden-creſſes, muſtard, *gum-ammoniacum*, benjamin, myrrh, the oil of fixed nitre, oil of tartar *per deliquium*, ſolutions of nitre, ſpirit of *ſal ammoniac*, ſalt of worm-wood with lemon-juice, and the ſalts of the medicinal waters. When grumous or coagulated blood, occaſioned by contuſions or blows, is to be attenuated, and again diſſolved, the intention is admirably anſwered by the roots of Solomon's ſeal, vinegar, and crabs eyes, the regenerated tartar, and nitre prepared with antimony. And in caſes where the lymph has acquired a preternatural thickneſs and viſcidity, eſpecially if from a venereal taint, the curative intention is moſt effectually anſwered by *guaiacum*, the acrid tincture of antimony, calomel, *æthiops* mineral, and the like; which when ſkilfully uſed, are of ſingular efficacy in diſſolving and attenuating the viſcid juices impacted in the glands of the liver.

ATTIRE, in *Hunting*, denotes the HEAD and horns of a deer. The *attire* of a ſtag, if perfect, conſiſts of bur, pearls, beam, gutters, antler, ſur-antlers, royal, ſur-royal, and croches.---Of a buck, of the bur, beam, brow-antler, advancer, paſm, and ſpellers.

ATTOLLENS, in *Anatomy*, a name common to ſeveral muſcles, whoſe office or action is to raiſe the parts they belong to. The *attollens*, or *attollent* muſcles, are otherwiſe called *levators* and *elevators*. For the origin, inſertion and uſes of theſe muſcles, ſee them as arranged in the Table of muſcles, under the reſpective articles; for repreſentation ſee Plate II.

ATTORNEY AT LAW, anſwers to the Procurator, or Proctor of the civilians and canoniſts: And he is one who is put in the place, ſtead, or turn of another, to manage his matters at law. Formerly every ſuitor was obliged to appear in perſon, to proſecute or defend his ſuit (according to the old Gothic conſtitution), unleſs by ſpecial licenſe under the king's letters patent. Attorneys are now formed into a regular body; they are admitted to the execution of their office by the ſuperior Courts of Weſtminſter-hall; and are in all points officers of the reſpective courts in which they are admitted; and as they have many privileges on account of their attendance there, ſo they are peculiarly ſubject to the cenſure and animadverſion of the judges. No man can practiſe as an attorney in any of thoſe courts, but ſuch as is admitted and ſworn an attorney of that particular court: an attorney of the court of king's bench cannot practiſe in the court of common pleas: nor *vice verſa*. To practiſe in the court of chancery, it is alſo neceſſary to be admitted a ſolicitor therein; and by the ſtatute 22 Geo. II. c. 46. no perſon ſhall act as an attorney at the court of quarter-ſeſſions, but ſuch as have been regularly admitted in ſome ſuperior court of record. So early as the ſtatute 4 Hen. IV. c. 18. it was enacted, that attorneys ſhould be examined by the judges, and none admitted but ſuch as were virtuous, learned, and ſworn to do their duty. And many ſubſequent ſtatutes have laid them under farther regulations. None are to be admitted to act either as the one or the other, without having ſerved a clerkſhip of five years, taken the oath provided in that caſe, and been enrolled.---Judges of the ſaid courts of law are to examine into the capacity of the *attorneys*; and thoſe of the courts of equity, into the capacity of the *ſolicitors*. 2 Geo. II. c. 23. There is a great diverſity of writs in the table of the regiſter, wherein the king commands the judges to admit of *attorneys*; whereby there aroſe ſo many unſkilful *attorneys*, and ſo many miſchiefs thereby, that, for reſtraining them, it was enacted 4 H. IV. c. 18. that the judges ſhould examine them, and diſplace the unſkilful; and again, 33 H. VI. c. 7. that there ſhould be but a certain number of *attorneys* in Norfolk and Suffolk. And many ſubſequent ſtatutes have brought them under farther regulations. 3 Jac. I. c. 7. 12 Geo. I. c. 29. 2 G. II. c. 23. 22. G. II. c. 46. 23 G. II. c. 26.

ATTORNEY *General*, is a great officer under the king, made by letters patent. It is his place to exhibit informations, and proſecute for the crown in matters criminal, eſpecially treaſon, ſedition, &c. and to file bills in the exchequer, for any thing concerning the king in inheritance or profits; and others may bring bills againſt the king's attorney. His proper place in court, upon any ſpecial matters of a criminal nature, wherein his attendance is required, is under the judges, on the left hand of the clerk of the crown: but this is only upon ſolemn and extraordinary occaſions; for uſually he does not ſit there, but within the bar in the face of the court.

ATTRACTION, in *Mechanics*, the act of a moving power, whereby a moveable is *drawn*, or brought nearer to the mover; as ACTION and RE-ACTION are always equal, and contrary; it follows, that, in all *attraction*, the mover is drawn towards the moveable, as much as the moveable towards the mover.

ATTRACTION, or ATTRACTIVE *force*, in *Phyſics*, denotes a natural power ſuppoſed to be inherent in certain bodies, whereby they act on other diſtant bodies, and draw them towards themſelves. This the Peripatetics call the *motion of attraction*; and, on many occaſions, SUCTION; and produce various inſtances where they ſuppoſe it to obtain.---Thus the air in reſpiration, is taken in, according to them, by *attraction of ſuction*; ſo is the ſmoke through a pipe of tobacco; and the milk out of the mother's breaſt: thus alſo it is, that the blood and humours riſe in a cupping-glaſs, water in a pump, and ſmoke in chimnies; ſo vapours and exhalations are attracted by the ſun, iron by the magnet, ſtraws by amber, and electrical bodies, &c. But the later philoſophers generally explode the notion of *attraction*; aſſerting, that a body cannot act where it is not: and that all motion is performed by mere impulſion.---Accordingly, moſt of the effects which the ancients attributed to this unknown part of *attraction*, the moderns have diſcovered to be owing to more ſenſible and obvious cauſes; particularly the preſſure of the AIR. To this are owing the *phenomena* of inſpiration, ſmoaking, ſucking, cupping-glaſſes, pumps, vapours, exhalations, &c. The power oppoſite to *attraction* is called REPULSION; which is alſo argued to have ſome place in natural things.

ATTRACTION, or ATTRACTIVE *power*, is more particularly uſed for a power, or principle, whereby all bodies, and the particles of all bodies, mutually tend towards each other.---Or, more juſtly, *attraction* is the effect of ſuch power, whereby every particle of matter tends towards every other particle.

The principle of *attraction*, in the Newtonian ſenſe of it, ſeems to have been firſt ſurmiſed by Copernicus. "As for gravity," ſays Copernicus, "I conſider it as nothing more than a certain natural appetence *(appetentia)* that the Creator has impreſſed upon all the parts of matter, in order to their uniting or coaleſcing into a globular form, for their better preſervation: and it is credible that the ſame power is alſo inherent in the ſun and moon, and planets, that thoſe bodies may conſtantly retain that round figure in which we behold them." De Rev. Orb. Cœleſt. lib. i. cap. 9. And Kepler calls gravity a corporeal and mutual affection between ſimilar bodies in order to their union. Aſt. Nov. in Introd. And he pronounces more poſitively, that no bodies whatſoever were abſolutely light, but only relatively ſo; and, conſequently, that all matter was ſubjected to the law of gravitation.

The firſt in this conntry who adopted the notion of *attraction*, was Dr. Gilbert, in his book de Magnete; and the next was the celebrated lord Bacon. Nov. Organ. lib. ii. Aphor. 36. 45. 48. Sylv. cent. i. exp. 33. In France it was received by Fermat and Roberval; and in Italy by Galilæo and Borelli. But till Sir Iſaac Newton appeared, this principle was very imperfectly defined and applied. It muſt be obſerved, that though this great author makes uſe of the word *attraction*, in common with the ſchool philoſophers; yet he very ſtudiouſly diſtinguiſhes between the ideas. The ancient *attraction* was ſuppoſed a kind of quality, inherent in certain bodies themſelves; and ariſing from their particular or ſpecific forms.

The Newtonian *attraction* is a more indefinite principle; denoting, not any particular kind or manner of action, nor the phyſical cauſe of ſuch action; but only tendency in the general, a *conatus accedendi*, to whatever cauſe, phyſical or metaphyſical, ſuch effect be owing: whether to a power inherent in the bodies themſelves, or to the impulſe of an external agent. Accordingly, that author in his Philoſoph. Nat. Prim. Math. notes, "that he uſes the words *attraction*, *impulſe*, and *propenſion* to the centre, indifferently; and cautions the reader not to imagine, that by *attraction* he expreſſes the modus of the action, or the efficient cauſe thereof; as if there were any proper powers in the centres, which in reality are only mathematical points; or, as if centres could attract." Lib. i. p. 5. So he "conſiders centripetal powers as *attractions*; though, phyſically ſpeaking, it were perhaps more juſt to call them *impulſes*." Ib. p. 148. He adds, "that what he calls *attraction* may poſſibly be effected by impulſe, though not a common or corporeal impulſe; or after ſome other manner unknown to us." Optic. p. 322.

Attraction, if conſidered as a quality ariſing from the ſpecific form of bodies, ought together with ſympathy, antipathy, and the whole tribe of occult qualities, to be exploded. But when we have ſet theſe aſide, there will remain innumerable *phenomena* of nature, and particularly the gravity or weight of bodies, or their tendency to a centre, which argue a principle of action ſeemingly diſtinct from impulſe; where, at leaſt, there is no ſenſible impulſion concerned. Nay, what is more, this action, in ſome reſpects, differs from all impulſion we know of; impulſe being always found to act in proportion to the ſurfaces of bodies; whereas gravity acts according to their ſolid content, and conſequently muſt ariſe from ſome cauſe that penetrates or pervades the whole ſubſtance thereof. This unknown principle, unknown, we mean, in reſpect of its cauſe, for its *phenomena* and effects are moſt obvious, with all the ſpecies and modifications thereof we call *attraction*; which is a general name, under which all mutual tendencies, where no phyſical impulſe appears, and which cannot, therefore, be accounted for from any known laws of nature, may be arranged.

And hence ariſe divers particular kinds of *attraction*; as, GRAVITY, MAGNETISM, ELECTRICITY, &c. which are ſo many different principles, acting by different laws; and only agreeing in this, that we do not ſee any phyſical cauſes thereof: but that as to our ſenſes, they may really ariſe from ſome power or efficacy in ſuch bodies, whereby they are enabled to act, even upon diſtant bodies; though our reaſon abſolutely diſallows of any ſuch action.

Attraction may be divided, with reſpect to the law it obſerves, into two kinds. 1. That which extends to a ſenſible diſtance. Such are the *attraction* of GRAVITY, found in all bodies; and the *attraction* of MAGNETISM, and ELECTRICITY, found in particular bodies. The ſeveral laws and *phenomena* of each, ſee under the article MAGNETISM, and in the Syſtems of *Electricity*, and *Mechanics*.

The *attraction* of GRAVITY, called alſo among mathematicians the *centripetal force*, is one of the greateſt and moſt univerſal principles in all nature. We ſee and feel it operate on bodies near the earth, and find, by obſervation, that the ſame power (i. e. a power which acts in the ſame manner, and by the ſame rules, viz. always proportionably to the quantities of matter, and as the ſquares of the diſtances reciprocally) does alſo obtain in the moon and the other planets, primary and ſecondary, as well as in the comets; and even that this is the very power whereby they are all retained in their orbits, &c. And hence, as gravity is found in all the bodies which come under our obſervation, it is eaſily inferred, by one of the ſettled rules of philoſophizing, that it obtains in all others; and as it is found to be as the quantity of matter in each body, it muſt

be in every particle thereof; and hence, every particle in nature is proved to *attract* every other particle, &c. See the demonſtration hereof laid down at large, with the application of the principle to the celeſtial motions in the Syſtem of ASTRONOMY, Sect. 10. and 15.

From this *attraction* ariſes all the motion, and conſequently all the mutation, in the great world. By this heavy bodies deſcend, and light ones aſcend; by this projectiles are directed, vapours and exhalations riſe, and rains, &c. fall. By this rivers glide, the air preſſes, the ocean ſwells, &c. In effect, the motions ariſing from this principle make the ſubject of that extenſive branch of mathematics, called MECHANICS or STATICS: with the parts or appendages thereof, HYDROSTATICS, PNEUMATICS. See the reſpective Syſtems, &c.

2. That which does not extend to ſenſible diſtances.—Such is found to obtain in the minute particles whereof bodies are compoſed, which attract each other at, or extremely near, the point of contact, with a force much ſuperior to that of gravity; but which at any diſtance from it decreaſes much faſter than the power of gravity. This power, a late ingenious author chooſes to call the *attraction* of COHESION; as being that whereby the atoms or inſenſible particles of bodies are united into ſenſible maſſes.

This latter kind of *attraction* owns Sir Iſaac Newton for its diſcoverer; as the former does for its improver. The laws of motion, percuſſion, &c. in ſenſible bodies, under various circumſtances, as falling, projected, &c. aſcertained by the later philoſophers, do not reach to thoſe more remote, inteſtine motions of the component particles of the ſame bodies, whereon the changes of the texture, colour, properties, &c. of bodies depend; ſo that our philoſophy, if it were only founded on the principle of gravitation, and carried ſo far as that would lead us, would neceſſarily be very deficient.

But, beſide the common laws of ſenſible maſſes, the minute parts they are compoſed of are found ſubject to ſome others, which have been but lately taken notice of, and are even yet very imperfectly known. Sir Iſaac Newton, to whoſe happy penetration we owe the hint, contents himſelf to eſtabliſh, that there are ſuch motions in the *minima naturæ*, and that they flow from certain powers, or forces, not reducible to any of thoſe in the great world.—In virtue of theſe powers he ſhews, "That the ſmall particles act on one another, even at a diſtance: and that many of the *phenomena* of nature are the reſult thereof. Senſible bodies, we have already obſerved, act on one another divers ways; and as we thus perceive the tenor and courſe of nature, it appears highly probable, that there may be other powers of the like kind: nature being very uniform and conſiſtent with herſelf.—Thoſe juſt mentioned reach to ſenſible diſtances, and ſo have been obſerved by vulgar eyes; but there may be others, which reach to ſuch ſmall diſtances as have hitherto eſcaped obſervation; and it is probable electricity may reach to ſuch diſtances, even without being excited by friction.

The great author juſt mentioned proceeds to confirm the reality of theſe ſuſpicions from a great number of *phenomena* and experiments, which plainly argue ſuch powers and actions between the particles, e. gr. of ſalts and water, oil of vitriol and water, *aqua fortis* and iron, ſpirit of vitriol and ſalt-petre. He alſo ſhews that theſe powers, &c. are unequally ſtrong between different bodies: ſtronger, e. gr. between the particles of ſalt of tartar, and thoſe of *aqua fortis*, than thoſe of ſilver; between *aqua fortis* and *lapis calaminaris*, than iron; between iron than copper, copper than ſilver, or mercury. So ſpirit of vitriol acts on water, but more on iron or copper, &c. The other experiments which countenance the exiſtence of ſuch principle of *attraction* in the particles of matter, are innumerable; many of the agents employed by nature to balance the power and natural effect of attraction are copiouſly defined and fully illuſtrated in the firſt Part of our Syſtem of CHYMISTRY, which treats largely on that uſeful Branch of Science, with reſpect to its principles, and their various applications, both with regard to theory and practice.

Theſe actions, in virtue whereof the particles of the bodies above-mentioned tend towards each other, the author calls by a general indefinite name, *attraction*, which is equally applicable to all actions, whereby diſtant bodies tend towards one another, whether by impulſe or by any other more latent power: and from hence he accounts for an infinity of *phenomena*, otherwiſe inexplicable, to which the principle of gravity is inadequate. Such are COHESION, DISSOLUTION, CRYSTALLIZATION, SECRETION, FLUIDITY, FERMENTATION, &c. See theſe Articles.

"Thus (adds our immortal author) will nature be found very conformable to herſelf, and very ſimple; performing all the great motions of the heavenly bodies, by the *attraction of* GRAVITY, which intercedes thoſe bodies, and almoſt all the ſmall ones of their parts, by ſome other attractive power diffuſed through the particles thereof. Without ſuch principles, there never would have been any motion in the world: and without the continuance thereof, motion would ſoon periſh, there being otherwiſe a great decreaſe or diminution thereof, which is only ſupplied by theſe active principles." Optics, p. 373.

We need not ſay how unjuſt it is in the generality of foreign philoſophers, to declare againſt a principle which furniſhes ſo beautiful a view, for no other reaſon, but becauſe they cannot conceive how one body ſhould act on another at a diſtance. It is certain, that philoſophy allows of no action but what is by immediate contact and impulſion (for how can a body exert any active power there, where it does not exiſt? to ſuppoſe this of any thing even the Supreme Being himſelf, would perhaps imply a contradiction): yet we ſee effects without ſeeing any ſuch impulſe; and where there are effects, we can eaſily infer there are cauſes, whether we ſee them or not. But a man may conſider ſuch effects, without entering into the conſideration of the cauſes; as indeed it ſeems the buſineſs of a philoſopher to do: for to exclude a number of *phenomena* which we do ſee, will be to leave a great chaſm in the hiſtory of nature; and to argue about actions which we do not ſee, will be to build caſtles in the air. It follows, therefore, that the *phenomena* of *attraction* are matter of phyſical conſideration, and as ſuch entitled to a ſhare in the ſyſtem of PHYSICS; but that the cauſes thereof will only become ſo, when they become ſenſible; i. e. when they appear to be the effect of ſome other higher cauſes (for a cauſe is no otherwiſe ſeen than as itſelf is an effect, ſo that the firſt cauſe muſt from the nature of things be inviſible): we are therefore at liberty to ſuppoſe the cauſes of *attraction* what we pleaſe without any injury to the effects. The illuſtrious author himſelf ſeems a little irreſolute as to the cauſes, inclining, ſometimes, to attribute *gravity* to the action of an immaterial cauſe; Optics, p. 343, &c. and ſometimes to that of a material one. Ibid. p. 325.

In his philoſophy, the reſearch into cauſes is the laſt thing; and never comes under conſideration till the laws and *phenomena* of the effect be ſettled; it being to theſe *phenomena* that the cauſe is to be accommodated. The cauſe even of any, the groſſeſt, and moſt ſenſible action, is not adequately known: how impulſe or percuſſion itſelf produces its effect, i. e. how motion is communicated by body to body, confounds the deepeſt philoſophers; yet is impulſe received not only into *philoſophy*, but into *mathematics*; and accordingly the laws and *phenomena* of its effects make the greateſt part of common *mechanics*.

The other ſpecies of *attraction*, therefore, in which no impulſe is remarkable, when their *phenomena* are ſufficiently aſcertained, have the ſame title to be promoted from *phyſical* to *mathematical* conſideration; and this, without any previous enquiry into their cauſes, which our conceptions may not be proportionate to: let their cauſes be occult, as all cauſes, ſtrictly ſpeaking, are, ſo that their effects, which alone immediately concern us, be but apparent.

Our noble countryman, then, far from adulterating philoſophy with any thing foreign, or metaphyſical, as many have reproached him with doing, has the glory of having thrown every thing of this kind out of his ſyſtem, and of having opened a new ſource of ſublimer *mechanics*, which, duly cultivated, might be of infinitely greater extent than all the *mechanics* yet known; it is hence alone we muſt expect to learn the manner of the changes, productions, generations, corruptions, &c. of natural things. with all that ſcene of wonders opened to us by the operations of *chymiſtry*.

Some of our own countrymen have proſecuted the diſcovery with laudable zeal: Dr. Keil, particularly, has endeavoured to deduce ſome of the laws of this new action, and applied them to ſolve divers of the more general *phenomena* of bodies, as *coheſion*, *fluidity*, *elaſticity*, *ſoftneſs*, *fermentation*, *coagulation*, &c. And Dr. Friend, ſeconding him, has made a further application of the ſame principles, to account at once for almoſt all the *phenomena* that *chymiſtry* preſents. So that ſome philoſophers are inclined to think that the new mechanics ſhould ſeem already raiſed to a complete ſcience; and that nothing now can occur, but what we have an immediate ſolution of from the *attractive force*.

But this ſeems a little too precipitate; a principle ſo fertile ſhould have been further explored; its particular laws, limits, &c. more induſtriouſly detected and laid down, before we had proceeded to the application.—*Attraction*, in the groſs, is ſo complex a thing, that it may ſolve a thouſand different *phenomena* alike; the notion is but one degree more ſimple and preciſe than action itſelf; and till more of its properties are aſcertained, it were better to apply it leſs, and ſtudy it more.—It may be added, that ſome of Sir Iſaac Newton's followers have been charged with falling into that error, which he induſtriouſly avoided, viz. of conſidering *attraction* as a cauſe or active property in bodies, not merely as a *phenomenon* or effect.

ATTRACTION *of mountains*. According to the Newtonian theory of *attraction*, this principle pervades the minuteſt particles of matter, and the combined action of all the parts of the earth, forms the *attraction* of the whole. From the ſame reaſon, therefore, that a heavy body tends downwards in a perpendicular to the earth's ſurface, conſidered as ſmooth and even, it muſt be *attracted* towards the centre of a neighbouring mountain, by a force proportional to the quantity of matter contained in it; and the effect of this *attraction*, or the accelerative force produced by it, muſt depend on the nearneſs or diſtance of the mountain from the gravitating body, becauſe this force increaſes as the ſquares of the diſtances decreaſe. For a copious diſquiſition of this branch of Philoſophy, ſee the Article MOUNTAIN.

ATTRACTIVES, or ATTRACTIVE *remedies*, denote medicines which are to be externally applied, and which by their activity and warmth penetrate the pores, and mix with and rarefy any obſtructed matter, ſo as to render it fit for diſcharge, upon laying

open

open the part by a caustic or incision. *Attrahents* are the same with what we otherwise call *drawers*, *ripeners*, *maturants*, and *digestives*. The principal simples belonging to this class are, the several fats or *adipes*, the dungs of pigeons and cows, bran, yest, herring, melilot, tobacco, oil, pitch, resin, frankincense, &c. In many instances, as the matter rarefies and grows more fluid by means of such medicines, the refluent blood is apt to wash it back into the common mass; which sometimes does great mischief; or by making it take up more room upon its rarefaction, it occasions it to distend more the parts in which it is contained: upon which a sense of pain is excited, and thereby a great concourse of fluid, and consequently an increase of the tumour.—So that medicines under this denomination require the most careful management.

ATTRIBUTE, in *Logic*, is an epithet given to any subject; or it is any predicate thereof; or whatever may be affirmed or denied of any thing. Every proposition consists of a subject, an *attribute*, and a *copula*, or conjunctive particle. See the System, Part II. Sect. 2, 3, 4, 5, and 6.

ATTRIBUTIVES, in *Grammar*, are words which are significant of *attributes*, and thus include adjectives, verbs, and particles, which are *attributes* of substances, and adverbs which denote the *attributes* only of *attributes*. Mr. Harris, who has introduced this distribution of words, denominates the former *attributives* of the first order, and the latter *attributives* of the second order. Harris's Hermes. For further particulars on this subject, see the System, Part I. c. 2. Sect. 1.

ATTRITION, *triture* or *friction*, expresses such a motion of bodies against one another, as strikes off some superficial particles; whereby they gradually become less and less. The grinding and polishing of bodies is performed by *attrition*. The effects of *attrition* in exciting heat, light, electricity, &c. see under ELECTRICITY, FIRE, HEAT, and LIGHT.

ATTRITION is also frequently used for the friction or rubbing of such simple bodies one against another, as will not wear out, but will occasion some particular determination of the fluids they contain. Thus the various sensations of hunger, pain, or pleasure, are said to be occasioned by the *attritions* of the organs formed for such impressions.

AVA AVA, a plant so called by the inhabitants of Otaheite, in the South Sea, from the leaves of which they express an intoxicating juice. It is drank very freely by the chiefs and other considerable persons who vie with each other in drinking the greatest number of draughts, each draught being about a pint; but it is carefully kept from their women.

AUBAINE, in the French *Customs*, a right formerly vested in the king, of being heir to a foreigner, who died within his dominions. The king of France, before the revolution, by the right of *aubaine*, claimed the inheritance of all foreigners in his dominions; exclusive of all other lords, and even of any testament the deceased could make. An ambassador, though not naturalized, is not subject to the right of *aubaine*. The Swiss, Savoyards, Scots, and Portuguese, are also exempted from the *aubaine*, as being reputed natives and regnicoles.

AUDIENCE given to ambassadors, a ceremony observed in courts, at the admission of ambassadors or public ministers to a hearing. In England, audience is given to ambassadors in the presence chamber; to envoys and residents, in a gallery, closet, or in any place where the king happens to be. Upon being admitted, as is the custom of all courts, they make three bows; after which they cover and sit down; but not before the king is covered and sat down, and has given them the sign to put on their hats. When the king does not care to have them covered, and sit, he himself stands uncovered; which is taken as a slight. At Constantinople, ministers usually have audience of the prime vizier.

AUDITORIUS MEATUS, or AUDITORY passage, a passage in *Anatomy*, called also *aurium alveare*, on account of the *cerumen* collected in it. See the System, Part VII. sect. 4. and Plate XI. fig. 7.

AUDITORY, *nerves* in *Anatomy*, a pair of nerves arising from the *medulla oblongata*, and distributed the one to the ear, the other to the tongue, eye, &c. See the System, Part VI. sect. 2. and Plate XI. fig. 5. The soft and spongy branch of the *auditory nerve*, being diffused through the labyrinth and *tympanum* of the ear, is the immediate organ of the sense of hearing. The *auditory nerves* make the seventh conjugation according to the way of reckoning of the moderns, and the fifth according to the ancients.

Anatomists observe a singular mark of the wisdom and contrivance of the Creator, in the *auditory nerves* being thus dispatched to different parts; an admirable and useful consent being hereby established between them.—Hence it is, that most animals, upon hearing any uncouth sound, are found to erect their ears, and prepare them to catch it; to open their eyes; to stand upon the watch; and to be ready with their mouth to call out, or testify their danger: accordingly most animals, when surprised or terrified, shriek, or cry out, &c.

Dr. Willis (*Anat. Cerebr.* cap. 17.) observes a farther use of this nervous communication between the ear and the mouth; which is, that the voice may correspond with the hearing, and be a kind of echo thereof: that what is heard with one of the two nerves, may be readily expressed with the voice by the help of the other.

AVE-MARIA, or AVE-MARY, the angel Gabriel's salutation of the Virgin, at his bringing her the tidings of the incarnation; thus called, as beginning with these words, *Ave Maria*, q. d. *Hail Mary*. The *Ave-Mary* is a prayer or *formula* of devotion very usual in the Romish church. It was added to their prayers by order of pope John XXII. in the fourteenth century.—Their chaplets and rosaries are divided into so many *Ave-Marys*, and so many *Pater-nosters*; and hence the beads themselves, which indicate them, are also called *Ave's*, or *Ave-Mary's*.

AVENA, OATS: A genus of the digynia order, belonging to the triandria class of plants; and, in the natural method, ranking under the 4th order, *Gramina*. The calyx has a double valve: The species are 13: Six of them natives of Britain, viz. 1. The nuda, or naked oats. 2. The fatua, or bearded oat-grass. 3. The pratensis, or meadow oat-grass. 4. The pubescens, or rough oat-grass. 5. The elatior, or tall oat-grass. 6. The flavescens, or yellow oat-grass. It is remarkable, that the native place of the sativa or common oat, cultivated in our fields, is almost totally unknown. Anson says, that he observed it growing wild, or spontaneously, in the island of Juan Fernandez. But a vague observation from an author of that kind is not to be depended on.

Oats are an article of the materia medica. Gruels made from them have a kind of soft mucilaginous quality; by which they obtund acrimonious humours, and prove useful in inflammatory diseases, coughs, hoarseness, and exulcerations of the fauces. For the culture of the several kinds of Oats see the System of Agriculture, Sect. 5.

AVENUE, in gardening, a walk planted on each side with trees, and leading to an house, garden-gate, wood, &c. and generally terminated by some distant object. For a further account of this branch of ornamental gardening, see the Treatise. Part II. Sect. 2.

AVES, BIRDS, the second class in Zoology, or the Animal Kingdom in the System Naturæ of Linnæus, called Ornithology, see Zoology: in this work it forms a complete System, including the arrangement of the several Birds into orders and genera. Descriptions of each genus, and the most remarkable species, are given under their respective names in the courses of the alphabet; and exact representations of all the genera, are given in the Plates annexed to the System; so that the discriminating Naturalist will find the most scrupulous attention paid to scientific demonstration, whether it is considered in a detached or systematic point of view.

AUGMENTATION, in a general sense, is the act of adding or joining something to another with a design to render it large. AUGMENTATION was also the name of a court erected 27 Henry VIII. so called from the augmentation of the revenues of the crown, by the suppression of religious houses; and the office still remains, wherein there are many curious records, though the court has been dissolved long since.

AUGUST, in chronology, the eighth month of our year, containing 31 days. August was dedicated to the honour of Augustus Cæsar, because, in the same month, he was created consul, thrice triumphed in Rome, subdued Egypt to the Roman Empire, and made an end of the civil wars; being before called *Sexatilis*, or the sixth month from March.

Our Saxon ancestors called it *Weod monath* that is *weed month*, on account of the plenty of weeds in this season. Spelman. This month is esteemed one of the richest in the whole year, because of the harvest of the several sorts of grain which is produced in that season. Hence is to be derived the French proverb, *a man has made his August*: which proverb is much used among merchants to signify a man has been successful in trade, and got an estate.

AUGUSTINS, or AUGUSTINIANS, an order of religious; thus called from St. Augustin, whose rule they observe. The *Augustins*, properly also called *Austin friars*, were originally hermets, whom pope Alexander IV. first congregated into one body, under their General Lanfranc, in 1256. Soon after this institution was brought into England, where they had about thirty-two houses at the time of their suppression. The *Augustins* are clothed in black, and make one of the four orders of mendicants. From these arose a reform, under the denomination of *bare-foot Augustins*, or *Minorites*, or *Friars Minor*.

There are also canons regular of St. *Augustin*, who are clothed in white, excepting their cope, which is black.

At Paris they are known under the denomination of *religious of* GENEVIEVE, that abbey being the chief of their order. There are also nuns and canonesses, who observe the rules of St. Augustin. He was the first archbishop of Canterbury, originally a monk in the convent of St. Andrew at Rome, and educated under St. Gregory, afterwards pope Gregory I. by whom he was dispatched into Britain, with 40 other monks of the same order, about the year 596, to convert the English Saxons to Christianity. They landed in the isle of Thanet; and having sent some French interpreters to king Ethelbert with an account of their errand, the king gave them leave to convert as many of his subjects as they could, and assigned their place of residence at Dorovernum, since called *Canterbury*; to which they were confined till the king himself was converted, whose example had a powerful influence in promoting the conversion of his subjects; but though he was extremely pleased at their becoming Christians, he never attempted to compel them. He dispatched a priest and a monk to Rome, to acquaint the pope with the success of his mission, and to desire his resolution of certain questions. These men brought back

back with them a pall, and several books, vestments, utensils, and ornaments for the churches. His holiness, by the same messengers, gave Augustin directions concerning the settling of episcopal sees in Britain; and ordered him not to pull down the idol temples, but to convert them into Christian churches: only destroying the idols, and sprinkling the place with holy water, that the natives by frequenting the temples they had been always accustomed to, might be the less shocked at their entrance into Christianity. Augustin resided principally at Canterbury, which thus became the metropolitan church of England; and having established bishops in several of the cities, he died on the 20th of May, 667. The Popish writers ascribe several miracles to him. The observation of the festival of St. Augustin was first enjoined in a synod held by Cuthbert, archbishop of Canterbury, and afterwards by the pope's bull in the reign of king Edward III.

AUK, the English name of the genus Alca in the System of ORNITHOLOGY. For description of the Genus, see Alca; for classification, see the System, for representation, see Plate V. Genus 84.

AVOIRDUPOIS, or AVERDUPOIS *weight*, a kind of weight used in England; the pound whereof contains sixteen ounces. The proportion of a pound *avoirdupois* to a pound *troy*, is as 17 to 14; or the *avoirdupois* pound contains 7000 grains, and the *troy* pound 5760. All the larger and coarser commodities are weighed by *avoirdupois* weight; as groceries, cheese, wool, lead, hops, &c.

AVOSETTA, the English name of the genus Recurvirostra, in the System of ORNITHOLOGY; for description of the Genus, see RECURVIROSTRA, for representation, see Plate V. Genus, 80.

AURELIA, in *Natural History*, the name of that state, otherwise called chrysalis, in which butterflies and several other animals pass their time between their caterpillar or other creeping state, and their winged ones. In this state no creatures afford so beautiful a variety as the butterfly kinds; and they all pass through this middle state without one exception. For the several metamorphoses through which this extraordinary insect passes in its several states, and the peculiarities incidental to each state, see the Article CHRYSALIS.

AURICLE, in *Anatomy*, the external ear; or that part of the ear which is prominent from the head. The word is a diminutive of *auris*, *ear*; q. d. *little ear*. For the structure and variety of the *auricle*, with the several parts thereof, with their names, &c. see the System, Part VII. Sect. 4. and Plate XI. Fig. 7.

AURICLE, is also applied to two appendages of the heart; being two muscular caps, covering the two ventricles thereof; thus called from the resemblance they bear to the external ear. They move regularly like the heart, only in an inverted order; their *systole* corresponding to the *diastole* of the heart, and *vice versa*. See the System, Part V. Sect. 3.

AURIGA, in *Astronomy*, the *Waggoner*; a constellation of stars in the northern hemisphere: whose stars in Ptolemy's catalogue, are 14; in Tycho's, 27; in Hevelius's, 40; in the Britannic catalogue, 66. See the System Sect. 8, and Plate VI. Fig. 1.

AURORA, the morning twilight; or that faint light which begins to appear in the morning, when the sun is within eighteen degrees of the horizon. The poets have personified, and even made it a goddess; representing her with a chariot, rosy fingers, &c.

AURORA BOREALIS, NORTHERN TWILIGHT, or *Streamers*; a kind of meteor appearing in the northern part of the heavens, mostly in the winter time, and in frosty weather. It is in the arctic regions that it appears in most perfection, particularly during the solstice. In the Shetland Islands, the *merry dancers*, as they are called, are the constant attendants of clear evenings, and prove great reliefs amidst the gloom of the long winter nights. They commonly appear at twilight near the horizon, of a dun colour, approaching to yellow; sometimes continuing in that state for several hours, without any sensible motion; after which they break out into streams of stronger light, spreading into columns, and altering slowly into ten thousand different shapes, varying their colours from all the tints of yellow to the obscurest russet. They often cover the whole hemisphere, and then make the most brilliant appearance. Their motions at these times are most amazingly quick: and they astonish the spectator with the rapid change of their form. They break out in places where none were seen before, skimming briskly along the heavens; are suddenly extinguished, and leave behind an uniform dusky tract. This again is brilliantly illuminated in the same manner, and as suddenly left a dull blank. In certain nights they assume the appearance of vast columns, on one side of the deepest yellow, on the other declining away, till it becomes undistinguished from the sky. They have generally a strong tremulous motion from end to end, which continues till the whole vanishes. In a word, we, who only see the extremities of these northern phænomena, have but a faint idea of their splendor and their motions. According to the state of the atmosphere, they differ in colours.... They often put on the colour of blood, and make a most dreadful appearance. The rustic sages become prophetic, and terrify the gazing spectators with the dread of war, pestilence, and famine. This superstition was not peculiar to the northern islands; nor are these appearances of recent date. The ancients called them *Chasmata*, and *Trabes*, and *Bolides*, according to their forms or colours.

In old times they were extremely rare, and on that account were the more taken notice of. From the days of Plutarch to those of our sage historian Sir Richard Baker, they were supposed to be portentous of great events, and timid imaginations shaped them into aerial conflicts:

Fierce fiery warriors fight upon the clouds
In ranks and squadrons and right form of war.

Dr. Halley tells us, that when he saw a great Aurora Borealis in 1716, he had begun to despair of ever seeing one at all; none having appeared, at least in any considerable degree, from the time he was born till then. Notwithstanding this long interval, however, it seems that in some periods the Aurora Borealis had been seen much more frequently; and perhaps this, as well as other natural phænomena, may have some stated times of returning.

The only thing that resembles a distinct history of this phenomenon, is what we have from the learned Dr. Halley, Phil. Trans. No 347. The first account he gives, is of the appearance of what is called by the author *Burning Spears*, and was seen at London on Jan. 30th, 1560. In 1621, Sept. 2d, this phenomenon was observed all over France, and described by Gassendus, who gave it the name of *Aurora Borealis*: yet neither this, nor any similar appearances posterior to 1574, are described by English writers till the year 1707; which, as Dr. Halley observes, shows the prodigious neglect of curious matters which at that time prevailed. From 1621 to 1707, indeed, there is no mention made of an Aurora Borealis being seen by any body; and considering the number of astronomers who during that period were in a manner continually poring on the heavens, we may very reasonably conclude that no such thing did make its appearance till after an interval of 86 years. In 1707, a small one was seen in November; and during that year and the next, the same appearances were repeated five times. The next on record is that mentioned by Dr. Halley, in March 1715-16, the brilliancy of which attracted universal attention, and by the vulgar was considered as marking the introduction of a foreign race of princes. Since that time those meteors have been so common, that no accounts have been kept of them.

It was for a long time a matter of doubt whether this meteor made its appearance only in the northern hemisphere, or whether it was to be observed near the south pole. This is now ascertained by Mr. Forster, who in his late voyage round the world, along with Captain Cook, assures us, that he observed them in the high southern latitudes, though with phenomena somewhat different from those which are seen here.

"A beautiful phenomenon (says he) was observed during the preceding night, which happened again this and several following nights. It consisted of long columns of a clear white light, shooting up from the horizon to the eastward, almost to the zenith ward, and gradually spreading on the whole southern part of the sky. These columns were sometimes bent sidewise at their upper extremities; and though in most respects similar to the northern lights (*aurora borealis*) of our hemisphere, yet different from them in being almost of a whitish colour, whereas ours assume various tints, especially those of a fiery purple hue. The sky was generally clear when they appeared, and the air sharp and cold."

Dr. Halley observed, that the Aurora Borealis described by him, arose to a prodigious height, it being seen from the west of Ireland, to the confines of Russia and Poland on the east; nor did he know how much further it might have been visible; so that it extended at least 30 degrees in longitude, and from latitude 50° north it was seen over all the northern part of Europe; and what was very surprising, in all those places where it was visible, the same appearances were exhibited which Dr. Halley observed at London. He observes, with seeming regret, that he could by no means determine its height, for want of observations made at different places; otherwise he might as easily have calculated the height of this Aurora Borealis, as he did of the fiery globe in 1719. To other philosophers, however, he gives the following exhortation. "When therefore, for the future, any such thing shall happen, all those that are curious in astronomical matters, are hereby *admonished and entreated* to set their clocks to the apparent time at London, for example, by allowing so many minutes as is the difference of meridians; and then to note, at the end of every half hour precisely, the exact situation of what at that time appears remarkable in the sky; and particularly the azimuths of those very tall pyramids so eminent above the rest, and therefore likely to be seen furthest: to the intent, that by comparing these observations taken at the same moment in distant places, the difference of their azimuths may serve to determine how far these pyramids are distant from us." This advice of Dr. Halley seems to have been totally neglected by all the philosophical people in this country. In other countries, however, they have been more industrious. Father Boscovich has determined the height of an Aurora Borealis, observed on the 16th of December, 1737, by the Marquis of Poleni, to have been 825 miles high; the celebrated Mr. Bergman, from a mean of 30 computations, makes the average height of the Aurora Borealis to be 70 Swedish, or upwards of 460 English miles. Euler supposes it to be several thousands of miles high; and Mairan also assigns them a very elevated region. In the 74th volume of the Philosophical Transactions, Dr. Blagden, when speaking of the height of some fiery meteors, tells us, that the "Aurora Borealis appears to occupy as high, if not a higher region above the surface of the earth, as may be judged from the very distant countries to which it has been visible at the same time."

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The height of theſe meteors, however, none of which appear to have exceeded, or even arrived at the height of a hundred miles, muſt appear trifling in compariſon of the vaſt elevations above-mentioned. But theſe enormous heights, varying ſo exceedingly, ſhow that the calculators have not had proper data to proceed upon; and indeed the immenſe extent of ſpace occupied by the Aurora Borealis itſelf, with its conſtant motion, muſt make it infinitely more difficult to determine the height of it, than of a fiery globe, which occupies but a ſmall portion of the viſible heavens. The moſt certain method of making a compariſon betwixt the Aurora Borealis and the meteors already mentioned, would be, if a ball of fire ſhould happen to paſs through the ſame part of the heavens where an Aurora Borealis was; when the comparative height of both could eaſily be aſcertained. One inſtance of this only has come under our obſervation, where one of the ſmall meteors, called *falling ſtars*, was evidently obſcured by an Aurora Borealis, and therefore muſt have been higher than the lower part of the latter at leaſt. A ſingularity in this meteor was, that it did not proceed in a ſtraight line through the heavens, as is uſual with falling ſtars, but deſcribed a very conſiderable arch of a circle, riſing in the north-weſt, and proceeding ſouthward a conſiderable way in the arch of a circle, and diſappearing in the north. Its edges were ill defined, and five or ſix coruſcations ſeemed to iſſue from it like the rays painted as iſſuing from ſtars. The Aurora Borealis was not in motion, but had degenerated into a crepuſculum in the northern part of the hemiſphere. Indeed, in ſome caſes, this kind of crepuſculum appears ſo plainly to be connected with the clouds, that we can ſcarcely avoid ſuppoſing it to proceed from them. We cannot, however, argue from this to the height of the aurora borealis when it moves with great velocity, becauſe it then may, and very probably does, aſcend much higher. Dr. Blagden, indeed, informs us, that inſtances are recorded, where the northern lights have been ſeen to join, and form luminous balls, darting about with great velocity, and even leaving a train like the common fire-balls. It would ſeem, therefore, that the higheſt regions of the aurora borealis are the ſame with thoſe in which fire-balls move.

With regard to the cauſe of the aurora borealis, many conjectures have been formed. The firſt which naturally occurred was, that it was occaſioned by the aſcent of inflammable ſulphureous vapours from the earth. To this ſuppoſition Dr. Halley objects the immenſe extent of ſuch phenomena, and that they are conſtantly obſerved to proceed from north to ſouth, but never from ſouth to north. This made him very reaſonably conclude, that there was ſome connection between the poles of the earth and the aurora borealis; but being unacquainted with the electric power, he ſuppoſed that this earth was hollow, having within it a magnetical ſphere, which correſponded in virtue with all the natural and artificial magnets on the ſurface; and the magnetic effluvia paſſing through the earth, from one pole of the central magnet to another, might ſometimes become viſible, in their courſe, which he thought was from north to ſouth, and thus exhibit the beautiful coruſcations of the aurora borealis. Had Dr. Halley, however, know that a ſtroke of electricity would give polarity to a needle that had it not, or reverſe the poles of one that had it before, he would undoubtedly have concluded the electric and magnetic effluvia to be the ſame, and that the aurora borealis was this fluid performing its circulation from one pole of the earth to the other. In fact, this very hypotheſis is adopted by S. Beccaria; and by the ſuppoſed circulation of the electric fluid he accounts for the phenomena of magnetiſm and the aurora borealis in a manner perfectly ſimilar to that of Dr. Halley, only changing the phraſe *magnetic effluvia* for *electric fluid*. The following is the account given us by Dr. Prieſtley of Beccaria's ſentiments on this matter.

"Since a ſudden ſtroke of lightning gives polarity to magnets, he conjectures, that a regular and conſtant circulation of the whole maſs of the fluid from north to ſouth may be the original cauſe of magnetiſm in general.

"That this ethereal current is inſenſible to us is no proof of its non-exiſtence, ſince we ourſelves are involved in it. He had ſeen birds fly ſo near a thunder-cloud, as he was ſure they would not have done had they been affected by its atmoſphere.

"This current he would not ſuppoſe to ariſe from one ſource, but from ſeveral, in the northern hemiſphere of the earth; and he thinks that the aurora borealis may be this electric matter performing its circulation in ſuch a ſtate of the atmoſphere as renders it viſible, or approaching the earth nearer than uſual. Accordingly very vivid appearances of this kind have been obſerved to occaſion a fluctuation in the magnetic needle."

A direct diſproof of this circulation, however, is furniſhed by the obſervation of Mr. Forſter already mentioned; with which, though neither Dr. Halley nor S. Beccaria could be acquainted, they might have thought of it as a final proof either of the truth or falſehood of their hypotheſis.—If the aurora borealis is no other than the electric fluid performing the above mentioned circulation, it ought to dart from the horizon towards the zenith in the northern hemiſphere, and from the zenith to the horizon in the ſouthern one; but Mr. Forſter plainly tells us, that the columns ſhot up from the horizon towards the zenith as well in the ſouthern hemiſphere as in the northern; ſo that if the aurora borealis is to be reckoned the flaſhings of electric matter, its courſe is plainly directed from both poles towards the equator, and not from one pole to the other.

Concerning the cauſe of this phenomenon, Mr. Canton has the following query: "Is not the aurora borealis the flaſhing of electrical fire from poſitive towards negative clouds at a great diſtance, through the upper part of the atmoſphere where the reſiſtance is leaſt?" But to this we muſt reply in the negative; for in this caſe it would flaſh in every direction according to the poſition of the clouds, as well as from north to ſouth. Beſides this query, he conjectures, that when the needle is diſturbed by the aurora borealis, that phenomenon proceeds from the electricity of the heated air; and ſuppoſes the air to have the property of becoming electric by heat, like the tourmalin. But neither does this hypotheſis appear at all probable; becauſe, in ſuch a caſe, the aurora borealis ought to be moſt frequent in ſummer when the air is moſt heated, whereas it is found to be the reverſe. Laſtly, with theſe electrical hypotheſes we ſhall contraſt that of Mr. Mairan, who imagined this phenomenon to proceed from the atmoſphere of the ſun, particles of which were thrown off by its centrifugal force acquired by his rotation on his axis; and that theſe particles falling upon the atmoſphere of the earth near its equatorial parts, were from thence propelled by the diurnal motion of the earth towards the polar regions, where they formed the aurora borealis. This hypotheſis, beſides its being a mere ſuppoſition unſupported by one ſingle appearance in nature, is liable to the objection already mentioned; for in this caſe the light ſhould dart from the equator to the poles, and not from the poles to the equator: or if we ſhould ſuppoſe this matter to be gradually accumulated at each of the poles, we muſt then make other ſuppoſitions equally vague and ill founded, concerning its getting back with ſuch ſurpriſing rapidity, in direct oppoſition to the power which once brought it thither.

The firſt perſon that ſeems to have endeavoured to find any poſitive proof for the electrical quality of the aurora borealis, is Dr. Hamilton of Dublin. He obſerves, that though this phenomenon is commonly ſuppoſed to be electrical, yet he had not ſeen any ſucceſsful attempt to prove that it is ſo: but the only proof he himſelf brings is an experiment of Mr. Hawkſbee, by which the electric fluid is ſhewn to put on appearances ſomewhat like the aurora borealis, when it paſſes through a vacuum. He obſerved, that when the air was moſt perfectly exhauſted, the ſtreams of electric matter were then quite white; but when a ſmall quantity of air was let in, the light aſſumed more of a purple colour. The flaſhing of this light therefore from the denſe regions of the atmoſphere into ſuch as are more rare, and the tranſitions through mediums of different denſity, he reckons the cauſe of the aurora borealis, and of the different colours it aſſumes.

Dr. Hamilton's proof, then, of the electricity of the aurora borealis, conſiſts entirely in the reſemblance the two lights bear to one another; and if to this we add, that, during the time of an aurora borealis, the magnetic needle hath been diſturbed, electric fire obtained from the atmoſphere in plenty, and at ſome times different kinds of rumbling and hiſſing ſounds heard, we have the ſum of all the poſitive evidence in favour of the electric hypotheſis.

Was the aurora borealis the firſt natural phenomenon the ſolution of which had been attempted by electricity, no doubt the proofs juſt now adduced would be very inſufficient: but when it is conſidered, that we have indiſputable evidence of the identity of the phenomena of thunder and of electricity; when we alſo conſider, that the higher parts of our atmoſphere are continually in a ſtrongly electrified ſtate; the analogy becomes ſo ſtrong, that we can ſcarce doubt of the aurora borealis ariſing from the ſame cauſe. The only difficulty is, to give a good reaſon why the electricity of the atmoſphere ſhould be conſtantly found to direct its courſe from the poles towards the equator, and not from the equator to the poles; and this we think may be done in the following manner.

1. It is found that all electric bodies, when conſiderably heated, become conductors of electricity; thus hot air, hot glaſs, melted roſin, ſealing wax, &c. are all conductors, till their heat is diſſipated, and then they again become electrics. See the Syſtem of ELECTRICITY.

2. As the converſe of every true propoſition ought alſo to be true, it follows from the above one, that if electrics when heated become conductors, then non-electrics when ſubjected to violent degrees of cold ought to become electric. In one inſtance this has been verified by experience; water, which is a conductor when warm, or not violently cooled, is found to become electric when cooled to 20° below 0 of Fahrenheit's thermometer. With regard to metallic ſubſtances, indeed, no experiments have as yet been made to determine whether their conducting power is affected by cold or not. Very probably we might not be able to produce ſuch a degree of cold as ſenſibly to leſſen their conducting power; but ſtill the analogy will hold; and, as we are by no means able to produce the greateſt degree of cold poſſible, reaſon will always ſuggeſt to us, that if a certain degree of cold changes one conductor into an electric, a ſufficient degree of it will alſo change all into electrics.

3. If cold is ſufficient to change conducting ſubſtances into electrics,

electrics, it muſt alſo increaſe the electric power of ſuch ſubſtances as are already electric; that is to ſay, very cold air, glaſs, roſin, &c. provided they are dry, will be more electric than when they are warmer. With regard to air, which is moſt to our preſent purpoſe, this is rendered extremely probable, by conſidering that clear froſty weather is of all others the moſt favourable for electric experiments. They may be made indeed with equal advantage almoſt in any ſtate of the atmoſphere, provided ſufficient pains is uſed, but in dry hard froſts they will ſucceed much more eaſily than at any other time.

Theſe three axioms being allowed, the cauſe of the aurora borealis is eaſily deduced from them. The air, all round the globe, at a certain height above its ſurface, is found to be exceedingly cold; and, as far as experiments have yet determined, exceedingly electrical alſo. The inferior parts of the atmoſphere between the tropics, are violently heated during the day-time by the reflection of the ſun's rays from the earth. Such air will therefore be a kind of conductor, and much more readily part with its electricity to the clouds and vapours floating in it, than the colder air towards the north and ſouth poles. Hence the prodigious appearances of electricity in theſe regions, ſhowing itſelf in thunder and other tempeſts of the moſt terrible kind. Immenſe quantities of the electric fluid are thus communicated to the earth, and the inferior warm atmoſphere having once exhauſted itſelf, muſt neceſſarily be recruited from the upper and colder region. This becomes very probable from what the French mathematicians obſerved when on the top of one of the Andes. They were often involved in clouds, which, ſinking down into the warmer air, appeared there to be highly electrified, and diſcharged themſelves in violent tempeſts of thunder and lightning; while in the mean time, on the top of the mountain, they enjoyed a calm and ſerene ſky. In the temperate and frigid zones, the inferior parts of the atmoſphere never being ſo ſtrongly heated, do not part with their electricity ſo eaſily as in the torrid zone, and conſequently do not require ſuch recruits from the upper regions; but notwithſtanding the difference of heat obſerved in different parts of the earth near the ſurface, it is very probable that at conſiderable heights the degree of cold is nearly equal all round it. Were there a like equality in the heat of the under part, there could never be any conſiderable loſs of equilibrium in the electricity of the atmoſphere: but as the hot air of the torrid zone is perpetually bringing down vaſt quantities of electric matter from the cold air that lies directly above it; and as the inferior parts of the atmoſphere lying towards the north and ſouth poles do not conduct in any great degree; it thence follows, that the upper parts of the atmoſphere lying over the torrid zone will continually require a ſupply from the northern and ſouthern regions. This eaſily ſhows the neceſſity of an electric current in the upper parts of the atmoſphere from each pole towards the equator: and thus we are alſo furniſhed with a reaſon why the aurora borealis appears more frequently in winter than in ſummer; namely, becauſe at that time the electric power of the inferior atmoſphere is greater on account of the cold than in ſummer; and conſequently the abundant electricity of the upper regions muſt go almoſt wholly off to the equatorial parts, it being impoſſible for it to get down to the earth: hence alſo the aurora borealis appears very frequent and bright in the frigid zones, the degree of cold in the upper and under regions of the atmoſphere being much more nearly equal in theſe parts than in any other. In ſome parts of Siberia particularly, this meteor appears conſtantly from October to Chriſtmas, and its coruſcations are ſaid to be very terrifying. Travellers agree, that here the aurora borealis appears in greateſt preſection: and it is to be remarked, that Siberia is the coldeſt country on earth. In confirmation of this, it may alſo be obſerved, that, from the experiments hitherto made with the electrical kite, the air appears conſiderably more electrical in winter than in ſummer, though the clouds are known to be often moſt violently electrified in the ſummer time; a proof, that the electricity naturally belonging to the air is in ſummer much more powerfully drawn off by the clouds than in the winter, owing to the exceſs of heat in ſummer, as already obſerved.

A conſiderable difficulty, however, ſtill remains, from the upright poſition which the ſtreams of the aurora borealis are generally obſerved to have; whereas, according to the hypotheſis above mentioned, they ought rather to run directly from north to ſouth. This difficulty occurred to Dr. Halley: but he anſwers it by ſuppoſing his magnetic effluvia to paſs from one pole to another in arches of great circles, ariſing to a vaſt height above the earth, and conſequently darting from the places whence they aroſe almoſt like the radii of a circle; in which caſe, being ſent off in a direction nearly perpendicular to the ſurface of the earth, they muſt neceſſarily appear erect to thoſe who ſee them from any part of the ſurface, as is demonſtrated by mathematicians. It is alſo reaſonable to think that they will take this direction rather than any other, on account of their meeting with leſs reſiſtance in the very high regions of the air than in ſuch as are lower.

But the greateſt difficulty ſtill remains: for we have ſuppoſed the equilibrium of the atmoſphere to be broken in the day-time, and reſtored only in the night; whereas, conſidering the immenſe velocity with which the electric fluid moves, the equilibrium ought to be reſtored in all parts almoſt inſtantaneouſly; yet the aurora borealis never appears except in the night, although its brightneſs is ſuch as muſt ſometimes make it viſible to us did it really exiſt in the day-time.

In anſwer to this it muſt be obſerved, that though the paſſage of electricity through a good conductor is inſtantaneous, yet through a bad conductor it is obſerved to take ſome time in paſſing. As our atmoſphere, therefore, unleſs very violently heated, is but a bad conductor of electricity; though the equilibrium in it is broken, it can by no means be inſtantaneouſly reſtored. Add to this, that as it is the action of the ſun which breaks the equilibrium, ſo the ſame action, extending over half the globe, prevents almoſt any attempt to reſtore it till night; when flaſhes ariſe from various parts of the atmoſphere, gradually extending themſelves with a variety of undulations towards the equator.

It now remains to explain only one particularity of the aurora borealis, namely, that its ſtreams do not always move with rapidity, ſometimes appearing quite ſtationary for a conſiderable time, and ſometimes being carried in different directions with a ſlow motion. To this indeed we can give no other reply, than that weak electric lights have been ſometimes obſerved to put on the ſame appearance at the ſurface of the earth; and much more may we ſuppoſe them capable of doing ſo at great heights above it, where the conductors are both fewer in number, and much more perfect. When M. de Romas was making experiments with an electric kite in Italy, a cylinder of blue light about four or five inches diameter was obſerved ſurrounding the ſtring. This was in the day-time; but had it been night, he imagined it muſt have been four or five feet in diameter; and as the ſtring was 780 feet long, it would probable have ſeemed pyramidal, pointing upwards like one of the ſtreams of the aurora borealis. A ſtill more remarkable appearance, Dr. Prieſtley tells us, was obſerved by Mr. Hartman. He had been making electrical experiments for four or five hours together in a very ſmall room; and upon going out of it, and returning with a light in his hand, walking pretty quick, he perceived a ſmall flame following him at about three feet diſtance. Being alarmed at this appearance, he ſtopped to examine it, upon which it vaniſhed. This laſt inſtance is very remarkable, and ſingular in its kind: from both, however, we are ſufficiently warranted to conclude, that ſmall portions of our atmoſphere may by various cauſes be ſo much electrified as to ſhine, and likewiſe be moved from one place to another without parting with the electricity they have received, for a conſiderable time.

The corona, or circle, which is often formed near the zenith by the aurora borealis, is eaſily accounted for in the ſame manner. As this corona is commonly ſtationary for ſome time, we imagine it would be a very proper mark whereby to determine the diſtance of the meteor itſelf. If an aurora borealis, for inſtance, was obſerved by two perſons, one at London, and the other at Edinburgh; by noting the ſtars among which the corona was obſerved at each place, its true altitude from the ſurface of the earth could eaſily be determined by trigonometry.

Under the article ATMOSPHERE it was ſuggeſted, that no good proof had been as yet brought for the extreme rarity of the air uſually ſuppoſed to take place at no very great heights above the earth. The brightneſs of the meteor there mentioned at 70 miles perpendicular from the ſurface, as alſo its figure, ſeemed to prove the air conſiderably denſer at that diſtance from the earth. Though the height of the aurora borealis has never been determined, we can ſcarce imagine it to be greater than that of this meteor, or indeed ſo great: but although its ſtreams reſemble the paſſage of electric light through a vacuum, it cannot be from thence inferred, that the air is at all in a ſtate ſimilar to the vacuum of an air-pump in thoſe places where the aurora borealis is produced; ſeeing we have inſtances of ſimilar appearances being produced in very denſe air. The plate of an electrophorus is often ſo highly electrified as to throw out flaſhes from different parts as ſoon as it is lifted up, and by proper management it may be always made to emit long and broad flaſhes, which ſhall ſcarcely be felt by the finger, inſtead of ſmall, denſe, and pungent ſparks; ſo that, though long flaſhes may be produced in rarefied air, it by no means follows that the ſame may not alſo be produced in denſer air. As little can we infer any thing from the colours; for we obſerve the electric ſpark ſometimes white, ſometimes blue, and ſometimes purple, in the very ſame ſtate of the atmoſphere, and from the ſame ſubſtance.

The aurora borealis is ſaid to be attended with a peculiar hiſſing noiſe in ſome very cold climates; Gmelin ſpeaks of it in the moſt pointed terms, as frequent and very loud in the north-eaſtern parts of Siberia; and other travellers have related ſimliar facts. Gmelin's account is very remarkable. "Theſe northern lights (ſays he) begin with ſingle bright pillars, riſing in the N. and almoſt at the ſame time in the N. E. which gradually increaſing, comprehend a large ſpace of the heavens, ruſh about from place to place with incredible velocity, and finally almoſt cover the whole ſky up to the zenith. The ſtreams are then ſeen meeting together in the zenith, and produce an appearance as if a vaſt tent was expanded in the heavens, glittering with gold, rubies, and ſapphire. A more beautiful ſpectacle cannot be painted; but, whoever ſhould ſee ſuch a northern light for the firſt time, could not behold it without terror. For however fine the illumination may be, it is attended, as I have learned from the relation of many perſons, with ſuch a hiſſing,

hiſſing, cracking, and ruſhing noiſe throughout the air, as if the largeſt fire-works were playing off. To deſcribe what they then hear, they make uſe of the expreſſion *Spolschi chodjat*, that is, the raging hoſt is paſſing. The hunters who purſue the white and blue foxes in the confines of the Icy Sea, are often overtaken in their courſe by theſe northern lights. Their dogs are then ſo much frightened, that they will not move, but lie obſtinately on the ground till the noiſe has paſſed. Commonly clear and calm weather follows this kind of northern lights. I have heard this account, not from one perſon only, but confirmed by the uniform teſtimony of many, who have ſpent part of ſeveral years in theſe very northern regions, and inhabited different countries from the Yeneſei to the Lena; ſo that no doubt of its truth can remain. This ſeems indeed to be the real birth-place of the *aurora borealis*.

The hiſſing or ruſhing noiſe above deſcribed, Dr. Blagden is inclined to attribute to ſmall ſtreams of electric matter running off to the earth from the maſſes or accumulations of electricity by which the northern lights are ſuppoſed to be produced.

We ſhall conclude this article with an account of a paper preſented to the Royal Society by Mr. Winn, in 1772, wherein he ſays, that the appearance of an aurora borealis is a certain ſign of an hard gale of wind from the ſouth or ſouth-weſt. This he never found to fail in 23 inſtances; and even thinks, that from the ſplendor of the meteor, ſome judgment may be formed concerning the enſuing tempeſt. If the aurora is very bright, the gale will come on within twenty-four hours, but will be of no long duration; if the light is faint and dull, the gale will be leſs violent, and longer in coming on, but will alſo laſt longer. His obſervations were made in the Engliſh channel, where ſuch winds are very dangerous; and by attending to the auroræ, he ſays he often got eaſily out of it, when others narrowly eſcaped being wrecked. This is an exceeding uſeful obſervation for ſailors: but it cannot be expected that the winds ſucceeding theſe meteors ſhould in all places blow from the ſouth weſt; though no doubt a careful obſervation of what winds ſucceed the aurora borealis, and other meteors, in different parts of the world, might contribute in ſome meaſure to leſſen the dangers of navigation.

That the aurora borealis ought to be ſucceeded by winds, may be eaſily deduced from the hypotheſis laſt-mentioned. If this phenomenon is occaſioned by the vaſt quantity of electric matter conveyed to the equatorial parts of the earth, it is certain that the earth cannot receive any great quantity of this matter at one place without emitting it at another. The electricity, therefore, which is conſtantly received at the equator, muſt be emitted nearer the poles, in order to perform its courſe, otherwiſe there could not be a conſtant ſupply of it for the common operations of nature. It is obſerved, that electrified bodies are always ſurrounded by a blaſt of air, which is ſent forth from them in all directions; hence, if the electric matter find a more ready paſſage through one part of the earth than another, a wind will be found to blow from that quarter. If therefore one of theſe places happens to be in the Atlantic ocean near the coaſt of France, or in the Bay of Biſcay, the electric matter which has been received at the equator during an aurora borealis will be diſcharged there ſome time after, and conſequently a wind will blow from that quarter, which will be from the ſouth-weſt to thoſe ſhips which are in the Engliſh channel.

It cannot be imagined, however, that all the matter can be diſcharged from one place; and therefore, according to the different ſituations of thoſe electrical vents, winds may blow in different directions; and thus the ſame aurora borealis may produce a ſouth-weſt wind in the Engliſh channel, and a north-weſt one in Scotland.

AURUM, GOLD. This metal was introduced into medicine by the Arabians, who eſteemed it one of the greateſt cordials and comforters of the nerves. From them Europe received it without any diminution of its character; in foreign pharmacopœias it is ſtill retained, and even mixed with the ingredients from which ſimple waters are to be diſtilled. But no one, it is preſumed, at this time, expects any ſingular virtues from it, ſince it certainly is not alterable in the human body. Mr. Geoffroy, though unwilling to reject it from the cordial preparations, honeſtly acknowledges that he has no other reaſon for retaining it than in complaiſance to the Arabian ſchools. The chymiſts have endeavoured, by many elaborate proceſſes, to extract what they call a ſulphur or anima of gold: but no method is as yet known of ſeparating the component parts of this metal; all the tinctures of it, and aurum potabile, which have hitherto appeared, are real ſolutions of it in aqua regia, diluted with ſpirit of wine or other liquors, and prove injurious to the body rather than beneficial. A place, however, is now given in ſome of the foreign pharmacopœias to the aurum fulminans; and it has of late been recommended as a remedy in ſome convulſive diſeaſes, particularly in the chorea ſancti viti. For a further account of this metal, ſee the ſyſtem of CHYMISTRY, Part III. Chap. 2. Sect. 7.

AUSTRALIS *Piſcis*, is a conſtellation of the ſouthern hemiſphere, not viſible in our latitude; whoſe ſtars in Ptolemy's catalogue are 18; and in the Britannic catalogue, 24. See the Syſtem, Sect. 8. and Plate VI. Fig. 2.

AUTOMATON, (from αυτος *ipſe* and μαομαι *excitor*) a ſelf-moving machine, or one ſo conſtructed, by means of weights, levers, pullies, &c. as to move for a conſiderable time, as though endued with animal life. According to this deſcription, clocks, watches, and all machines of that kind, are automata.

Under the article ANDROIDES, in the order of the alphabet, we obſerved, that the higheſt perfection to which automata could be carried was, to imitate exactly the motions and actions of living creatures, eſpecially of mankind, which are more difficultly imitated than thoſe of other animals. Very ſurpriſing imitations, however, have been made of other creatures. So long ago as 400 years before Chriſt, Archytas of Tarentum is ſaid to have made a wooden pigeon that could fly: nor will this appear at all incredible, when we conſider the flute-player made by M. Vaucanſon, and the cheſs-player, by M. Kempell. Dr. Hook is alſo ſaid to have made the model of a flying chariot, capable of ſupporting itſelf in the air. But M. Vaucanſon abovementioned, hath diſtinguiſhed himſelf more eminently. That gentleman, encouraged by the favourable reception of his flute-player, made a duck, which was capable of eating, drinking, and imitating exactly the voice of a natural one. Nay, what is ſtill more ſurpriſing, the food it ſwallowed was evacuated in a digeſted ſtate; not that it really was in a ſtate of natural excrement, but only conſiderably altered from what it was when ſwallowed: and this digeſtion was performed on the principles of ſolution, not of trituration. The wings, viſcera, and bones, of this artificial duck, were alſo formed ſo as very ſtrongly to reſemble thoſe of a living animal. Even in the actions of eating and drinking, this reſemblance was preſerved; the artificial duck ſwallowed with avidity, and vaſtly quick motions of the head and throat; and likewiſe muddled the water with his bill, exactly like a natural one.

M. Le Droz, of La Chaux de Fonds, in the county of Neufchatel, hath alſo executed ſome very curious pieces of mechaniſm, which well deſerve to be ranked with thoſe already mentioned. One was a clock, which was preſented to his Spaniſh majeſty; and had, among other curioſities, a ſheep, which imitated the bleating of a natural one; and a dog watching a baſket of fruit: when any one attempted to purloin the fruit, the dog gnaſhed his teeth and barked; and if it was actually taken away, he never ceaſed barking till it was reſtored. Beſides this, he made a variety of human figures, which exhibited motions truly ſurpriſing; but all inferior to Mr. Kempell's cheſs-player, which may juſtly be looked upon as the greateſt maſter-piece in mechanics that ever appeared. See ANDROIDES.

AUTUMN, the third ſeaſon of the year, when the harveſt and fruits are gathered in. Autumn is repreſented in painting, by a man at perfect age, clothed like the vernal figure, and girded with a ſtarry girdle; holding in one hand a pair of ſcales equally poiſed, with a globe in each: in the other hand, a bunch of divers fruits and grapes. His age denotes the perfection of this ſeaſon; and the balance, that ſign of the zodiac which the ſun enters when our autumn begins. Autumn begins on the day when the ſun's meridian diſtance from the zenith, being on the decreaſe, is a mean between the greateſt and the leaſt; which in theſe countries is ſuppoſed to happen when the ſun enters Libra. Its end coincides with the beginning of winter.

AUTUMNAL POINT, is that part of the equinox from which the ſun begins to deſcend towards the ſouth pole. AUTUMNAL *Signs*, in aſtronomy, are the ſigns Libra, Scorpio, Sagittarius, through which the ſun paſſes during the autumn. AUTUMNAL *Equinox*, that time when the ſun enters the autumnal point. For an account of theſe articles, ſee the Syſtem, Sect. 9, and the Plate annexed to the Treatiſe on Globes.

AWARD, in *Law*, the judgment of ſome perſon who is neither aſſigned by law, nor appointed by the judge, for ending a matter in controverſy; but is choſen by the parties themſelves that are at variance. See ARBITER and ARBITRATION.

AXILLA, or ALA, in *Anatomy*, the cavity under the upper part of the arm, commonly called the ARM-*pit*. Abſceſſes in the *axillæ* are uſually dangerous, on account of the many blood-veſſels, lymphatics, nerves, &c. thereabout, which form ſeveral large PLEXUS. By the ancient laws, criminals were to be hanged by the *axillæ*, if they were under the age of puberty.

AXILLARY *artery*, is a ramification of the trunk of the ſubclavian artery; which paſſing under the arm-pits, changes its name, and is called *axillary*. AXILLARY *vein*, is one of the ſubclavian veins, which paſſing under the arm-pits, divides itſelf into ſeveral branches; *ſuperior*, *inferior*, *external*, *internal*, &c. which are ſpread over the arm. See the Syſtem of Anatomy. Part V. Sect. 1.

AXILLARY *nerve*, called alſo the *auricular nerve*, ariſes from the laſt two cervical pairs; runs into the hollow of the *axilla*, behind the head of the *os humeri*, between the *muſculus teres major & minor*, &c. The ſecond *vertebra* of the back is ſometimes alſo called the *axillary vertebra*; becauſe it is neareſt to the arm-pits. See the Syſtem, Part VI. and Plate XII.

AXIOM, AXIOMA, from αξιοω, *I am worthy*, a ſelf-evident truth: or a propoſition whoſe truth every perſon receives at firſt ſight. Thus that the whole is greater than a part; that a thing cannot be and not be at the ſame time; and that from nothing, nothing can ariſe, are *axioms*. By *axioms*, called alſo *maxims*, are underſtood all common notions of the mind, whoſe evidence is ſo clear and forcible, that a man cannot deny them without renouncing common ſenſe and natural reaſon. The rule of *axioms* is this, that whatever propoſition expreſſes the immediate clear compariſon

pariſon of two ideas without the help of a third, is an *axiom*. On the other hand, a truth which does not ariſe from an immediate compariſon of two ideas, is no *axiom*. For a copious diſquiſition of this ſubject, as appertaining to the art of Logic, or thinking and reaſoning juſtly, ſee the Syſtem of Logic, Part II. throughout.

AXIOM is alſo an eſtabliſhed principle in ſome art or ſcience.--- Thus, it is an *axiom* in *Phyſics*, that nature does nothing in vain; that effects are proportional to their cauſes, &c. So it is an *axiom* in *Geometry*, that things equal to the ſame third, are alſo equal to one another; that if to equal things you add equals, the ſums will be equal, &c.

AXIS, in geometry, the ſtraight line in a plain figure, about which it revolves, to produce or generate a ſoild. Thus, if a ſemicircle be moved round its diameter at reſt, it will generate a ſphere, the axis of which is that diameter. See the Syſtem, Part I. Sect. 3.

AXIS, in aſtronomy, is an imaginary right line ſuppoſed to paſs through the centre of the earth and the heavenly bodies, about which they perform their diurnal revolutions. See the Syſtem, Sect. 2.

AXIS, in mechanics. The axis of the balance is that line about which it moves, or rather turns about. *Axis of oſcillation*, is a right line parallel to the horizon, paſſing through the centre, about which a pendulum vibrates. See *Oſcillation*.

AXIS *in Peritrochio*, one of the ſix mechanical powers, conſiſting of a peritrochium or wheel concentric with the baſe of a cylinder, and moveable together with it about its axis. See Syſtem of Mechanics, Sect. 3, and Plate III. Fig. 2.

AXIS, in anatomy, the name of the ſecond vertebra of the neck; it hath a tooth which goes into the firſt vertebra, and this tooth is by ſome called the *axis*. See the Syſtem, Part I. Sect. 3. Art. 1.

AXIS *of incidence*, in *Dioptrics*, is a right line drawn through the point of INCIDENCE, perpendicularly to the refracting ſurface. See the Syſtem of Optics, Part III.

AZIMUTH, in *Aſtronomy*. The *azimuth* of the ſun, or a ſtar, is an arch of the HORIZON, comprehended between the meridian of the place, and any given vertical, in which the ſun or ſtar is. See the Syſtem, Sect. 9. Definition 30.

The *azimuth* is the complement of the eaſtern or weſtern amplitude to a quadrant. The *azimuth* is found trigonometrically, by this proportion; as radius is to the tangent of the latitude, ſo is the tangent of the ſun's altitude to the coſine of the *azimuth* from the ſouth, at the time of the equinox.

Magnetical AZIMUTH, is an arch of the horizon contained between the ſun's *azimuth* circle and the magnetical meridian; or it is the apparent diſtance of the ſun from the north or ſouth point of the compaſs. It is found, by obſerving the ſun with an *azimuth* compaſs, when he is about 10 or 15 degrees high, either in the forenoon or afternoon.

AZIMUTH *Compaſs*, an inſtrument for finding either the magnetical azimuth or amplitude of an heavenly object. The learned mathematician Dr. Knight, invented ſome time ſince a very accurate and uſeful ſea-compaſs, which is at preſent uſed in the navy. This inſtrument with the contrivance added by an ingenious aſtronomer, anſwers the purpoſes of an azimuth and amplitude compaſs. For a copious deſcription of this inſtrument, and full directions for uſing it in finding the variations of the compaſs, by the ſun's amplitude and azimuth, ſee the Syſtem of Navigation, Part I. Sect. 1 and 4. For repreſentation of the Inſtrument, ſee the Plate annexed, Fig. 2 and 3.

AZIMUTHS, called alſo *vertical circles*, are great circles interſecting each other in the zenith and nadir, and cutting the horizon at right angles in all the points thereof. The HORIZON being divided into 360°, there are uſually reckond 360 *azimuths*. The *azimuths* are repreſented by the rhombs on common ſea charts. On the globe theſe circles are repreſented by the quadrant of altitude, when ſcrewed in the zenith. On theſe *azimuths* is reckoned the height of the ſtars, and the ſun when he is not in the meridian; that is, the *azimuths* ſhew what diſtance theſe are from the HORIZON.

AZYGOS, in *Anatomy*, a vein ariſing out of the *cava*, otherwiſe called VENA *ſine pari*, becauſe ſingle, whence its name. For a particular account, ſee the Syſtem, Part V.

B, The ſecond letter of our alphabet, and of moſt others. This obſervation fails in the ancient Iriſh alphabet; where B is the firſt, and A the ſeventeenth; and in the Abyſſinian, where A is the thirteenth.

B is one of thoſe letters which the eaſtern grammarians call *labial*, becauſe the principal organs employed in its pronunciation are the lips.

B requires an entire cloſure and preſſure of the lips, and is pronounced by forcing them open with a ſtrong breath.

In *Muſic* b is uſed to denote a flat, or the lowering of a ſound by a ſemi-tone minor. Thus A^b or $^b A$ is the flat of A, or the ſemi-tone minor below A. B, b, *quadro*, a mark that in the ſcale of muſical notes, ſignifies the ſound which is a tone above A, and a ſemi-tone below C.

B is alſo uſed as a contraction for *Bachelor*; as B. A. *Bachelor of Arts*, B. L L. and B. D.

BAAL, the ſame as BEL, or BELUS: an idol of the Chaldeans, and Phœnicians, or Canaanites. The former worſhipped Mars under this name, according to Joſephus; who ſpeaking of Thurus, the ſucceſſor of Ninus, ſays, "To this Mars the Aſſyrians erected the firſt ſtatue, and worſhipped him as a god, calling him *Baal*." It is probable the Phœnicians worſhipped the ſun under the name of Baal: for Joſiah, willing to make ſome amends for the wickedneſs of Manaſſiah, in worſhipping Baal and all the hoſt of heaven, *put to death the idolatrous prieſts that burnt incenſe unto Baal, to the ſun and to the moon, and to the planets, and to all the hoſt of heaven. He likewiſe took away the horſes the kings of Judah had given to the ſun, and burnt the chariots of the ſun with fire.* 2 Kings, xxiii. 5. 11.

Some learned men think that the Baal of the Phœnicians is the Saturn of the Greeks; which is probable enough from the conformity there is between the human ſacrifices offered to Saturn, and thoſe which the Scripture tells us were offered to Baal. Others are of opinion, that Baal was the Pœnician or Tyrian Hercules, a god of great antiquity in Phœnicia.

BAAL-BERITH, the god of the Shechemites. Baal-berith ſignifies *Lord of the Covenant*. The idolatrous Iſraelites, we are told, *made Baal-berith their god*. Judg. viii. 33.

BAAL-ZEBUB, *Beel-zebub*, or *Belzeoub*, the idol or god of the Ekronites. In Scripture he is called the *Prince of Devils*. His name is rendered the *Lord of Flies*, or the *God-fly*; which ſome think was a mock appellation beſtowed on him by the Jews. He had a famous temple and oracle at Ekron. Ahaziah king of Iſrael, having fallen from the terraſs of his houſe, into a lower room, and being dangerouſly hurt, ſent to conſult this delty, to know if he ſhould be cured of his wounds. The worſhip of this falſe god muſt have prevailed in our Saviour's time, ſince the Jews accuſed him of driving out devils in the name of *Belzebub* their prince. Scaliger derives the name of this deity from *Baalim-zeba-him*, which ſignifies the *Lord of ſacrifices*.

BABEL, a city and tower undertaken to be built by the whole human race ſoon after the flood, remarkable for the miraculous fruſtration of the attempt by the confuſion of languages. As to the ſituation of ancient Babel, moſt authors are of opinion that it was exactly in the place where the celebrated city of Babylon afterwards ſtood. That it was in the ſame country, appears indiſputably from Scripture; but that it was exactly in the ſame place is what cannot be proved, nor is it a matter of any conſequence.

Authors have been much divided about the motive by which the whole race of mankind were induced to join as one man in ſuch an undertaking. Some have imagined that it was out of fear of a ſecond deluge; others, that they knew beforehand that they were to be diſperſed through all the different countries of the world, and built this tower in order to defeat the deſigns of the Deity, becauſe having a tower of ſuch vaſt height as they propoſed, thoſe who were at a diſtance could eaſily find their way back again. Had either of theſe been their deſign, however, it is probable they would have choſen an eminence rather than a plain for the ſituation of their tower, or indeed, that they would have choſen ſome high mountain ſuch as Ararat for their mark, rather than any tower at all; for though it is ſaid that they deſigned the top of their tower to reach to heaven, we can ſcarce ſuppoſe them to have been ſo abſurd, as to imagine this poſſible in the ſenſe we underſtand it; and muſt therefore rather take it in the limited ſenſe in which it is often uſed by Moſes and his countrymen, where they ſpeak of cities walled up to heaven. Others there are, who imagine that the top of this tower was not to reach up to heaven, but to be conſecrated to the heavens, *i. e.* to the worſhip of the ſun, moon, and ſtars; of the fire, air, &c. and other natural powers as deities; and therefore, that the true Deity interpoſed in order to prevent a total and irrecoverable defection.

BABOON, a ſpecies of the Genus Simia, in the Syſtem of *Mammalia*. For deſcription of the Genus and ſeveral Species, ſee the Article *Simia*. For Claſſification, ſee the Syſtem. For repreſentation of this Species, ſee Plate I. Genus 2. Species 6.

BABYROUSSA, a ſpecies of the *genus Sus*, in the ſyſtem of MAMMALIA. For deſcription of the Genus and principal Species, ſee the article SUS. For repreſentation of the Babyrouſſa, ſee Plate X. Order 6, Genus 35, Species 5.

BACCHANALIA, feaſts celebrated in honour of Bacchus by the ancients. The two moſt remarkable were called the *greater* and leſſer. The latter, called *Lenæa*, from a word ſignifying a *wine-preſs*, were held in the open fields about autumn; the greater, called *Dionyſia*, from one of the names of Bacchus, were celebrated in the city, about the ſpring-time. Both theſe feaſts were accompanied with games, ſpectacles, and theatrical repreſentations, and it was at this time the poets contended for the prize of poetry. Thoſe who were initiated into the celebration of theſe feaſts, repreſented ſome Silenus; others, Pan; others, Satyrs. Men and women

women met promiſcuouſly, all perfectly naked, except only for the vine leaves, and cluſters of grapes, which bound their heads and hips; here they danced and jumped tumultuouſly, and with ſtrange geſticulations, ſung hymns to Bacchus, till being weary and giddy, they tumbled down. See the Article BACCHUS.

BACCHUS, in Heathen mythology, the god of wine, with whoſe fabulous adventures every ſchool-boy is acquainted. He is repreſented under a figure of a jolly beardleſs youth, crowned with ivy and vine leaves; a ſpear wrapped with the ſame, in one hand, and with grapes, or a cup, in the other. This perſonage is ſeldom named in modern times, but as a ſenſual encourager of feaſt and jollity; but he was regarded in a more reſpectable light by the ancients, who worſhipped him in different countries under the following appellations; in Egypt he was called *Oſiris*; in Myſia, *Fanaces*; in India, *Dionyſius*; *Liber*, throughout the Roman dominions; *Adoneus*, in Arabia; and *Pentheus*, by the Lucanians. Mythologiſts furniſh reaſons for all theſe different names given to the ſame god, which may be ſeen in the ſecond volume of Banier's Mythology.

Dr. Burney obſerves, that the dithyrambics which gave birth to dramatic repreſentations, are as ancient as the worſhip of Bacchus in Greece; and there is little doubt but that the ceremonies of his myſteries gave riſe to the pomp and illuſions of the theatre. Many of the moſt ſplendid exhibitions upon the ſtage for the entertainment of the people of Athens and Rome, being performed upon the feſtivals of Bacchus, gave occaſion to the calling all thoſe that were employed in them, whether for ſinging, dancing, or reciting, *ſervants of Bacchus*.

Pauſanias, in his Attics, ſpeaks of a place at Athens conſecrated to *Bacchus the finger*; thus named, he ſays, for the ſame reaſon as Apollo is called the *chief* and *conductor* of the muſes. Whence it ſhould ſeem that Bacchus was regarded by the Athenians not only as god of wine, but of ſong; and it muſt be owned, that his followers, in their cups, have been much inclined to ſinging ever ſince. Indeed, we are certain, that in none of the orgies, proceſſions, triumphs, and feſtivals, inſtituted by the ancients to the honour and memory of this prince of *bons vivans*, muſic was forgotten, as may be ſtill gathered from ancient ſculpture, where we find not only that muſicians, male and female, regaled him with the lyre, the flute, and with ſong; but he was accompanied by fawns and ſatyrs, playing upon timbrels, cymbals, bagpipes, and horns: theſe Suidas calls his minſtrels; and Strabo gives them the appellations of *Bacchi*, *Sileni*, *Satyri*, *Bacchæ*, *Lenæ*, *Thyæ*, *Mamillones*, *Naiades*, *Nymphæ*, and *Tityri*. Theſe repreſentations have furniſhed ſubjects for the fineſt remains of ancient ſculpture; and the moſt voluptuous paſſages of ancient poetry are deſcriptions of the orgies and feſtivals of Bacchus.

BACHELOR, or BATCHELOR, a common term for a man not married, or who is yet in a ſtate of celibacy.—In England, there was a tax on bachelors, after 25 years of age, 12l. 10s. for a duke, a common perſon 1s. by 7 Will. III. 1695. In Britain, at preſent, they are taxed by an extra duty on their ſervants. Every man of the age of 21 years and upwards, never having been married, who ſhall keep one male ſervant or more, ſhall pay 1l. 5s. for each above or in addition to the ordinary duties leviable for ſervants. Every man of the age of 21 years and upwards, never having been married, keeping one female ſervant, ſhall pay 2s. 6d. in addition to the former 2s. 6d.; 5s. in addition for each, if he has two female ſervants; and 10s. in addition for each for three or more female ſervants.

Knights-BACHELORS, the moſt ancient, but the loweſt order of knights in England; known by the name of *knights* only. They are ſtyled *knights bachelors*, either (according to ſome) as denoting their degree, *quaſi bas chevaliers*; or, according to others, becauſe this title does not deſcend to their poſterity.

The cuſtom of the ancient Germans was to give their young men a ſhield and a lance in the great council: this was equivalent to the *toga virilis* of the Romans. Before this, they were not permitted to bear arms, but were accounted as part of the father's houſehold; after it, as part of the public. Hence ſome derive the uſage of knighting, which has prevailed all over the weſtern world ſince its reduction by colonies, from thoſe northern heroes. Knights are called in Latin *equites aurati*: *aurati*, from the gilt ſpurs they wore; and *equites*, becauſe they always ſerved on horſeback: for it is obſervable, that almoſt all nations call their knights by ſome appellation derived from an horſe. They are alſo called in our law *milites*, becauſe they formed a part, or indeed the whole of the royal army, in virtue of their feodal tenures; one condition of which was, that every one who held a knight's fee (which in Henry II's time amounted to 20l. *per annum*) was obliged to be knighted, and attend the king in his wars, or pay a fine for his non compliance. The exertion of this prerogative, as an expedient to raiſe money in the reign of Charles I. gave great offence, though warranted by law and the recent example of Queen Elizabeth. At the Reſtoration, it was, together with all other military branches of the feodal law, aboliſhed: and it now only exiſts as an honorary title; though on account of its indiſcriminate attainment, not very generally regarded. It is conferred indiſcriminately upon gowſmen, burghers, and phyſicians, by the king's lightly touching the perſon, who is then kneeling, upon the right ſhoulder, with a drawn ſword, and ſaying *Riſe Sir*. See the article KNIGHT.

BACHELORS, in an univerſity ſenſe, are perſons that have attained to the baccalaureate, or who have taken the firſt degree in the liberal arts and ſciences.

The degree of bachelor was firſt introduced in the 13th century, by Pope Gregory IX, but it remains ſtill unknown in Italy. At Oxford, before a perſon is entitled to the degree of *bachelor of arts*, he muſt have ſtudied there four years; three years more to become maſter of arts; and ſeven more to commence bachelor of divinity. At Cambridge to commence bachelor of arts, he muſt have been admitted near four years; and above three years more before he commence maſter; and ſeven more ſtill to become bachelor of divinity. He may commence bachelor of law after having ſtudied it ſix years. Bachelors in the canon law are admitted after two years ſtudy in the ſame, and ſuſtaining an act according to the forms. A bachelor of phyſic muſt have ſtudied two years in medicine, after having been four years maſter of arts in the univerſity, and have ſtood an examination; after which he is inveſted with the fur, in order to be licenſed.

BACK-*bone*. For a copious account, ſee the Syſtem of Anatomy, Part I. Sec. 3. Art. 1.

BACK-*ſtaff*, in *Navigation*, an inſtrument, by the French called the *Engliſh Quadrant*: it was invented by Capt. Davis; and is of good uſe in taking the ſun's altitude at ſea. It is called alſo the *Sea Quadrant*, or Davis's Quadrant. For its deſcription and uſes, ſee the Syſtem of Navigation, Part III. Sect. 1. For repreſentation, ſee the Plate annexed, Fig. 11.

BACON, ſwine's fleſh ſalted and dried in the chimney. Writers on this branch of œconomics, give rules for the hanging, the ſalting, and curing of *bacon*, larding with *bacon*, &c. This appears to be in general an extremely improper and unwholeſome aliment, eſpecially for people who do not uſe great exerciſe; for thoſe who do, may almoſt eat any thing without injury. Swine's fleſh, conſidered as an aliment, is none of the beſt: and when hardened by ſalt, and dried by ſmoke, it is rendered more indigeſtible, and, in conſequence of that, productive of obſtructions in a very great degree. We may add, that the fat of *bacon* frequently becomes rancid and acrimonious, and often even excoriates the mouth and throat.

Old hiſtorians and law-writers ſpeak of the *ſervice of the bacon*, a cuſtom in the manor of Whichenacre in Staffordſhire, and priory of Dunmore in Eſſex; in the former of which places, by an ancient grant of the lord, a flitch of bacon, with half a quarter of wheat, was to be given to every married couple who could ſwear that, having been married a year and a day, they would never within that time have once exchanged their mate for any other perſon on earth, however richer, fairer, or the like. But they were to bring two of their neighbours to ſwear with them that they believed they ſwore the truth. On this the lord of another neighbouring manor, of Rudlow, was to find a horſe ſaddled, and a ſack to carry the bounty in, with drums and trumpets, as far as a day's journey out of the manor: all the tenants of the manor being ſummoned to attend, and pay ſervice to the bacon. The bacon of Dunmore, firſt erected under Henry III. was on much the ſame footing: only the tenor of the oath was, that the parties had never once repented, or wiſhed themſelves unmarried again.

BADGER, the Engliſh name of a ſpecies of the genus *Urſus*, in the Syſtem of Mammalia. For deſcription of the genus and ſeveral ſpecies, ſee *Urſus*. For repreſentation of this ſpecies, ſee Plate V. Genus 16. Species 2.

BAG-PIPE, a muſical inſtrument of the wind kind, chiefly uſed in Scotland and Ireland. The peculiarity of the bag-pipe, and from which it takes its name, is, that the air which blows it is collected into a leathern bag, from whence it is preſſed out by the arm into the pipes. Theſe pipes conſiſt of a baſs and tenor, or rather treble; and are different according to the ſpecies of the pipe. The baſs part is called the *drone*, and the tenor or treble part the *chanter*. In all the ſpecies, the baſs never varies from its uniform note, and therefore very deſervedly gets the name of *drone*; and the compaſs of the chanter is likewiſe very limited. There is a conſiderable difference between the Highland and Lowland bagpipe of Scotland; the former being blown with the mouth, and the latter with a ſmall bellows; though this difference is not eſſential, every ſpecies of bag-pipe being capable, by a proper conſtruction of the reeds, of producing muſic either with the mouth or bellows.

The *Highland Bag-Pipe*. This conſiſts of a chanter and two ſhort drones, which ſound in uniſon the loweſt note of the chanter except one. This is exceedingly loud, and almoſt deafening, if played in a room; and is therefore moſtly uſed in the fields, for marches, &c. It requires a prodigious blaſt to ſound it; ſo that thoſe unaccuſtomed to it cannot imagine how Highland pipers can continue to play for hours together, as they are often known to do. For the ſame reaſon, thoſe who uſe the inſtrument are obliged either to ſtand on their feet or walk when they play. This inſtrument hath but nine notes; its ſcale, however, hath not yet been reduced to a regular ſtandard by comparing it with that of other inſtruments,

inſtruments, ſo that we can ſay nothing about its compaſs. Thoſe who are beſt acquainted with it, however, affirm that it plays only the natural notes, without being capable of variation by flats or ſharps."

As to the origin of bag-pipe muſic, ſome are of opinion that it is to be derived from the Danes; but Mr. Pennant thinks differently, and gives the following reaſons for deriving it from Italy.

"Neither of theſe inſtruments (the Highland and Lowland pipe above deſcribed) were the invention of the Danes, or, as is commonly ſuppoſed, of any of the northern nations; for their ancient writers prove them to have been animated by the *clangor tubarum*. Notwithſtanding they have had their ſæck-pipe long amongſt them, as their old ſongs prove, yet we cannot allow them the honour of inventing this melodious inſtrument; but muſt aſſert, that they borrowed it from the invaded Caledonians. We muſt ſtill go farther, and deprive even that ancient race of the credit; and derive its origin from the mild climate of Italy, perhaps from Greece.

"There is now in Rome a moſt beautiful bas relievo, a Grecian ſculpture of the higheſt antiquity, of a bag-piper playing on his inſtrument, exactly like a modern Highlander. The Greeks had their Ασκαυλης or inſtrument, compoſed of a pipe or blown-up ſkin: the Romans in all probability borrowed it from them, and introduced it among their ſwains, who ſtill uſe it under the names of *piva* and *cornu-muſa*.

The Bag-pipe appears to have been an inſtrument of great antiquity in Ireland, though it is uncertain whence they derived it. Mr. Pennant, by means of an antique found at Richborough, in Kent, has determined that the bag-pipe was introduced at a very early period into Britain; whence it is probable, that both Iriſh and Danes might borrow the inſtrument from the Caledonians with whom they had ſuch frequent intercourſe. Ariſtides Quintilianus informs us, that it prevailed in the Highlands in very early ages; and indeed the genius of the people ſeems to render the opinion highly probable. The attachment of that people to their muſic called *pibrachs* is almoſt incredible, and on ſome occaſions is ſaid to have produced effects little leſs marvellous than thoſe aſcribed to the ancient muſic. At the battle of Quebec in 1760, while the Britiſh troops were retreating in great diſorder, the general complained to a field-officer in Fraſer's regiment, of the bad behaviour of his corps. "Sir, (ſaid he, with ſome warmth) you did very wrong in forbidding the pipers to play this morning, nothing encourages the Highlanders ſo much in the day of action. Nay, even now they would be of uſe." "Let them blow like the devil, then (replies the general), if it will bring back the men." The pipers were then ordered to play a favourite martial air; and the Highlanders, the moment they heard the muſic, returned and formed with alacrity in the rear. In the late war in India, Sir Eyre Coote, aware of the attachment of the Highlanders to their favourite inſtrument, gave them 50l. to buy a pair of bag-pipes after the battle of Porto Nuovo.

The Lowland pipe was reformed, and the muſic improved, by George Mackie, who is ſaid to have attended the college of Skie ſeven years. He had before been the beſt performer on that inſtrument in that part of the country where he lived; but, while attending the college at Skie, he adapted the graces of the Highland muſic to the Lowland pipe. Upon his return he was heard with aſtoniſhment and admiration; but unluckily, not being able to commit his improvements to writing, and indeed the nature of the inſtrument ſcarce admitting of it, the knowledge of this kind of muſic hath continued to decay ever ſince, and will probably ſoon wear out altogether. What contributes much to this is, that bag-pipers, not content with the nine natural notes which their inſtrument can play eaſily, force it to play tunes requiring higher notes, which diſorders the whole inſtrument in ſuch a manner, as to produce the moſt horrid diſcords; and this practice brings, though undeſervedly, the inſtrument itſelf into contempt.

BAIL, BALLIUM, (from the French *bailler*, which comes of the Greek βαλλειν, and ſignifies to deliver into hands), is uſed in our common law for the freeing or ſetting at liberty of one arreſted or impriſoned upon any action, either civil or criminal, on ſurety taken for his appearance at a day and place certain. The reaſon why it is called *bail*, is becauſe by this means the party reſtrained is delivered into the hands of thoſe that bind themſelves for his forthcoming, in order to a ſafe keeping or protection from priſon; and the end of bail is to ſatisfy the condemnation and coſts, or render the defendant to priſon.

With reſpect to bail in civil caſes, it is to be obſerved, there is both common and ſpecial bail. Common bail is in actions of ſmall concernment, being called *common*, becauſe any ſureties in that caſe are taken; whereas, in cauſes of greater weight, as actions upon bonds, or ſpeciality, &c. where the debt amounts to 10l. *ſpecial* bail or ſurety muſt be taken, ſuch as ſubſidy men at leaſt, and they according to the value.

The commitment of a perſon being only for ſafe cuſtody, wherever bail will anſwer the ſame intention, it ought to be taken; as in moſt of the inferior crimes: but in felonies, and other offences of a capital nature, no bail can be a ſecurity equivalent to the actual cuſtody of the perſon. For what is there that a man may not be induced to forfeit, to ſave his own life? and what ſatisfaction or indemnity is it to the public, to ſeize the effects of them who have bailed a murderer, if the murderer himſelf be ſuffered to eſcape with impunity? Upon a principle ſimilar to which, the Athenian magiſtrates, when they took a ſolemn oath never to keep a citizen in bonds that could give three ſureties of the ſame quality with himſelf, did it with an exception to ſuch as had embezzled the public money, or been guilty of treaſonable practices.

Bail may be taken either in court, or, in ſome particular caſes, by the ſheriff or other magiſtrate; but moſt uſually by the juſtices of the peace. To refuſe or delay to bail any perſon bailable is an offence againſt the liberty of the ſubject, in any magiſtrate, by the common law; as well as by the ſtatute Weſtm. 1. 3 Edw. I. c. 15. and the *habeas corpus* act, 31 Car. II. c. 2. And, leſt the intention of the law ſhould be fruſtrated by the juſtices requiring bail to a greater amount than the nature of the caſe demands, it is expreſsly declared by ſtatute 1 W. & M. ſt. 2. c. 1. that exceſſive bail ought not to be required; though what bail ſhall be called *exceſſive*, muſt be left to the courts, on conſidering the circumſtances of the caſe, to determine. And on the other hand, if the magiſtrate takes inſufficient bail he is liable to be fined, if the criminal doth not appear. In *civil* caſes, every defendant is bailable.

BAIL *above*, or BAIL *to the action*, ſucceeds the return of the writ, or the appearance of the perſon *bailed*. The perſons who put in this *bail*, muſt be at leaſt two in number, and enter into a recognizance, whereby they do jointly and ſeverally undertake, that if the defendant be condemned in the action, he ſhall pay the coſts and condemnation, or render himſelf a priſoner, or that they will pay it for him; which recognizance is tranſmitted to the court in a ſlip of parchment, called the *bail-piece*. And if required, the *bail* muſt juſtify themſelves by ſwearing that they are houſekeepers, and each of them worth double the ſum for which they are *bail*, after payment of all their debts.

BAILIFF, from the French word *bayliff*, that is, *præfectus provinciæ*: and as the name, ſo the office itſelf was anſwerable to that of France prior to the revolution; where there were eight parliaments, or high courts, from whence lay no appeal, and within the precincts of the ſeveral parts of that kingdom, which belonged to each parliament, there were ſeveral provinces to which juſtice was adminiſtered by certain officers called *bayliffs*. In England there are ſeveral counties in which juſtice hath been adminiſtered to the inhabitants by the officer who is now called *ſheriff*, or *viſcount* (one of which names deſcends from the Saxons, the other from the Normans;) and though the ſheriff is not called *bailiff*, yet it is probable that was one of his names alſo; becauſe the county is often called *baſtiva*. And in the ſtatute of Magna Charta, cap. 28. and 14 Edw. 3. c. 9. the word *bailiff* ſeems to compriſe as well ſheriffs as bailiffs of hundreds. As the realm is divided into counties, ſo every county is divided into hundreds; within which in ancient times the people had juſtice miniſtered to them by the officers of every hundred. But now the hundred courts, except certain franchiſes, are ſwallowed in the county courts; and the bailiff's name and office is grown into contempt, they being generally officers to ſerve writs, &c. within their liberties. Though in other reſpects the name is ſtill in good eſteem: for the chief magiſtrates in divers towns are called *bailiffs* or *bailies:* and ſometimes the perſons to whom the king's caſtles are committed are termed *bailiffs*, as the *bailiff of Dover caſtle*, &c.

Of the ordinary bailiffs there are ſeveral ſorts, viz. ſheriff's bailiffs, bailiffs of liberties, &c. Sheriff's bailiffs, or ſheriff's officers, are either bailiffs of hundreds, or ſpecial bailiffs. Bailiffs of hundreds are officers appointed over thoſe reſpective diſtricts by the ſheriffs, to collect fines therein; to ſummon juries: to attend the judges and juſtices at the aſſiſes, and quarter ſeſſions; and alſo to execute writs and proceſs in the ſeveral hundreds. But as theſe are generally plain men, and not thoroughly ſkilful in this latter part of their office, that of ſerving writs, and making arreſts and executions, it is now uſual to join ſpecial bailiffs with them, who are generally mean perſons employed by the ſheriffs on account only of their adroitneſs and dexterity in hunting and ſeizing of their prey.

Water-BAILIFF, is an officer anciently eſtabliſhed in all port-towns, for the ſearching of ſhips; as appears from 28 Hen. VI. cap. 5. There is ſuch an officer ſtill on foot in the city of London, who ſuperviſes and ſearches all fiſh brought thither; and gathers the toll ariſing from the river Thames.—He attends alſo on the lord-mayor in his expeditions by *water*, and hath the principal care of marſhalling the gueſts at the table.—He alſo arreſts men for debt, or other perſonal or criminal matters, on the river Thames, by warrant of his ſuperiors.

BAILIWICK, that liberty which is exempted from the ſheriff of the county; over which liberty the lord thereof appoints his own bailiff, with a like power within his precinct as an under ſheriff exerciſes under the ſheriff of the county: or it ſignifies the precinct of a bailiff, or the place within which his juriſdiction is terminated.

BAIT, in *Fiſhing*. *Baits* make a capital article in angling; on the choice whereof much of the ſport depends; different ſeaſons and different game having their appropriate *baits*. For a diſtinct and intelligible view of the neceſſary Baits, whether Flies, Paſtes, Worms, Fiſh, or Inſects, ſee the Table under the Article

ANGLING, which explains the appropriate Baits for every month in the year, as well as the Fiſh they are intended to catch.

BAITING, the act of ſmaller or weaker beaſts attacking and harraſſing greater and ſtronger. In this ſenſe we hear of the baiting of bulls or bears by maſtiffs, or bull-dogs with ſhort noſes, that they may take the better hold. Utility is urged in juſtification of *bull-baiting*. It is ſaid, by the vulgar, the exerciſe of the animal makes its fleſh tender and more digeſtible. In reality, it diſpoſes it for putrefaction; ſo that, unleſs taken in time, baited fleſh is ſoon loſt. But a ſpirit of barbariſm had the greateſt ſhare in ſupporting the ſport; bulls are kept on purpoſe, and exhibited as ſtanding ſpectacles for the public entertainment. The poor beaſts have not fair play: they are not only tied down to a ſtake, with a collar about their necks, and a ſhort rope, which gives them not above four or five yards play; but they are diſarmed too, and the tips of their horns cut off, or covered with leather, to prevent their hurting the dogs. In this ſport, the chief aim of the dog is to catch the bull by the noſe, and hold him down; to which end he will even creep on his belly; the bull's aim, on the contrary, is, with equal induſtry, to defend his noſe; in order to which, he thruſts it cloſe to the ground, where his horns are alſo in readineſs to toſs the dog.---Bull-baiting was firſt introduced into England as an amuſement in the reign of king John, about 1209.

Whales are baited by a kind of fiſh called *oriæ*, or *killers*; ten or twelve of which will attack a young whale at once, and not leave him till he is killed. Philoſoph. Tranſ. No. 287. p. 265.

BAKING, the art of preparing bread, or reducing meals of any kind, whether ſimple or compound, into bread. See the article BREAD.

The various forms of baking among us may be reduced into two, the one for unleavened, the other for leavened bread. For the firſt, the chief is manchet-baking; the proceſs whereof is as follows. The meal, ground and boulted, is put into a trough; and to every buſhel are poured in about three pints of warm ale, with barm and ſalt, to ſeaſon it. This is kneaded well together with the hands through the brake; or, for want thereof, with the feet, through a cloth; after which, having laid an hour to ſwell, it is moulded into manchets; which, ſcorched in the middle, and pricked up at top, to give room to riſe, are baked in the oven by a gentle fire.---For the ſecond, ſometimes called *cheat-bread baking*, it is thus: Some leaven (ſaved from a former batch) filled with ſalt, laid up to ſour, and at length diſſolved in water, is ſtrained through a cloth into a hole made in the middle of the heap of meal in the trough; then it is worked with ſome of the flour into a moderate conſiſtence: this is covered up with meal, where it lies all night; and in the morning the whole heap is ſtirred up, and mixed with a little warm water, barm, and ſalt, by which it is ſeaſoned, ſoftened, and brought to an even leaven: it is then kneaded, moulded, and baked, as before.

Method of raiſing a buſhel of flour, with a tea-ſpoonful of barm; by James Stone, of Amport in Hampſhire.---Suppoſe you want to bake a buſhel of flour, and have but one tea-ſpoonful of barm. Put your flour into your kneading-trough or trendle; then take about three quarters of a pint of warm water, and take the tea-ſpoonful of thick ſteady barm and put it into the water, ſtir it until it is thoroughly mixed with the water: then make a hole in the middle of the flour, large enough to contain two gallons of water, pour in your ſmall quantity; then take a ſtick about two feet long, (which you may keep for that purpoſe), and ſtir in ſome of the flour, until it is as thick as you would make batter for a pudding; then ſtrew ſome of the dry flour over it, and go about your uſual buſineſs for an hour; then take about a quart of warm water more, and pour in; for in one hour you will find that ſmall quantity raiſed ſo, that it will break through the dry flour which you ſhook over it; and when you have poured in the quart of warm water, take your ſtick as before, and ſtir in ſome more flour, until it is as thick as before; then ſhake ſome more dry flour over it, and leave it for two hours more, and then you will find it riſe and break through the dry flour again; then you may add three quarts or a gallon of water more, and ſtir in the flour, and make it as thick as at firſt, and cover it with dry flour again: in about three or four hours more you may mix up your dough, and then cover it up warm; and in four or five hours more you may put it in the oven, and you will have as light bread as though you had put a pint of barm. It does not take above a quarter of an hour more time than the uſual way of baking, for there is no time loſt but that of adding water three or four times.

The author of this method aſſures us, that he conſtantly bakes this way in the morning about ſix or ſeven o'clock, puts the flour out, and puts this ſmall quantity of barm into the before-mentioned quantity of water, in an hour's time ſome more, in two hours more a greater quantity, about noon makes up the dough, and about ſix in the evening it is put into the oven, and he has always good bread, never heavy nor bitter.

When you find, he ſays, your body of flour ſpunged large enough, before you put in the reſt of your water, you ſhould, with both your hands, mix that which is ſpunged and the dry flour all together, and then add the remainder of warm water, and your dough will riſe the better and eaſier.

The reaſon he aſſigns why people make heavy bread, is not becauſe they have not barm enough, but becauſe they do not know that barm is the ſame to flour as fire is to fuel; that, as a ſpark of fire will kindle a large body by only blowing of it up, ſo will a thimble full of barm, by adding of warm water, raiſe or ſpunge any body of flour; for warm water gives freſh life to that which is before at work; ſo that the reaſon of making bread heavy is, becauſe the body ſpunged is not large enough, but was made up and put into the oven before it was ripe.

In regard to the difference of ſeaſons, he preſcribes, that in the ſummer you ſhould put your water blood warm; and in winter, in cold froſty weather, as warm as you can bear your hand in it without making it ſmart; being ſure you cover up your dough very warm in the winter, and your covering of it with dry flour every time you add warm water, will keep in the heat; when you have added ſix or eight quarts of warm water, as before-mentioned, in ſuch a gradual way, you will find all that body of flour which is mixed with the warm water, by virtue of that one tea-ſpoonful of barm, brought into great agitation, waxing or fermenting; for it is to the flour what the ſpirit is to the body, it ſoon fills it with motion.

The *bakers* of London make the nineteenth company. They were incorporated about the year 1307, and conſiſt of a maſter, four wardens, thirty aſſiſtants, and one hundred and forty-nine on the livery, beſides the commonalty. The *bakers* of London are under the juriſdiction of the lord-mayor and aldermen. A penalty is inflicted on *bakers* ſelling at a higher price than is ſet by the lord-mayor. See 3 Geo. II. cap. 29. and by 22 Geo. II. cap. 46. *bakers* are to ſet their marks on their bread. The aſſize of bread is regulated by ſeveral ſtatutes. See 8 Ann. cap. 18. 31 Geo. II. cap. 29. 32 Geo. II. cap. 18. 3 Geo. III. cap. 6 and 11.

The manner of *baking* at Otaheite, and in many iſlands of the South Seas, is as follows. They make fire by rubbing the end of one piece of dry wood upon the ſide of another, juſt as the carpenters whet a chiſſel; they then dig a pit in the ground about half a foot deep, and two or three yards in circumference; they pave the bottom of it with large pebble ſtones, which they lay very ſmooth and even, and then kindle a fire in it with dry leaves, and the huſks of the cocoa-nut. When the ſtones are properly heated, they take out the embers and rake out the aſhes on every ſide, then cover the ſtones with a layer of green cocoa-nut-tree leaves, and wrap up the animal that is to be dreſſed in the leaves of the plantain. If it be a ſmall hog or dog, they wrap them up whole: if large, they ſplit them. When placed in the pit, they cover it with hot embers, and lay upon them bread fruit and yams wrapped up in like manner in the leaves of the plaintain. Over theſe they ſpread the remainder of the embers, mixing them among ſome of the hot ſtones, with more cocoa-nut-tree leaves, and then cloſe up all with earth, ſo that the heat is kept in. After a time proportioned to what is dreſſing, the oven is opened, and the meat taken out, tender, full of gravy, and, as Captain Wallis thought, better in every reſpect than when it was dreſſed any other way. Having no veſſels in theſe iſlands that could bear the fire, the inhabitants of them had no idea of hot water, or its effects, and therefore always roaſted or baked their meat in the manner above related. See Bankes's Geography.

BALÆNA, or WHALE, a genus of the mammalia claſs, belonging to the order of cete. The characters of this genus are theſe: The balæna, in place of teeth, has a horny plate on the upper jaw, and a double fiſtula or pipe for throwing out water. The ſpecies are four, viz.

1. The myſtycetus, or common whale, which has many turnings and windings in its noſtrils, and has no fin on its back. This is the largeſt of all animals; it is even at preſent ſometimes found in the northern ſeas 90 feet in length; but formerly they were taken of a much greater ſize, when the captures were leſs frequent, and the fiſh had time to grow. Such is their bulk within the arctic circle; but in thoſe of the torrid zone, where they are unmoleſted, whales are ſtill ſeen 160 feet long. The head is very much diſproportioned to the ſize of the body, being one third the ſize of the fiſh: The under lip is much broader than the upper. The tongue is compoſed of a ſoft ſpongy fat, capable of yielding five or ſix barrels of oil. The gullet is very ſmall for ſo vaſt a fiſh, not exceeding four inches in width. In the middle of the head are two orifices, through which it ſpouts water to a vaſt height, and with a great noiſe, eſpecially when diſturbed or wounded. The eyes are not larger than thoſe of an ox, and when the cryſtalline humour is dried, it does not appear larger than a pea. They are placed towards the back of the head, being the moſt convenient ſituation for enabling them to ſee both before and behind; as alſo to ſee over them where their food is principally found. They are guarded by eye-lids and eye-laſhes, as in quadrupeds: and they ſeem to be very ſharp-ſighted.

Nor is their ſenſe of hearing in leſs perfection; for they are warned at great diſtance of any danger preparing againſt them. It would ſeem as if nature had deſignedly given them theſe advantages, as they multiply little, in order to continue their kind. It is true, indeed, that the external organ of hearing is not perceptible, for this might not only embarraſs them in their natural element; but as ſoon as the ſcarf-ſkin after mentioned is removed, a black ſpot is diſcovered behind the eye, and under that is the auditory canal, that leads to a regular apparatus for hearing. In ſhort the

animal

animal hears the ſmalleſt ſounds at very great diſtances, and at all times, except when it is ſpouting water; which is the time the fiſhers approach to ſtrike it. What is called *whalebone* adheres to the upper jaw; and is formed of thin parallel laminæ, ſome of the longeſt four yards in length: of theſe there are commonly 350 on each ſide, but in very old fiſh more; about 500 of them are of a length fit for uſe, the others being too ſhort. They are ſurrounded with long ſtrong hair, not only that they may not hurt the tongue, but as ſtrainers to prevent the return of their food when they diſcharge the water out of their mouths. The real bones of the whale are hard, porous, and full of marrow. Two great ſtrong bones ſuſtain the upper lip, lying againſt each other in the ſhape of an half moon.

The tail is broad and ſemilunar; and when the fiſh lies on one ſide, its blow is tremendous. The tail alone it makes uſe of to advance itſelf forward in the water; and it is ſurpriſing to ſee with what force and celerity its enormous bulk cuts through the ocean. The fins are only made uſe of for turning in the water, and giving a direction to the velocity impreſſed by the tail. The female alſo makes uſe of them, when purſued, to bear off her young, clapping them on her back, and ſupporting them by the fins on each ſide from falling. The penis is eight feet in length, incloſed in a ſtrong ſheath. The teats in the female are placed in the lower part of the belly.

In copulation, the female joins with the male, as is aſſerted, *more humano*; and once in two years feels the acceſſes of deſire.

The whale goes with young nine or ten months, and is then fatter than uſual; particularly when near the time of bringing forth. It is ſaid that the embryo, when firſt perceptible, is about 17 inches long, and white; but the cub, when excluded, is black, and about 10 feet long, ſhe generally produces one young one, and never above two. When ſhe ſuckles her young, ſhe throws herſelf on one ſide on the ſurface of the ſea, and the young one attaches itſelf to the teat.

Nothing can exceed the tenderneſs of the female for her offſpring; ſhe carries it with her wherever ſhe goes, and, when hardeſt purſued, keeps it ſupported between her fins. Even when wounded, ſhe ſtills claſps her young one; and when ſhe plunges to avoid danger, takes it to the bottom; but riſes ſooner than uſual, to give it breath again. The young ones continue at the breaſt for a year; during which time, they are called, by the ſailors, *ſhort-heads*. They are then extremely fat, and yield above 50 barrals of blubber. The mother at the ſame time is equally lean and emaciated. At the age of two years they are called *ſtunts*, as they do not thrive much immediately after quitting the breaſt: they then yield ſcarce above 20 or 24 barrels of blubber: from that time forward they are called *ſkull-fiſh*, and their age is wholly unknown.

Every ſpecies of whale propagates only with thoſe of its own kind, and does not at all mingle with the reſt: however they are generally ſeen in ſhoals, of different kinds together, and make their migrations in large companies from one ocean to another. They are gregarious animals; which implies their want of mutual defence againſt the invaſions of ſmaller, but more powerful fiſhes. It ſeems aſtoniſhing, therefore, how a ſhoal of theſe enormous animals find ſubſiſtence together, when it would ſeem that the ſupplying even one with food, would require greater plenty than the ocean could furniſh. To increaſe our wonder, we not only ſee them herding together, but uſually find them fatter than any other animals of whatſoever element. We likewiſe know that they cannot ſwallow large fiſhes, as their throat is ſo narrow, that an animal larger than an herring could not enter. How then do they ſubſiſt and grow ſo fat? A certain ſort of ſmall ſnail, or (as Linnæus ſays) the *meduſa*, or ſea-blubber, is ſufficient for this ſupply. Content with this ſimple food, it purſues no other animal, leads an inoffenſive life in its element, and is harmleſs in proportion to its ſtrength to do miſchief.

As the whale is an inoffenſive animal, it is not to be wondered that it has many enemies, willing to take advantage of its diſpoſition, and inaptitude for combat. There is a ſmall animal of the ſhell-fiſh kind, called the *whale-louſe*, that ſticks to its body, as we ſee ſhells ſticking to the foul bottom of a ſhip. This inſinuates itſelf chiefly under the fins; and whatever efforts the great animal makes, it ſtill keeps its hold, and lives upon the fat, which it is provided with inſtruments to arrive at.

The ſword-fiſh, however, is the whale's moſt terrible enemy. "At the ſight of this little animal," ſays Anderſon, "the whale ſeems agitated in an extraordinary manner; leaping from the water as if with affright: wherever it appears, the whale perceives it at a diſtance, and flies from it in the oppoſite direction." For the manner of taking whales, ſee WHALE-FISHERY.

BALANCE, or BALLANCE, one of the ſix ſimple powers, in *Mechanics*, uſed principally for determining the equality, or difference of weights in heavy bodies, and conſequently their maſſes or quantities of matter.

The *balance* is of two kinds, viz. the *ancient* and *modern*. The *ancient* or *Roman*, called alſo *ſtatera Romana*, or *ſteelyard*, conſiſts of a lever or beam, moveable on a centre, and ſuſpended near one of its extremes: on one ſide the centre are applied the bodies of the weighed, and their weight is meaſured by the diviſion marked on the beam: on the other ſide is the place where a weight moveable along it keeps the *balance* in equilibrio. The *modern balance*, now ordinarily in uſe, conſiſts in a lever, or beam, ſuſpended exactly by the middle; to the extremes whereof are hung ſcales, or baſons. For the Conſtructions and Uſes of theſe Engines, ſee the Syſtem, Sect. 3. For the repreſentation of the ancient Balance, ſee Plate II. Fig. 1. For the modern Balance, ſee Plate II. Fig. 13.

BALANCE *of the air*, is uſed to denote the weight of that fluid, whereby, according to its known property, it preſſes where it is leaſt reſiſted, till it be equally adjuſted in all parts. See the Article ATMOSPHERE, and the Syſtem of AEROLOGY.

Aſſay BALANCE, is a nice *balance* uſed in determining the exact weight of minute bodies. Its ſtructure is very little different from that of the common ſort; except that it is made of the beſt ſteel, and fitted for moving with the ſmalleſt weight.

Hydroſtatical BALANCE, is an inſtrument for determining the ſpecific gravities of bodies. For the conſtruction and uſes, ſee the Syſtem of HYDROSTATICS, Part I. Sect. 2. For the repreſentation, ſee Plate I. Fig. 7.

BALANCE, in the *Accounts of Merchants*, is, when the debtor and creditor ſides of any diſtinct account are equal. In ſuch caſe the account is ſaid to be *balanced*. *Balance* of a merchant, or trader's books. This is a branch of the art of accountantſhip. In the method of keeping the books of traders, according to that excellent art of charge and diſcharge by double entry, ſuch books, if correctly kept, will always be fit for a general *balance*. For ſuch is the excellency of that method, that the books of themſelves muſt neceſſarily *balance* on the whole, though not in every diſtinct account throughout the ledger. For copious deſcription and rules, ſee the Syſtem of BOOK-KEEPING.

BALANCE *of Power*, in the *Political Syſtem*, originates from, and is maintained by, the alliances of different nations, as their circumſtances and intereſt may require.

BALANCE *of trade* denotes an equality between the value of commodities bought of foreigners, and the value of the native productions tranſported into other nations.

It is neceſſary that this *balance* be kept in trading nations: and if it cannot be made in commodities, it muſt in ſpecie. Hereby it is, that we know whether a nation gains or loſes by foreign trade; or any branch thereof: and conſequently whether that nation grows richer or poorer.

There are divers *methods of arriving at this knowledge*. 1. That moſt received is, by taking a ſtrict ſurvey of what proportion the value of the commodities exported bears to thoſe imported. If the exports exceed the imports, it is concluded that nation is in a gaining way, it being ſuppoſed that the overplus is imported in bullion, and ſo increaſes the treaſure of the nation. But this method is very uncertain, by reaſon of the difficulty of obtaining a true account either of the exports or imports. (1) Cuſtom-houſe books are no rule in this caſe; by reaſon of the running of goods, eſpecially many fine commodities of ſmall bulk, but great value: as point, lace, ribbands, ſilk, jewels, fine linens, &c. alſo wines, brandies, teas, and the like. (2) To which add various accidents which affect the ſtock either ſent out or brought in; as loſſes at ſea, markets, bankrupts, ſeizures, &c. (3) Then as to particular trades, there are divers countries to which the manufactures we ſend out are inconſiderable, yet the goods we import are neceſſary to the carrying on our trade in general; as the trade to Norway, &c. for timber and naval ſtores. Alſo the Eaſt India company, whoſe imports much exceed their exports; yet is their trade highly advantageous to the nation; as we ſell much of theſe imports to foreigners, and wear others, e. gr. callicoes and ſilks, in lieu of linens and ſilks from other countries, which would coſt us dearer.

2. The ſecond method is, by obſerving the courſe of exchange, which, if generally above the intrinſic value or par of the coins of foreign countries, ſhews that we not only loſe by ſuch exchanges, but that we loſe by the general courſe of our trade. But this method is imperfect; ſince we trade to many countries, with which there is no ſettled courſe of exchange.

3. A third way is, by obſerving the increaſe and diminution of our coin and bullion. But this is the leaſt obvious and palpable of any; for the money ſeems to vulgar eyes moſt plentiful when there is the leaſt occaſion for it; and more ſcarce as the occaſions for employing it are more numerous and advantageous; by which means we ſeem to have moſt money when we have leaſt trade. Thus, e. gr. when the Eaſt India company have a great ſale to make, money is generally found to be ſcarce in London; becauſe the occaſion engages people to employ quantities which they had provided for that purpoſe. So, a high rate of intereſt will make money ſeem ſcarce, becauſe every man, as ſoon as he makes up a ſmall ſum, employs it in the purchaſe of ſtock.

4. The fourth method (which is Sir Joſ. Child's) is derived from the increaſe or the diminution of our trade and ſhipping in general: for if theſe diminiſh, whatever profit particular men may make, the nation loſes; and *vice verſa*. He lays it down as an infallible rule, that in all parts of the world wherever trade is great, and continues ſo, and grows daily greater, and the ſhipping increaſes for a ſucceſſion of ages, that trade muſt be nationally profitable. Even in the caſe of a merchant, who, by driving a great trade, ruins himſelf; though he loſe, what a multitude are gainers by him, as the king and cuſtom-houſe officers; beſides ſhipwrights, butchers, brewers, bakers, rope-makers, porters, carmen, manufacturers, mariners, &c.

BALE *goods* ſignify, among the Engliſh merchants, ſuch goods

as ſaltpetre, pepper, cotton, raw ſilk, &c.

BALISTES, in amphibiology, a genus of fiſhes belonging to the order of amphibia nantes. The moſt remarkable ſpecies is the monoceros, whoſe head-fin conſiſts of but one ray, and the tail-rays are carinated. It is called the unicorn-fiſh by Cateſby; who informs us, that the guts of this fiſh are full of ſmall ſhells and coralline ſubſtances, which by the ſtrength and hardneſs of its jaws it is enabled to grind very ſmall. Theſe fiſh, he adds, are not eaten, being accounted poiſonous. They moſtly frequent thoſe ſeas, among the Bahama iſlands, where the corals are in greateſt plenty.

BALLS, in electricity. Mr. Canton's balls are two pieces of cork, or pith of elder, nicely turned in a lathe, to the ſize of a ſmall pea, and ſuſpended by fine linen threads: intended as electrometers, and of excellent uſe to diſcover ſmall degrees of electricity, to obſerve the changes of it from poſitive to negative, and *vice verſa*; and to eſtimate the force of a ſhock before the diſcharge, ſo that the operator ſhall always be able to tell very nearly before the diſcharge, by knowing how high he has charged his jars, what the exploſion will be. Dr. Prieſtley's Hiſt. of Elect. 3d edit. 8vo. vol. ii. p. 102. For experiments with the electrified cork-ball electrometer, ſee the Syſtem of ELECTRICITY, Sect. 2. Art. 1.

BALLS *of fire in the air*, are meteors ſometimes ſeen paſſing over countries, and computed by philoſophers to be often at leaſt thirty miles high. They ſometimes burſt at that height; and though the air muſt be exceedingly rare there, yet the exploſion is heard at that diſtance, and for ſeventy miles round on the ſurface of the earth, &c. Does not this look as if a rare atmoſphere, almoſt a vacuum, was no bad conductor of ſound? Dr. Franklin's Works, p. 437. See the articles METEOR and AURORA BOREALIS.

BALLS. Naturaliſts ſpeak of a ſort of balls of hair covered over with a ſmooth ſhining coat, or ſhell, found in the ſtomachs of oxen, cows, calves, horſes, ſheep, and goats, particularly the chamois, or rupicapra. Bezoars have uſually ſome ſeed for a nucleus. The origin and formation of theſe balls are conteſted. See the article BEZOAR. Bartholin, and after him Dr. Plott, and others, attribute them to the creatures licking themſelves, and ſwallowing the hair, which being elaborated in the *retriculum*, becomes compacted together much after the manner that the wool of a hat is by the hand of the workman; and lying long in the ſtomach, have a thick tough coat, ſuperinduced by the plenty of ſlime it there meets with. Plott, l. c. Sect. 71.

Martial BALLS, in pharmacy, are a mixture of filings of iron and cream of tartar, formed into a ſolid conſiſtence and form of a ball, which is uſed to impregnate water or other liquids with iron diſſolved by the tartareous acid. To make theſe balls, one part of filings of iron and two parts powdered cream of tartar are mixed well together, and put into an earthen or iron veſſel, with ſome water. This mixture is to be ſtirred from time to time, till it becomes almoſt dry; and then it is to receive more water, and to be ſtirred as before. This treatment is to be continued till it acquires, when nearly dry, ſomewhat of the conſiſtence and tenacity of ſoftened roſin. Then it is to be rolled up in the form of a ball, which is generally kept tied up in a rag; and when intended to be uſed, is to be infuſed into water, till it gives ſome colour to that liquid. The infuſion of martial balls is tonic, vulnerary, diſcutient, and aperitive; and is employed both internally and externally. See the article IRON, and the Syſtem of CHYMISTRY, Part III. Chap. II. Sect. 3. Iron being ſoluble in all acids, is attacked in this preparation by the tartareous acid, which reduces it to a kind of neutral ſalt not cryſtallizable. This ſalt would remain liquid, and would form a ſoluble martial tartar, called *tartariſed tincture of Mars*. If proper proportions of filings of iron and cream of tartar be uſed, and treated long enough for an entire and complete combination, nothing would be obtained but a liquor or magma, which could not be preſerved in a ſolid form, but would be continually moiſt. Therefore, in the martial ball, there is a good deal of the cream of tartar and filings of iron not combined together, by which its ſolidity is preſerved.

BALLAD, or BALLET, a popular ſong containing the recital of ſome action, adventure, or intrigue. The French confine their ballads to ſtricter terms. A ballad, according to Richelet, is a ſong conſiſting of three ſtrophes, or ſtanzas, of eight verſes each, beſides a half ſtrophe; the whole in rhime, of two, three, or four verſes, with a burthen repeated at the end of each ſtrophe, as well as of the half ſtrophe. In the old Engliſh verſion of the Bible, the book of Canticles is intitled the ballet of ballets; which has given ſcandal to ſome Romiſh writers, as countenancing the opinion of thoſe who hold that book a ballet of love, or a recital of the amours between Solomon and his concubine, as Caſtalio and ſome others have conceived it to be.

Some have ſuggeſted that a collection of ballads is neceſſary to a miniſter, in order to learn the temper and inclinations of a people, which are here frequently uttered with great ſimplicity. The great Cecil, chief miniſter to Queen Elizabeth, is ſaid to have made a moſt ample collection of ballads, on this account.

A very ingenious political writer, Mr. Fletcher of Saltoun, ſays, that if he could but make the ballads of a nation, he would care very little who made the religion of it. There is a very curious collection of old Engliſh and Scottiſh ballads, publiſhed in 3 vols. 8vo. by Dr. Percy; in which, and in a diſſertation prefixed to Aikin's Collection of Songs, &c. the curious in this way may find abundance of entertainment and information concerning old ballads, and ballad-makers. See BARD.

BALLET, BALET, or BALETTO, a kind of dramatic poem, repreſenting ſome fabulous action or ſubject, divided into ſeveral entries: wherein ſeveral perſons appear, and recite things under the name of ſome deity, or other illuſtrious character. Ballet is more particularly uſed for a kind of comic dance, conſiſting of a ſeries of ſeveral airs of different kinds of movements, which together repreſent ſome ſubject or action. They were formerly performed chiefly by maſks, repreſenting ſylvans, tritons, nymphs, ſhepherds, and the like; and conſiſt of three parts, the entry, figure, and the retreat.

F. Meneſtrier has a treatiſe expreſs on ancient and modern ballets according to the rules of the ſtage; wherein he explains the nature of dancing according to Ariſtotle and the ancients.

BALLIAGE, a ſmall duty paid to the city of London, by aliens, and even denizens, for certain commodities exported by them; which they claim by their charter, dated the 5th of September, in the ſixteenth of Charles II. confirmed by the twentieth rule of the Book of Rates; and by 2 W. and M. cap. 8.

BALLOON, a name given to an aërоſtatic machine, employed for the purpoſe of aërial navigation. For the conſtruction of ſeveral of theſe machines, and the principles on which they are actuated, together with the reſult of different aërial voyages, ſee the Syſtem of AEROSTATION, throughout. For repreſentation of various Balloons, with the implements &c. ſee the plate annexed.

BALLUSTRADE, in architecture, an aſſemblage of one or more rows of balluſters, high enough to reſt the elbow on, fixed upon a terrace, or the top of a building, by way of ſecurity; ſometimes alſo to make a ſeparation between one part and another, as thoſe around altars, fonts, &c. See the Syſtem, Part II. Sect. 15.

BALSAM, properly denotes an oily, reſinous, and odorous ſubſtance, oozing from inciſions in certain plants; of ſovereign virtue in the cure of wounds, and divers other diſorders. They are liquid, but ſomewhat thick, and flow ſpontaneouſly from certain trees. If pure balſam be dropped on a woollen cloth, it may be waſhed off without leaving the leaſt ſtain, but adulterated balſam ſticks to the place. Pure balſam coagulates with milk, but adulterated balſam will not. True balſam dropped into water diſcovers its genuineneſs by ſpreading on the ſurface, imparting its taſte and ſmell; it is ſo thick, that the groſs parts at the top may be taken off with a needle. Theſe are called natural balſams, to diſtinguiſh them from compoſitions of the ſame name.

Balſams are only reſins in their liquid ſtate, which when combined with any conſiderable proportion of gum, are called gummy reſins. They are ſoluble in vinous ſpirits and oils, not acted upon by water, nor volatile in the heat of boiling water, fuſible in a ſmall degree of heat, and readily inflammable on the contact of any flaming or ignited body.

Balſams by yolks of eggs are rendered ſoluble in water; more elegantly ſtill by ſugar; and moſt elegantly, as eſſential oils alſo are, by the intervention of gums and mucilages; the ſolutions thus prepared are moſt permanent. Gum is the medium employed by nature herſelf to unite the reſinous and balſamic with the watery juices of vegetables. Of themſelves they have no ſmell; but they often retain, or have preſerved in them induſtriouſly, a part of the odorous principle, and are nevertheleſs looked upon as pure reſins. They derive both their liquidity and ſmell from a greater or leſs quantity of eſſential oil, which they contain, and which may be extracted by diſtillation.

Balſams may even be conſidered as true eſſential oils, which have loſt ſome of their odoriferous principle, and of their fineſt and moſt volatile part. When they are deprived of their remaining part of volatile oil, their *reſidua* exactly reſemble thoſe which remain after the rectification of eſſential oils. Their *reſidua* are true reſins, from the analyſis of which the ſame principles are obtained, as from natural reſins, which are themſelves nothing elſe but balſams exhauſted by time, or by the action of the air and of the ſun, of all their odoriferous and volatile parts. Neumann. Lewis. Macquer. See further on this ſubject in the Syſtem of CHYMISTRY, Part IV. Chap. 1. Sect. 3.

Balſamic medicines are of a nature ſomewhat hot and acrid. Under this denomination come what we commonly call cephalic, nervous, apoplectic, and antiparalytic medicines, as alſo ſpirituous cordials, and other ſubſtances of ſimilar natures and properties. But of all the medicines belonging to the balſamic claſs, the moſt noted and efficacious are aloes wood, together with its reſin and eſſence; yellow ſaunders, with its eſſence, reduced to a liquid balſam; ambergriſe; liquid amber; balm of Gilead; amber; benzoin; ſtorax, with its reſin; the ladaniferous ſhrub, with its reſin; the balſams of Peru, and Tolu; balſam of Caſour; and that called the red American balſam; the true Peruvian bark; the bitter ceſtus; Indian bark; cinnamon; cloves; cardamoms; cubebs; mace; nutmegs; ſavory; thyme; rue; mother of thyme; lavender; our *origanum*, and that of Crete; marjoram; our own, and Turkiſh balm; Roman chamomile; Syrian herb maſtich; baſil; ſouthernwood; ſpikenard; camel's hay; bay; and myrtle leaves; together

together with the genuine fragrant and unadulterated oils diſtilled from them. The compound balſamics are, the apoplectic balſam of Crollius; the balſamum celerſe; that of Scherzerus, and the liquid balſam of life; ſpirit of Peruvian balſam, ſpirit of amber and maſtich; the apoplectic water of Sennertus; the *aqua Anhaltina*; true eſſence of amber, and volatile oily ſpirits, impregnated with oil of cinnamon, mace, and cedar.

Balſams are of great ſervice in medicine and ſurgery. To uſe them, they are commonly liquified with ſpirit of wine, or oil, and ſometimes mixed up with the yolk of an egg. Are to be uſed cautiouſly and in moderate doſes by young people, and patients of choleric and delicate conſtitutions, as alſo in caſes where the body abounds with blood and humours.

Balſamics labour under this defect, that they muſt make a vaſt progreſs in moſt inſtances, before they can arrive at the intended ſcene of action; by which means they not only come ſlowly, and in ſmall quantities, but much altered, and variouſly modified, by the action of the blood veſſels, and the intermixture of its humours.

In the intentions where balſamics are chiefly given, the ſeat of the diſorder is generally in the viſcera; where a medicine can only arrive by the common conveyance of the blood; and how long, from its being taken into the ſtomach, muſt ſuch a medicine be, and how many alterations muſt it undergo in the divers parts of the body it paſſes through, before it comes to the place deſired? Though the lungs are, by their ſituation, ſo near the ſtomach, a medicine cannot arrive there, till it has taken its courſe through the lacteals, paſſed all the meanders of the myſentery, gone up with the chyle into the ſubclavian vein, and there entered the blood: and, after all, it has only the chance of coming to the part in ſuch a quantity, as, with regard to the whole medicine which entered the blood, bears the ſame proportion, as the blood in the pulmonary artery bears to all the blood in the other arteries.

Hence nothing is to be expected from balſamics, in a ſhort time, or a few days: they muſt be repeated, and followed, till the animal juices are ſufficiently charged therewith, to afford a continual ſupply. Add, that balſamics generally load and clog the ſtomach, and hence have often bad effects. This conſideration led the biſhop of Cloyne to prefer tar-water to all other balſamics.

Balsam, or *balm of Gilead*, is in the greateſt eſteem, though there are ſome who hold that of Peru equal to it in virtue. It is drawn by inciſion from a tree of the ſame name growing in Egypt and Judea, but chiefly in Arabia Felix, and which is held ſo precious, that it makes part of the ſpecial revenue of the grand ſignior, without whoſe permiſſion none are allowed to be planted or cultivated. See Dr. Lewis's Mater. Medic. p. 432. Its ſmell is agreeable, and very briſk; its taſte bitter, ſharp, and aſtringent; it eaſily diſſolves in the mouth, and leaves no ſtain on woollen cloth.

At preſent there are three ways of obtaining it, and according to theſe there are three kinds of the balſam. The firſt kind is that obtained from the natural cracks, or wounds made in the bark, as by the ancients, which is the beſt and moſt precious kind. But there is ſo little procured this way, that it ſcarcely ſupplies the ſeraglio and the great officers; and hardly a drop of it is ever ſent out of the country. The ſecond kind is called by ſome the Conſtantinople balſam; this alſo rarely comes to us, unleſs in ſmall quantities preſented by the great men of the Porte, and is prepared by boiling. They fill large veſſels with the young twigs and leaves of the balſam ſhrub; and adding a large quantity of water, they boil them gently. During the boiling, there ariſes to the ſurface of the liquor an oily and balſamic matter, which they ſkim off and preſerve for uſe. After all this fine matter is raiſed, they increaſe the fire, and a large quantity of ſomewhat thicker balſam riſes more like turpentine; this they alſo ſeparate, and preſerve by itſelf; and this is principally what is brought into Europe.

It is unqueſtionably a very noble detergent and balſamic; is of the ſame uſe with capivi in gonorrhœas, and is excellent in ulcers of the kidneys and bladder. It is by ſome eſteemed a cure for conſumptions; and though it does not abſolutely deſerve that title, yet with proper management it may do great ſervice in them. Externally it has been deſervedly famous for curing wounds of all kinds; where the wound is indeed a ſimple ſolution of continuity, and there is no bruiſe with it, the cures with balſams of this kind are very ſudden. For internal uſe it may be either given in boluſes, or dropped in ſugar, or finally diſſolved, by means of the yolk of an egg, into emulſions.

There is alſo the balſam of Mecca, which is alſo a dry, white gum, reſembling white copperas, eſpecially when old. It is brought from Mecca, by the return of the caravans of pilgrims and Mahometan merchants, who travel thither out of devotion to the birth-place of their prophet. It has all the virtues of the balm of Gilead, or Judea; and is probably the ſame, only hardened, and its colour altered.

Balsam, *Luccatellus's*, is compoſed of oil, two parts, and turpentine and wax, each one part; the red ſanders only contributing to its colour and ſmell.

Balsam *of Peru* is of three kinds; or rather, it is one and the ſame balſam, having three ſeveral names, viz. balſam of inciſion, which is a white glutinous reſin, oozing at an inciſion in the tree, and afterwards thickened and hardened. This is excellent for green wounds, and much reſembles the opobalſamum, excepting in ſmell, which diſtinguiſhes it. Dry balſam, which is diſtilled from the tips of branches cut off, to which are faſtened little veſſels to receive the liquor, which at firſt is like milk, but reddens by being expoſed to the ſun. Its chief uſe is in the compoſition of the lac virginale, which is made much better with this than with ſtyrax or benzoin. Laſtly, the balſam of lotion, which is blackiſh, and is drawn from the bark, roots, and leaves of the tree, minced and boiled together. This is uſed in wounds like the white balſam; and, on account of its excellent ſmell, by the perfumers.

The virtues of this balſam as a cordial, pectoral, and diuretic, are very great. It is given with ſucceſs from four to eight drops for a doſe, in conſumptions, aſthmas, nephritic complaints, obſtructions of the viſcera, and ſuppreſſions of the menſes. It has alſo externally all the virtues of the balm of Gilead, and conſolidates wounds in the ſame remarkable manner. It is beſt taken dropped on ſugar; the yolk of an egg will indeed diſſolve it, and it may that way be made into an emulſion, but it is more acrid in that form than when taken ſingly. It is often made an ingredient in boluſes and electaries; and is in ſome of the officinal compoſitions.

Balsam of *Capabu*, or *Copaiba*, vulgarly *Capivi*, comes from Braſil, in earthen bottles. There are two ſorts, the one bright and thin; the other thick; the firſt white, of a reſinous ſmell; the other a little more on the yellow; both are admirable for wounds; the Jews uſe this balſam after circumciſion to ſtop the blood. Many of the Americans call all odoriferous reſins, and ſweet-ſcented gums, *copal*; and the word *iba*, or *iva*, is the name for a tree; by which the etymology of *copaiba* eaſily appears. It is a great cleanſer of the urinary paſſages; on which account it obtains much in gonorrhœas, and all obſtructions and ulcerations in thoſe parts. It is efficacious in the *fluor albus*, and in gleets. It is alſo reputed a powerful balſamic, and, as ſuch, uſed in many diſtempers of the breaſt. But its heat and acrimony render it hurtful in inflammatory caſes, phthiſis, diſorders of the kidneys, &c.

The balſam of copaiba is frequently adulterated with oil of ſweet almonds, and oil of turpentine; the near reſemblance it bears to this laſt, has occaſioned them to be ſometimes confounded. They may be diſtinguiſhed by the conſiſtence as well as by colour; turpentine being thicker, and of a vitreous caſt, but the balſam whiter, and more inclining to a yellow: add, that it is more odorous, as well as ſharper and bitter to the taſte. Beſide the common uſes of this balſam, the art of the modern chymiſts has found a new and very profitable one, that is the debaſing and adulterating the dearer eſſential oils with it, as the ſmell in its oil is much ſweeter than that of turpentine or deal wood. This balſam yields a very large proportion of eſſential oil, by diſtillation with water, even to the quantity of five or ſix ounces from a pound; and the chymiſts who know this, adulterate their oils, either by mixing them with the oil of copaiba, or more artfully, by putting a proper quantity of this balſam with the ingredients into the ſtill, and ſo drawing off the oil of both mixed intimately together. There ſeems no eaſy way of detecting this fraud: the nice uſe of a hydroſtatical balance indeed would do it; and it is worth obſerving, whether the oils thus adulterated will not, on long keeping, diſcharge the ink of their written label, as the eſſential oils, adulterated with the oil of turpentine, are known to do, on account of the acid vapour which continually exhales from that oil.

Balsam *of Tolu*, is at firſt a liquid reſin, which, as it grows old, becomes of the colour and conſiſtence of Flanders glue. It comes by inciſion from ſome trees growing in New Spain, where the inhabitants receive it in little veſſels of black wax: in taſte and ſmell it reſembles balm of Gilead; as it grows old, it takes the conſiſtence of a dry balſam. It is an excellent balſamic and reſtorative; and good in all decays, eſpecially of the lungs. It ſoftens and thickens the blood, and cures catarrhs, and coughs, from tickling defluxions, &c. Its healing virtues extend even to the ſeminal parts, where it is good in old gleets, &c. There is a ſyrup of it in the ſhops; but the beſt form of adminiſtering it is in pills, or in a ſolution of ſome ſpirituous menſtruum. It takes its denomination from a place called Tolu, ſituated between Carthagena and Nombre de Dios.

Compound Balsams are numerous; the diſpenſatory writers furniſh a great number of forms, as magiſterial, chalybeat, paralytic, nephritic, and polychreſt balſams; red, green, Spaniſh, and Samaritan balſams; balſums of Arcus, of amber, of pitch, &c. Beſides theſe, chymiſts and alchymiſts ſpeak of balſams of antimony, of life, &c. See ſome remarks on the uſe of balſams in the cure of conſumptions, Lond. Med. Obſerv. &c. vol. iv. p. 231, by Dr. Fothergill, who is of opinion that all medicines poſſeſſed of heating, ſtimulating qualities, are in general improper in the treatment of this diſorder.

Balsam *of ſulphur*, is a ſolution of the flowers of ſulphur in ſome oil: it is made by boiling the two together over a ſoft fire the ſpace of an hour, or till the ſulphur be totally incorporated with the oil into a red balſam, which enters into their compoſition. Thus if it be made with the eſſential oil of turpentine, it is called *terebinthinated* balſam of ſulphur; if made with the eſſential oil of anniſeed, it is called the balſam of ſulphur with oil of anniſeed; theſe are the two moſt in uſe. When it is made with the oil of nuts, it is called Rulland's balſam of ſulphur. It is recommended both

both for external and internal cafes as being warm and mollifying in cafes of wounds, fanious ulcers, fiftulas, &c. and curative even of ulcers of the lungs.

BALSAMICS. *Balfamica* is a Latin word, which fignifies mitigating. The term balfamic is a very lax one; it includes medicines of very different qualities, as emollients, detergents, reftoratives, &c. but in medicines of all thefe kinds there feems to be this requifite in them, viz. that they be foft, yielding, and adhefive, alfo that by their fmallnefs they have a ready difpofition to motion. Medicines of this tribe are generally required for complaints whofe feat is in the vifcera; and as they cannot be conveyed there but by the common road of the circulation, it follows, that no great effects can be expected from them by their long continuation. Hoffman calls by the name of balfamics thofe medicines which are hot and acrid, alfo the natural balfams, gums, &c. by which the vital heat is increafed.

BAMBOE, in botany, the Engliſh name of the ſpecies of the Arundo. The Indian bamboe is the largeſt kind of cane that is known. It is of an extraordinary height and bigneſs, when it bears no bloſſom: each cane is often, toward the bottom, of the ſize of a man's thigh, decreaſing gradually to the top, where it bears a bloſſom or flower like our reeds in their proper ſeaſon. The bamboe grows in all maritime countries in the Eaſt-Indies. With theſe canes of bamboe the Indians build their houſes, and make all ſorts of furniture in a very ingenious manner. The wood of theſe canes is ſo hard and ſtrong, that they ſerve very well to make piles for ſupporting their little houſes built over rivers, which have a gentle courſe. They alſo make with this wood all ſorts of utenſils for their kitchens and tables. They ſerve to make the ſticks, or poles, with which the ſlaves carry thoſe ſort of litters called palanquins, which are ſo common in all the Eaſt. They likewiſe make of them a kind of pails, in which the water keeps extremely cool. The ſmall ſhoots of them ſerve to make walking canes. A decoction is made of the leaves, of uſe for diſperſing coagulated blood; and of the pithy part in the middle they alſo make a medicine againſt the ſtranguary.

BANANA, a ſpecies of the muſa, or plantain-tree, of the common kind; which the Portugueſe call *pacocirca*, and we particularly, the banana-tree. The fruit of this tree is ſaid to be nouriſhing, to excite urine, and to be a provocative to venery. The abbé Poyart deſcribes two trees under the name of bananas, which he met with in Africa. The one, which is rather a plant than a tree, riſes to the height of between twelve and fifteen feet, on a ſtalk or trunk of eight or ten inches in diameter. The fruit ſhoots forth from the trunk in a cluſter, containing between one and two hundred bananas, each an inch thick, and eight or ten inches in length. As ſoon as one cluſter is produced the plant dies, and ſeveral new plants ſpring up in the room of the old one. The trunk of the tree is encompaſſed with ſeveral ſprigs, of the rind of which the negroes make cords. The leaves of this plant are ſeven or eight feet long, and twenty inches broad; as ſtrong as parchment, and are uſed for umbrellas, and other purpoſes. The other tree is the fig-banana, or fig-tree of Adam, and differs from the former only in the nature and qualities of its fruit. The produce of the former is a kind of bread, which is dry and mealy; that of the latter a delicious fruit, which is ſoft and moiſt. Hiſtoire de Loango, &c. vol. i. 1776. Paris.

BANDAGE, in ſurgery, the application of a band, ſwath, roller, or fillet, to a part of the body; or the act of rolling or tying a ſwath, or band, round the part affected, and the parts adjacent, with compreſſes, plaſters, and the like. Of bandages there are two ſorts: one ſort are remedies of themſelves; the other, being intended only to keep the medicaments on the part, are called more particularly contentive bandages. Bandages are a very neceſſary part of the apparatus in dreſſing and binding up of wounds. They are not only of greater ſervice than compreſſes and plaſters, in ſecuring the other dreſſings, but are alſo of excellent uſe in reſtraining dangerous hæmorrhages, and in joining fractured or diſlocated bones. Almoſt all bandages, uſed in dreſſing of wounds, ulcers, or fractured or diſlocated bones, ſhould be made of clean linen-cloth, ſoftened by wearing, but ſtrong. They are to be made of a proper length and breadth for the occaſion; and, that they may be ſtrong, examine the courſe of the threads, and tear the cloth lengthways. Darns, ſeams, and large hems in the cloth, are, as much as poſſible, to be avoided, that no inconvenience may be brought on by the roughneſs and irregularity of the roller. There are different ſorts of bandages, for different uſes. Some are common; others are proper. Theſe laſt are only to be applied to particular parts; the others may be applied to any.

BANGUE, a ſpecies of opiate, in great uſe throughout the eaſt, for drowning cares and inſpiring joy. This by the Perſians is called *bengi* by the Arabs, *effrar*, corruptly *aſſeral*, and *aſſurth*; by the Turks, *bangtie*, and vulgarly called *maſſack*; by the European naturaliſts, *bangue*, or *bunge*. It is the leaf of a kind of wild hemp, growing in the countries of the Levant: it differs little, either as to leaf or ſeed, from our hemp, except in ſize. Some have miſtaken it for a ſpecies of althea. There are divers manners of preparing it in different countries. Olearius deſcribes the method uſed in Perſia. Mr. Sale tells us, that among the Arabs, the leaf is made into pills, or conſerves. But the moſt diſtinct account is that given by Alexander Maurocordato, counſellor and phyſician of the Ottoman Porte, in a letter to Wedelius. According to this author, bangue is made of the leaves of wild hemp, dried in the ſhade, then ground to powder; put into a pot wherein butter has been kept; ſet in an oven till it begin to torrify; then taken out, and pulverized again; thus to be uſed occaſionally, as much at a time as will lie on the point of a knife. Such is the Turkiſh bangue. The effects of this drug are, to confound the underſtanding, ſet the imagination looſe, induce a kind of folly, and forgetfulneſs, wherein all cares are left, and joy and gaiety take place thereof. Bangue, in reality, is a ſuccedaneum to wine, and obtains in thoſe countries where Mahometaniſm is eſtabliſhed; which prohibiting the uſe of that liquor abſolutely, the poor muſſelmans are forced to have recourſe to ſuccedanea, to rouſe their ſpirits. The principal are opium and this bangue. As to the opinion among Europeans, that the Turks prepare themſelves for battle by a doſe of bangue, which rouſes their courage, and drives them, with eagerneſs, to certain death, Dr. Maurocordato aſſures us, that it is a popular error: the Turks think they are then going aſſuredly to receive the crown of martyrdom; and would not, for any conſideration, loſe the merit of it, which they would do, by eating the bangue, as being held unlawful by their apoſtle, among other things which intoxicate.

BANISHMENT, EXILE, among us, is of two kinds: the one voluntary, and upon oath; the other by compulſion, for ſome offence or crime. The former, properly called abjuration, is now ceaſed; the latter is chiefly enjoined by judgment of parliament. Yet outlawing and tranſportation may alſo be conſidered as a ſpecies of exile. By Magna Charta, none ſhall be outlawed or baniſhed his country, but by lawful judgment of his peers, or according to the law of the land. 9. Hen. III. cap. 29. And by the common law no perſon ſhall be baniſhed but by authority of parliament; or in caſe of abjuration for felony, &c. But this is taken away by ſtatute 3. Inſt. 115. Stat. 21. Jac. I. cap. 28.

BANK, in commerce, a common repoſitory, where many perſons agree to keep their money, to be always ready at their call or direction: or, certain ſocieties or communities, who take the charge of other people's money, either to improve it, or to keep it ſecure. The firſt inſtitution of banks was in Italy, where the Lombard Jews kept benches in the market-places for the exchange of money and bills; and banco being the Italian name of bench, banks took their title from this word.

Banks are of two principal kinds, viz. Company Banks and Banks of Depoſit.

1. Company Banks are either public, conſiſting of a company of monied men, who being duly eſtabliſhed, and incorporated by the laws of their country, agree to depoſit a conſiderable fund, or joint ſtock, to be employed for the uſe of the ſociety, as lending money upon good ſecurity, buying and ſelling bullion, diſcounting bills of exchange, &c.; or private, i. e. ſet up by private perſons, or partnerſhips, who deal in the ſame way as the former upon their own ſingle ſtock and credit.

The greateſt bank of circulation in Europe is the Bank of England. The company was incorporated by parliament in the fifth and ſixth years of King William and Queen Mary, by the name of The Governors and Company of the Bank of England; in conſideration of the loan of 1,200,000l. granted to the government; for which the ſubſcribers received almoſt 8 per cent. By this charter, the company are not to borrow under their common ſeal, unleſs by act of parliament; they are not to trade, or ſuffer any perſon in truſt for them to trade, in any goods or merchandize; but they may deal in bills of exchange, in buying or ſelling bullion, and foreign gold and ſilver coin, &c.

By an act of parliament paſſed in the 8th and 9th years of William III. they were empowered to enlarge their capital ſtock to 2,201,171l. 10s. It was then alſo enacted, that bank ſtock ſhould be a perſonal and not a real eſtate; that no contract either in word or writing, for buying or ſelling bank-ſtock, ſhould be good in law, unleſs regiſtered in the books of the bank within ſeven days, and the ſtock transferred in fourteen days; and that it ſhall be felony, without benefit of clergy, to counterfeit the common ſeal of the bank, or any ſealed bank-bill, or any bank-note, or to alter or eraſe ſuch bills or notes. By another act paſſed in the 7th of Queen Anne, the company were empowered to augment their capital to 4,402,343l. and they then advanced 400,000l. more to the government; and in 1714, they advanced another loan of 1,500,000l.

In the third year of the reign of King George I. the intereſt in their capital ſtock was reduced to 5 per cent. when the bank agreed to deliver up as many exchequer bills as amounted to 800,000l. and to accept an annuity of 100,000l. and it was declared lawful for the bank to call from their members, in proportion to their intereſts in the capital ſtock, ſuch ſums of money as in a general court ſhould be found neceſſary. If any member ſhould neglect to pay his ſhare of the monies ſo called for, at the time appointed by notice in the London Gazette, and fixed upon the Royal Exchange, it ſhould be lawful for the bank, not only to ſtop the dividend of ſuch member, and to apply it towards payment of the money in queſtion, but alſo to ſtop the tranſfers of the ſhare of ſuch defaulter, and to charge him with an intereſt of 5 per cent. per annum, for the money ſo omitted to be paid: and if the principal and intereſt ſhould be three months unpaid, the bank ſhould then have

have power to ſell ſo much of the ſtock belonging to the defaulter as would ſatisfy the ſame. After this, the bank reduced the intereſt of the 2,000,000l. lent to the government from 5 to 4 per cent. and purchaſed ſeveral other annuities, which were afterwards redeemed by the government, and the national debt due to the bank reduced to 1,600,000l. But in 1742, the company engaged to ſupply the government with 1,600,000l. at 3 per cent. which is now called 3 per cent. annuities; ſo that the government was now indebted to the company 3,200,000l. the one-half carrying 4, and the other 3 per cent.

In the year 1746, the company agreed that the ſum of 986,800l. due to them in the exchequer-bills unſatisfied, on the duties for licences to ſell ſpirituous liquors by retail, ſhould be cancelled, and in lieu thereof to accept of an annuity of 39,442l. the intereſt of that ſum at 4 per cent. The company alſo agreed to advance the further ſum of 1,000,000l. into the exchequer, upon the credit of the duties ariſing by the malt and land tax at 4 per cent. for exchequer bills to be iſſued for that purpoſe; in conſideration of which, the company were enabled to augment their capital with 986,800l.; the intereſt of which, as well as that of the other annuities, was reduced to 3¼ per cent. till the 25th of December 1757, and from that time to carry only 3 per cent.

And in order to enable them to circulate the ſaid exchequer bills, they eſtabliſhed what is now called bank circulation. The nature of which may be underſtood from what follows. The company of the bank are obliged to keep caſh ſufficient, not only to anſwer the common, but alſo any extraordinary demand that may be made upon them; and whatever money they have by them, over and above the ſum ſuppoſed neceſſary for the purpoſes, they employ in what may be called the trade of the company; that is to ſay, in diſcounting bills of exchange, in buying gold and ſilver, and in government ſecurities, &c. But when the bank entered into the abovementioned contract, as they did not keep unemployed a larger ſum of money than what they deemed neceſſary to anſwer their ordinary and extraordinary demands, they could not conveniently take out of their current caſh ſo great a ſum as a million, with which they were obliged to furniſh the government, without either leſſening that ſum they employed in diſcounting, buying gold and ſilver, &c. (which would have been very diſadvantageous to them) or inventing ſome method that ſhould anſwer all the purpoſes of keeping the million in caſh. The method which they choſe, and which fully anſwers their end, was as follows:

They opened a ſubſcription, which they renew annually, for a million of money; wherein the ſubſcribes advance 10 per cent. and enter into a contract to pay the remainder, or any part thereof, whenever the bank ſhall call upon them, under penalty of forfeiting the 10 per cent. ſo advanced; in conſideration of which, the bank pays the ſubſcribers 4 per cent. intereſt for the money paid in, and ¼ per cent. for the whole ſum they agree to furniſh; and in caſe a call ſhall be made upon them for the whole, or any part thereof, the bank further agrees to pay them at the rate of 5 per cent. per annum for ſuch ſum until they repay it, which they are under an obligation to do at the end of the year. By this means the bank obtains all the purpoſes of keeping a million of money by them; and though the ſubſcribers, if no call is made upon them (which is in general the caſe) receive 6½ per cent. for the money they advance, yet the company gains the ſum of 23,500l. per annum by the contract; as will appear by the following account:

The bank receives from the government for the advance of a million	£30,000
The bank pays the ſubſcribers who advance 100,000l. and engage to pay (when called for) 900,000l. more	6,500
The clear gain to the bank therefore is	23,500

This is the ſtate of the caſe, provided the company ſhould make no call on the ſubſcribers; which they will be very unwilling to do, becauſe it would not only leſſen their profit, but affect the public credit in general.

Bank-ſtock may not improperly be called a trading ſtock, ſince with this they deal very largely in foreign gold and ſilver, in diſcounting bills of exchange, &c. Beſides which, they are allowed by the government very conſiderable ſums annually for the management of the annuities paid at their office. All which advantages render a ſhare in their ſtock very valuable; though it is not equal in value to the Eaſt-India ſtock. The company make dividends of the profits half-yearly, of which notice is publicly given; when thoſe who have occaſion for their money may readily receive it; but private perſons, if they judge convenient, are permitted to continue their funds, and to have their intereſt added to the principal.

This company is under the direction of a governor, deputy-governor, and 24 directors, who are annually elected by the general court, in the ſame manner as the Eaſt-India Company. Thirteen, or more, compoſe a court of directors for managing the affairs of the company. The officers of this company are very numerous. The ſtability of the bank of England is equal to that of the Britiſh government. All that it has advanced to the public muſt be loſt before its creditors can ſuſtain any loſs. No other banking company in England can be eſtabliſhed by act of parliament, or can conſiſt of more than ſix members. It acts, not only as an ordinary bank, but (as we have already ſeen) as a great engine of ſtate; receiving and paying the greater part of the annuities which are due to the creditors of the public; circulating exchequer bills; and advancing to government the annual amount of the land and malt taxes, which are frequently not paid up till ſome years thereafter. It likewiſe has, upon ſeveral different occaſions, ſupported the credit of the principal houſes, not only in England, but of Hamburgh and Holland. Upon one occaſion it is ſaid to have advanced for this purpoſe, in one week, above 1,600,000l. a great part of it in bullion.

In Scotland there are two public banks, both at Edinburgh. The one, called The Bank of Scotland, was eſtabliſhed by act of parliament in 1695; the other, called The Royal Bank, by royal charter in 1727.

Within theſe 30 years there have alſo been erected private banking companies in almoſt every conſiderable town, and even in ſome villages. Hence the buſineſs of the country is almoſt entirely carried on by paper-currency, i. e. by the notes of thoſe different banking companies, with which purchaſes and payments of all kinds are commonly made. Silver very ſeldom appears, except in the change of a twenty-ſhillings bank-note, and gold ſtill ſeldomer. But though the conduct of all thoſe different companies has not been unexceptionable, and has accordingly required an act of parliament to regulate it; the country, notwithſtanding, has evidently derived great benefit from their trade. It has been aſſerted, that the trade of the city of Glaſgow doubled in about 15 years after the firſt erection of the banks there, and that the trade of Scotland has more than quadrupled ſince the firſt erection of the two public banks at Edinburgh. Whether the trade, either of Scotland in general, or of the city of Glaſgow in particular, has really increaſed in ſo great a proportion, during ſo ſhort a period, we do not pretend to know. If either of them has increaſed in this proportion, it ſeems to be an effect too great to be accounted for by the ſole operation of this cauſe. That the trade and induſtry of Scotland, however, have increaſed very conſiderably during this period, and that the banks have contributed a good deal to this increaſe, cannot be doubted.

It is chiefly by diſcounting bills of exchange, that is, by advancing money upon them before they are due, that the greater part of banks and bankers iſſue their promiſſory notes. They deduct always, upon whatever ſum they advance, the legal intereſt till the bill ſhall become due. The payment of the bill, when it becomes due, replaces to the bank the value of what had been advanced, together with a clear profit of the intereſt. The banker, who advances to the merchant whoſe bill he diſcounts, not gold and ſilver, but his own promiſſory notes, has the advantage of being able to diſcount to the greater amount, by the whole value of his promiſſory notes, which he finds by experience are commonly in circulation. He is thereby enabled to make his clear gain of intereſt on ſo much a larger ſum.

The commerce of Scotland, which at preſent is not very great, was ſtill more inconſiderable when the two firſt banking companies were eſtabliſhed; and thoſe companies would have had but little trade, had they confined their buſineſs to the diſcounting of bills of exchange. They invented, therefore, another method of iſſuing their promiſſory notes, by granting what they called caſh accounts; that is, by giving credit to the extent of a certain ſum (200l. or 300l. for example) to any individual who could procure two perſons of undoubted credit and good landed eſtate to become ſurety for him, that whatever money ſhould be advanced to him within the ſum for which the credit had been given, ſhould be repaid upon demand, together with the legal intereſt. Credits of this kind are commonly granted to banks and bankers in all the different parts of the world. But the eaſy terms on which the Scots banking companies accept of repayment are peculiar to them, and have perhaps been the principal cauſe, both of the great trade of theſe companies, and of the benefit which the country has received from it.

Whoever has a credit of this kind with one of thoſe companies, and borrows 1000l. upon it for example, may repay this ſum piece-meal, by 20l. and 30l. at a time, the company diſcounting a proportionable part of the intereſt of the great ſum from the day on which each of thoſe ſmall ſums is paid in, till the whole be in this manner repaid. All merchants, therefore, and almoſt all men of buſineſs, find it convenient to keep ſuch caſh accounts with them; and are thereby intereſted to promote the trade of thoſe companies, by readily receiving their notes in all payments, and by encouraging all thoſe with whom they have any influence to do the ſame. The banks, when their cuſtomers apply to them for money, generally advance it to them in their own promiſſory notes. Theſe the merchants pay away to the manufacturers for goods, the manufacturers to the farmers for materials and proviſions, the farmers to their landlords for rent, the landlords repay them to the merchants for the conveniences and luxuries with which they ſupply them, and the merchants again return them to the banks in order to balance their caſh accounts, or to replace what they have borrowed of them; and thus almoſt the whole money-buſineſs of the country is tranſacted by means of them. Hence the great trade of thoſe companies.

By means of thoſe caſh accounts, every merchant can, without imprudence, carry on a greater trade than he otherwiſe could do

If there are two merchants, one in London and the other in Edinburgh, who employ equal ſtocks in the ſame branch of trade, the Edinburgh merchant can, without imprudence, carry on a greater trade, and give employment to a greater number of people than the London merchant. The London merchant muſt always keep by him a conſiderable ſum of money, either in his own coffers, or in thoſe of his banker (who gives him no intereſt for it) in order to anſwer the demands continually coming upon him for payment of the goods which he purchaſes upon credit. Let the ordinary amount of this ſum be ſuppoſed 500l. The value of the goods in his houſe muſt always be leſs by 500l. than it would have been, had he not been obliged to keep ſuch a ſum unemployed. Let us ſuppoſe that he generally diſpoſes of his whole ſtock upon hand, or of goods to the value of his whole ſtock upon hand, once in the year. By being obliged to keep ſuch a great ſum unemployed, he muſt ſell in a year 500l. worth leſs goods than he might otherwiſe have done. His annual profits muſt be leſs by all that he could have made by the ſale of 500l. worth more goods; and the number of people employed in preparing his goods for the market, muſt be leſs by all thoſe 500l. more ſtock could have employed. The merchant in Edinburgh, on the other hand, keeps no money unemployed for anſwering ſuch occaſional demands. When they actually come upon him, he ſatisfies them for his caſh-account with the bank, and gradually replaces the ſum borrowed with the money or paper which comes in from the occaſional ſales of his goods. With the ſame ſtock, therefore, he can, without imprudence, have at all times in his warehouſe a larger quantity of goods than the London merchant; and can thereby both make a greater profit himſelf, and give conſtant employment to a greater number of induſtrious people who prepare thoſe goods for the market. Hence the great benefit which the country has derived from this trade.

The late multiplication of banking companies in both parts of the united kingdoms, an event by which many people have been much alarmed, inſtead of diminiſhing, increaſes the ſecurity of the public. It obliges all of them to be more circumſpect in their conduct, and, by not extending their currency beyond its due proportion to their caſh, to guard themſelves againſt thoſe malicious runs which the rivalſhip of ſo many competitors is always ready to bring upon them. It reſtrains the circulation of each particular company within a narrower circle, and reduces their circulating notes to a ſmaller number. By dividing the whole circulation into a greater number of parts, the failure of any one company, an accident which, in the courſe of things, muſt ſometimes happen, becomes of leſs conſequence to the public. This free competition too obliges all bankers to be more liberal in their dealings with their cuſtomers, leſt their rivals ſhould carry them away. In general, if any branch of trade, or any diviſion of labour, be advantageous to the public, the freer and more general the competition, it will always be the more ſo.

2. Banks of Depoſit. Theſe are inſtituted wholly on the public account, and are therefore called Banks of Depoſit; the nature of which not being generally underſtood, the following particular explanation may not be unacceptable:—

The currency of a great ſtate, ſuch as Britain, generally conſiſts almoſt entirely of its own coin. Should this currency, therefore, be at any time worn, clipt, or otherwiſe degraded below its ſtandard value, the ſtate by a reformation of its coin can effectually reeſtabliſh its currency. But the currency of a ſmall ſtate, ſuch as Genoa or Hamburgh, can ſeldom conſiſt altogether in its own coin, but muſt be made up, in a great meaſure, of the coins of all the neighbouring ſtates with which its inhabitants have a continual intercourſe. Such a ſtate, therefore, by reforming its coin, will not always be able to reform its currency. If foreign bills of exchange are paid in this currency, the uncertain value of any ſum, of what is in its own nature ſo uncertain, muſt render the exchange always very much againſt ſuch a ſtate, its currency being, in all foreign ſtates, neceſſarily valued even below what it is worth. In order to remedy the inconvenience to which this diſadvantageous exchange muſt have ſubjected their merchants, ſuch ſmall ſtates, when they began to attend to the intereſt of trade, have frequently enacted, that foreign bills of exchange of a certain value ſhould be paid, not in common currency, but by an order upon, or by a tranſfer in the books of, a certain bank, eſtabliſhed upon the credit and under the protection of the ſtate; this bank, being always obliged to pay, in good and true money, exactly according to the ſtandard of the ſtate. The banks of Venice, Genoa, Amſterdam, Hamburgh, and Nuremberg, ſeem to have been all originally eſtabliſhed with this view, though ſome of them may have afterwards been made ſubſervient to other purpoſes. The money of ſuch banks, being better than the common currency of the country, neceſſarily bore an agio, which was greater or ſmaller, according as the currency was ſuppoſed to be more or leſs degraded below the ſtandard of the ſtate. The agio of the bank of Hamburgh, for example, which is ſaid to be commonly about 14 per cent. is the ſuppoſed difference between the good ſtandard money of the ſtate, and the clipt, worn, and diminiſhed currency poured into it from all the neighbouring ſtates.

BANKER, in commerce. The hiſtory of private banks is as follows. The royal mint in the Tower of London had for ſome years, before the year 1640, been made uſe of as a kind of bank, or depoſit, for merchants to lodge their caſh in. But king Charles the Firſt having in that year made free with their money, the mint loſt its credit. After this, the merchants and traders of London generally truſted their caſh with their ſervants, until the breaking out of the civil war, when it was very cuſtomary for their apprentices and clerks to leave their maſters and go into the army. Whereupon in ſuch unſettled times, merchants not daring longer to confide in their apprentices, began firſt, about the year 1645, to lodge their neceſſary caſh in goldſmiths' hands, both to receive and pay for them; until which time the whole and proper buſineſs of London goldſmiths was to buy and ſell plate, and foreign coins of gold and ſilver, to melt and cull them, to coin ſome at the mint, and with the reſt to ſupply the refiners, platemakers, and merchants, as they found the price to vary. This account of the matter we have from a ſcarce and moſt curious ſmall pamphlet publiſhed in 1676, entitled the Myſtery of the new-faſhioned Goldſmiths or Bankers diſcovered, in only eight quarto pages.

Bankers on their firſt eſtabliſhment allowed to thoſe who entruſted their money in their hands a moderate intereſt for the ſame, and hereby their buſineſs was very conſiderably increaſed, and roſe to great reputation in the year 1667, when the Dutch burnt our ſhips at Chatham; but this event cauſed a run on the bankers, which hurt their credit; and in the year 1672 king Charles II. ſhut up the exchequer, and ſeized the money which the bankers had lent him at 8 per cent. intereſt, the whole ſum amounting to 1,328,526l. The king was afterwards neceſſitated to pay 6 per cent. intereſt for this debt out of his hereditary exciſe, but the principal was never paid. However, the parliament of 12 William, cap. 12, provided for a larger arrear of intereſt, and ſettled an intereſt of 3 per cent. for the future. The debt was hereby made redeemable, on paying one moiety of the principal ſum, viz. 664,263l. farther confirmed by an act of 2 and 3 Anne, cap. 15. which moiety now became the proper debt of the public; and being reduced from 6 to 5 per cent. in 1717, was finally ſubſcribed into the South-ſea capital ſtock in the year 1720.

Bankers now allow no intereſt, and by inveſting a certain proportion of it in the funds, or laying it out on other ſufficient ſecurity, and trafficking with it in the ſtocks, in diſcounts, &c. reap very conſiderable advantage from it; and by negociating bills, &c. on the part of their creditors, greatly contribute to the convenience and diſpatch of buſineſs. In Italy, the employment of a banker, eſpecially in republics, does not derogate from nobility; and hence it is, that moſt of the cadets, or younger ſons of perſons of condition, undertake it for the ſupport of their family.

BANKRUPT, a dealer, who has other men's goods, or money, in his hands, and abſconds to cheat his creditors; or being ſo reduced or involved, that he can conduct his buſineſs no longer, is deſirous of being legally diſcharged from farther demands and trouble.

A bankrupt with us, from the ſeveral deſcriptions given in our ſtatute law, may be thus defined: All and every perſon who ſhall uſe the trade of merchandiſe by way of bargaining, exchange, bartering, or otherwiſe in groſs, or by ſeeking his or her living by buying and ſelling, who ſhall depart his houſe, or abſent himſelf, or ſuffer himſelf to be arreſted for any debt, or other thing, not grown due for money delivered, wares ſold, or other good conſideration; or ſhall ſuffer himſelf to be outlawed, or go to priſon, or fraudulently procure himſelf to be arreſted, or his money or his goods attached; or make any fraudulent conveyance of his land, goods, or chattels, whereby his creditors may be defeated in the recovery of their juſt debts; or, being arreſted for debt, ſhall lie in priſon ſix months or more, upon ſuch arreſt or detention, ſhall be adjudged a bankrupt. For the better underſtanding of this article, it will be proper to conſider, 1. Who may become a bankrupt? 2. What acts make a bankrupt? 3. The proceedings on a commiſſion of bankruptcy: and, 4. In what manner an eſtate in goods and chattels may be tranſferred by bankruptcy.

1. Who may become a bankrupt: A bankrupt was formerly conſidered merely in the light of a criminal or offender; and in this ſpirit we are told by Sir Edward Coke, that we have fetched as well the names, as the wickedneſs, of bankrupts from foreign nations. But at preſent the laws of bankruptcy are conſidered as laws calculated for the benefit of trade, and founded on the principles of humanity as well as juſtice; and to that end they confer ſome privileges, not only on the creditors, but alſo on the bankrupt or debtor himſelf. On the creditors; by compelling the bankrupt to give up all his effects to their uſe, without any fraudulent concealment: on the debtor; by exempting him from the rigour of the general law, whereby his perſon might be confined at the diſcretion of his creditor, though in reality he has nothing to ſatisfy the debt; whereas the law of bankrupts, taking into conſideration the ſudden and unavoidable accidents to which men are liable, has given them the liberty of their perſons, and ſome pecuniary emoluments, upon condition they ſurrender up their whole eſtate to be divided among their creditors.

In this reſpect our legiſlature ſeems to have attended to the example of the Roman law. We mean not the terrible law of the

The Binder is deſired to obſerve this Sheet (5 F—1) is to be placed before Sheet (5 F—2) it being an additional Sheet, introduced to enlarge the Article Bank and Bankrupt, in the new Edition of this Work.

twelve tables; whereby the creditors might cut the debtor's body into pieces, and each of them take his proportionable ſhare: if indeed that law, *de debitore in partes ſecando*, is to be underſtood in ſo butcherly a light; which many learned men have with reaſon doubted. Nor do we mean thoſe leſs inhuman laws (if they may be called ſo, as their meaning is indiſputably certain) of impriſoning the debtor's perſon in chains; ſubjecting him to ſtripes and hard labour, at the mercy of his rigid creditor; and ſometimes ſelling him, his wife, and children, to perpetual foreign ſlavery, *trans Tiberim:* an oppreſſion, which produced ſo many popular inſurrections, and ſeceſſions to the *mons ſacer*, as is the caſe in Pegu, and the adjacent countries in Eaſt India, the creditor is entitled to diſpoſe of the debtor himſelf, and likewiſe of his wife and children: inſomuch that he may even violate, with impunity, the chaſtity of the debtor's wife; but then, by ſo doing, the debt is underſtood to be diſcharged. But we mean the law of ceſſion, introduced by the Chriſtian emperors; whereby, if a debtor ceded or yielded up all his fortune to his creditors, he was ſecured from being dragged to a goal, "*omni quoque corporali cruciatu ſemoto.*" For, as the emperor juſtly obſerves, "*inhumanum erat ſpoliatum fortunis ſuis ſolidum damnari.*" Thus far was juſt and reaſonable: but as the departing from one extreme is apt to produce its oppoſite, we find it afterwards enacted, that if the debtor by any unforeſeen accident was reduced to low circumſtances, and would ſwear that he had not ſufficient left to pay his debts, he ſhould not be compelled to cede or give up even that which he had in his poſſeſſion; a law which, under a falſe notion of humanity, ſeems to be fertile of perjury, injuſtice, and abſurdity.

The laws of England, more wiſely, have ſteered in the middle between both extremes; providing at once againſt the inhumanity of the creditor, who is not ſuffered to confine an honeſt bankrupt after his effects are delivered up; and at the ſame time taking care that all his juſt debts ſhall be paid, ſo far as the effects will extend. But ſtill they are cautious of encouraging prodigality and extravagance by this indulgence to debtors: and therefore they allow the benefit of the laws of bankruptcy to none but actual traders; ſince that ſet of men are, generally ſpeaking, the only perſons liable to accidental loſſes, and to an inability of paying their debts, without any fault of their own. If perſons in other ſituations of life run in debt without the power of payment, they muſt take the conſequences of their own indiſcretion, even though they meet with ſudden accidents that may reduce their fortunes: for the law holds it to be an unjuſtifiable practice for any perſon but a trader to encumber himſelf with debts of any conſiderable value. If a gentleman, or one in a liberal profeſſion, at the time of contracting his debts has a ſufficient fund to pay them, the delay of payment is a ſpecies of diſhoneſty, and a temporary injuſtice to his creditor; and if, at ſuch time, he has not a ſufficient fund, the diſhoneſty and injuſtice is the greater. He cannot therefore murmur, if he ſuffers the puniſhment which he has voluntarily drawn upon himſelf. But in mercantile tranſactions, the caſe is far otherwiſe. Trade cannot be carried on without mutual credit on both ſides: the contracting of debts is therefore here not only juſtifiable but neceſſary. And if by accidental calamities, as by the loſs of a ſhip in a tempeſt, the failure of brother traders, or by the non-payment of perſons out of trade, a merchant or trader becomes incapable of diſcharging his own debts, it is his misfortune and not his fault. To the misfortune, therefore, of debtors, the law has given a compaſſionate remedy, but denied it to their faults: ſince, at the ſame time that it provides for the ſecurity of commerce, by enacting that every conſiderable trader may be declared a bankrupt, for the benefit of his creditors as well as himſelf; it has alſo, to diſcourage extravagance, declared, that no one ſhall be capable of being made a bankrupt, but only a trader; nor capable of receiving the full benefit of the ſtatutes, but only an induſtrious trader.

In the interpretation of the ſeveral ſtatutes made concerning Engliſh bankrupts, it hath been held, that buying only, or ſelling only, will not qualify a man to be a bankrupt; but it muſt be both buying and ſelling, and alſo getting a livelihood by it: as, by exerciſing the calling of a merchant, a grocer, a mercer, or, in one general word, a chapman, who is one that buys and ſells any thing.

2. What makes a bankrupt? To learn what the acts of bankruptcy are which render a man a bankrupt, we muſt conſult the ſeveral ſtatutes, and the reſolutions formed by the courts thereon. Among theſe may therefore be reckoned, 1. Departing from this realm, whereby a man withdraws himſelf from the juriſdiction and coercion of the law, with an intent to defraud his creditors. 2. Departing from his own houſe, with intent to ſecrete himſelf and avoid his creditors. 3. Keeping in his own houſe, privately (except for juſt and neceſſary cauſe) ſo as not to be ſeen or ſpoken with by his creditors; which is likewiſe conſtrued to be an intention to defraud his creditors, by avoiding the proceſs of the law. 4. Procuring or ſuffering himſelf willingly to be arreſted, or outlawed, or impriſoned, without juſt and lawful cauſe; which is likewiſe deemed an attempt to defraud his creditors. 5. Procuring his money, goods, chattels, and effects, to be attached or ſequeſtrated by any legal proceſs; which is another plain and direct endeavour to diſappoint his creditors of their ſecurity. 6. Making any fraudulent conveyance to a friend, or ſecret truſtee, of his lands, tenements, goods, or chattels; which is an act of the ſame ſuſpicious nature with the laſt. 7. Procuring any protection, not being himſelf privileged by parliament, in order to ſcreen his perſon from arreſts; which alſo is an endeavour to elude the juſtice of the law. 8. Endeavouring, or deſiring, by any petition to the king, or bill exhibited in any of the king's courts, againſt any creditors, to compel them to take leſs than their juſt debts; or to procraſtinate the time of payment, originally contracted form; which are either an acknowledgment of his poverty or knavery. 9. Lying in priſon for two months or more, upon arreſt, or other detention for debt, without finding bail, in order to obtain his liberty. For the inability to procure bail argues a ſtrong deficiency in his credit, owing either to his ſuſpected poverty, or ill character; and his neglect to do it, if able, can ariſe only from a fraudulent intention: in either of which caſes, it is high time for his creditors to look to themſelves, and compel a diſtribution of his effects. 10. Eſcaping from priſon after an arreſt for a juſt debt of 100l. or upwards. For no man would break priſon, that was able and deſirous to procure bail; which brings it within the reaſon of the laſt caſe. 11. Neglecting to make ſatisfaction for any juſt debt to the amount of 100l. within two months after ſervice of legal proceſs, for ſuch debt, upon any trader having privilege of parliament.

Theſe are the ſeveral acts of bankruptcy expreſsly defined by the ſtatutes relating to this article; which being ſo numerous, and the whole law of bankrupts being an innovation of the common law, our courts of juſtice have been tender of extending or multiplying acts of bankruptcy by any conſtruction or implication. And therefore Sir John Holt held, that a man's removing his goods privately to prevent their being ſeized in execution, was no act of bankruptcy. For the ſtatutes mention only fraudulent gifts to third perſons, and procuring them to be ſeized by ſham proceſs, in order to defraud creditors: but this, though a palpable fraud, yet, falling within neither of thoſe caſes, cannot be adjudged an act of bankruptcy. So alſo it has been determined expreſsly, that a banker's ſtopping or refuſing payment is no act of bankruptcy: for it is not within the deſcription of any of the ſtatutes; and there may good reaſons for his ſo doing, as ſuſpicion of forgery, and the like: and if, in conſequence of ſuch refuſal, he is arreſted, and puts in bail, ſtill it is no act of bankruptcy; but if he goes to priſon, and lies there two months, then, and not before, is he become a bankrupt.

3. In the proceedings on a commiſſion of bankruptcy there muſt, in the firſt place, be a petition to the lord-chancellor by one creditor to the amount of 100l. or by two to the amount of 150l. or by three or more to the amount of 200l.; upon which he grants a commiſſion to ſuch diſcreet perſons as to him ſhall ſeem good, who are then ſtyled commiſſioners of bankrupt. The petitioners, to prevent malicious applications, muſt be bound in a ſecurity of 200l. to make the party amends, in caſe they do not prove him a bankrupt. And if, on the other hand, they receive any money or effects from the bankrupt, as a recompence for ſuing out the commiſſion, ſo as to receive more than their rateable dividends of the bankrupt's eſtate, they forfeit not only what they ſhall have ſo received, but their whole debt. When the commiſſion is awarded and iſſued, the commiſſioners are to meet at their own expence, and to take an oath for the due execution of their commiſſion, and to be allowed a ſum not exceeding 20s. per diem each, at every ſitting. And no commiſſion of bankruptcy ſhall abate or be void on any demiſe of the crown.

When the commiſſioners have received their commiſſion, they are firſt to receive proof of the perſon's being a trader, and having committed ſome act of bankruptcy; and then to declare him bankrupt, if proved ſo; and to give notice thereof in the gazette, and at the ſame time to appoint three meetings. At one of theſe meetings an election muſt be made of aſſignees, or perſons to whom the bankrupt's eſtate ſhall be aſſigned, and in whom it ſhall be veſted for the benefit of the creditors; which aſſignees are choſen by the major part, in value, of the creditors who ſhall then have proved their debts; but may be originally appointed by the commiſſioners, and afterwards approved or rejected by the creditors: but no creditor ſhall be admitted to vote in the choice of aſſignees, whoſe debt, on the balance of accounts, does not amount to 10l. And at the third meeting at fartheſt, which muſt be on the 42d day after the advertiſement in the gazette, the bankrupt, upon notice alſo perſonally ſerved upon him, or left at his uſual place of abode, muſt ſurrender himſelf perſonally to the commiſſioners, and muſt thenceforth in all reſpects conform to the directions of the ſtatutes of bankruptcy; or, in default thereof, ſhall be guilty of felony without benefit of clergy, and ſhall ſuffer death, and his goods and eſtate ſhall be divided among his creditors.

In caſe the bankrupt abſconds, or is likely to run away between the time of the commiſſion iſſued and the laſt day of ſurrender, he may, by warrant from any judge or juſtice of the peace, be apprehended and committed to the county goal, in order to be forth-coming to the commiſſioners, who are alſo empowered

powered immediately to grant a warrant for ſeizing his goods and papers.

When the bankrupt appears, the commiſſioners are to examine him touching all matters relating to his trade and effects. They may alſo ſummon before them, and examine, the bankrupt's wife, and any other perſon whatſoever, as to all matters relating to the bankrupt's affairs: and in caſe any of them ſhall refuſe to anſwer, or ſhall not anſwer fully, to any lawful queſtion, or ſhall refuſe to ſubſcribe ſuch their examination, the commiſſioners may commit them to priſon, without bail, till they make and ſign a full anſwer: the commiſſioners ſpecifying in their warrant of commitment the queſtion ſo refuſed to be anſwered. Any goaler, permitting ſuch perſon to eſcape or go out of priſon, ſhall forfeit 500*l.* to the creditors.

The bankrupt, upon this examination, is bound, upon pain of death, to make a full diſcovery of all his eſtate and effects, as well in expectancy as poſſeſſion, and how he has diſpoſed of the ſame; together with all books and writings relating thereto: and is to deliver up all in his power to the commiſſioners (except the neceſſary apparel of himſelf, his wife, and his children;) or, in caſe he conceals or embezzles any effects to the amount of 20*l.* or with-holds any book or writings, with intent to defraud his creditors, he ſhall be guilty of felony without benefit of clergy.

After the time allowed the bankrupt for ſuch diſcovery is expired, any other perſon voluntarily diſcovering any part of his eſtate before unknown to the aſſignees, ſhall be entitled to five per cent. out of the effects ſo diſcovered, and ſuch farther reward as the aſſignees and commiſſioners ſhall think proper. And any truſtee wilfully concealing the eſtate of any bankrupt, after the expiration of 42 days, ſhall forfeit 100*l.* and double the value of the eſtate concealed, to the creditors.

Hitherto every thing is in favour of the creditors; and the law ſeems to be rather rigid and ſevere againſt the bankrupt; but, in caſe he proves honeſt, it makes him full amends for all this rigour and ſeverity. For, if the bankrupt hath made an ingenuous diſcovery, hath conformed to the directions of the law, and hath acted in all points to the ſatisfaction of his creditors; and if they, or four parts in five of them in number and value (but none of them creditors for leſs than 20*l.*) will ſign a certificate to that purport; the commiſſioners are then to authenticate ſuch certificate under their hands and ſeals, and to tranſmit it to the lord chancellor: and he, or two judges whom he ſhall appoint, on oath made by the bankrupt that ſuch certificate was obtained without fraud, may allow the ſame; or diſallow it, upon cauſe ſhown by any of the creditors of the bankrupt.

If no cauſe be ſhewn to the contrary, the certificate is allowed of courſe; and then the bankrupt is intitled to a decent and reaſonable allowance out of his effects, for his future ſupport and maintenance, and to put him in a way of honeſt induſtry. This allowance is alſo in proportion to his former good behaviour, in the early diſcovery of the decline of his affairs, and thereby giving his creditors a larger dividend. For if his effects wil not pay one-half of his debts, or 10s. in the pound, he is left to the diſcretion of the commiſſioners and aſſignees, to have a competent ſum allowed him, not exceeding 3 per cent.; but if they pay 10s. in the pound, he is to be allowed 5 per cent.; if 12s. and 6d. then 7½ per cent.; and if 15s. in the pound, then the bankrupt ſhall be allowed 10 per cent.; provided that ſuch allowance do not in the firſt caſe exceed 200*l.* in the ſecond 250*l.* and the third 300*l.*

Beſides this allowance, he has alſo an indemnity granted him, of being free and diſcharged for ever from all debts owing by him, at the time he became a bankrupt; even though judgment ſhall have been obtained againſt him, and he lies in priſon upon execution for ſuch debts; and, for that among other purpoſes, all proceedings on commiſſion of bankrupt, are, on petition, to be entered on record, as a perpetual bar againſt actions to be commenced upon this account: though, in general, the production of the certificate properly allowed ſhall be ſufficient evidence of all previous proceedings. Thus the bankrupt becomes a clear man again; and by the aſſiſtance of his allowance and his own induſtry, may become an uſeful member of the commonwealth: which is the rather to be expected, as he cannot be intitled to theſe benefits, but by the teſtimony of his creditors themſelves of his honeſt and ingenuous diſpoſition; and unleſs his failure have been owing to misfortunes, rather than to miſconduct and extravagance.

4. The manner in which an eſtate in goods and chattels may tranſferred by bankruptcy.

By virtue of the ſtatutes before mentioned, all the perſonal eſtate and effects of the bankrupt are conſidered as veſted, by the act of bankruptcy, in the future aſſignees of his commiſſioners, whether they be goods in actual poſſeſſion, or debts, contracts, and other choſes in action; and the commiſſioners by their warrant may cauſe any houſe or tenement of the bankrupt to be broke open, in order to enter upon and ſeize the ſame. And when the aſſignees are choſen or approved by the creditors, the commiſſioners are to aſſign every thing over to them; and the property of every part of the eſtate is thereby as fully veſted in them as it was in the bankrupt himſelf, and they have the ſame remedies to recover it.

The property veſted in the aſſignees is the whole that the bankrupt had in himſelf, at the time he committed the firſt act of bankruptcy, or that has been veſted in him ſince, before his debts are ſatisfied or agreed for. Therefore it is uſually ſaid, that once a bankrupt, always a bankrupt: by which it is meant that a plain direct act of bankruptcy once committed, cannot be purged or explained away, by any ſubſequent conduct, as a dubious equivocal act may be; but that, if a commiſſion is afterwards awarded, the commiſſion and the property of the aſſignees ſhall have a relation, or reference, back to the original act of bankruptcy. Inſomuch that all tranſactions of the bankrupt are from that time abſolutely null and void, either with regard to the alienation of his property, or the receipt of his debts from ſuch as are privy to his bankruptcy: for they are no longer his property, or his debts, but thoſe of the future aſſignees. And if an execution be ſued out, but not ſerved and executed on the bankrupt's effects till after the act of bankruptcy, it is void, as againſt the aſſignees. But the king is not bound by this fictitious relation, nor is within the ſtatutes of bankrupts; for if, after the act of bankruptcy committed, and before the aſſignment of his effects, and extent iſſues for the debt of the crown, the goods are bound thereby. In France this doctrine of relation is carried to a very great length; for there, every act of a merchant, for 10 days precedent to the act of bankruptcy, is preſumed to be fraudulent, and is therefore void. But with us the law ſtands upon a more reaſonable footing; for as theſe acts of bankruptcy may ſometimes be ſecret to all but a few, and it would be prejudicial to trade to carry this notion to its utmoſt length, it is provided by ſtat. 19 Geo. II. c. 32, that no money paid by a bankrupt to a *bona fide*, or real, creditor, in a courſe of trade, even after an act of bankruptcy done, ſhall be liable to be refunded. Nor by ſtat. 1 Jac. I. c. 15, ſhall any debtor of a bankrupt that pays him his debt without knowing of his bankruptcy, be liable to account for it again: the intention of this relative power being only to reach fraudulent tranſactions, and not to diſtreſs the fair trader. The aſſignees may purſue any legal method of recovering this property ſo veſted in them, by their own authority; but cannot commence a ſuit in equity, nor compound any debts owing to the bankrupt, nor refer any matters to arbitration, without the conſent of the creditors, or the major part of them in value, at a meeting to be held in purſuance of notice in the gazette.

When they have got in all the effects they can reaſonably hope for, and reduced them to ready money, the aſſignees muſt, within 12 months after the commiſſion iſſued, give 21 days notice to the creditors of a meeting for a dividend or diſtribution; at which time they muſt produce their accounts, and verify them upon oath, if required. And then the commiſſioners ſhall direct a dividend to be made, as ſo much in the pound, to all creditors who have before proved, or ſhall then prove, their debts. This dividend muſt be made equally, and in a rateable proportion, to all the creditors, according to the quantity of their debts; no regard being had to the quality of them. Mortgages, indeed, for which the creditor has a real ſecurity in his own hands, are entirely ſafe; for the commiſſion of bankrupt reaches only the equity of redemption. So are alſo perſonal debts, where the creditor has a chattel in his hands, or a pledge or pawn, for the payment, or has taken the debtor's lands or goods in execution. And, upon the equity of the ſtat. 8 An. c. 14 (which directs, that upon all executions of goods being on any premiſes demiſed to a tenant, one year's rent, and no more, ſhall, if due, be paid to the landlord) it hath alſo been held, that under a commiſſion of bankrupt, which is in the nature of a ſtatute execution, the landlord ſhall be allowed his arrears of rent to the ſame amount, in preference to other creditors, even though he hath neglected to diſtrain while the goods remained on the premiſes: which he is otherwiſe entitled to do for his entire rent, be the quantum what it may. But otherwiſe judgments and recognizances (both which are debts of record, and therefore at other times have a priority) and alſo bonds and obligations by deed or ſpecial inſtrument (which are called debts by ſpecialty, and are uſually the next in order) theſe are all put on a level with debts by mere ſimple contract, and all paid *pari paſſu*. Nay, ſo far is this matter carried, that, by the expreſs proviſion of the ſtatutes, debts, not due at the time of the dividend made, as bonds or notes of hand, payable at a future day, ſhall be paid equally with the reſt, allowing a diſcount or drawback in proportion. And inſurances, and obligations upon bottomry or reſpondentia, *bona fide* made by the bankrupt, though forfeited after the commiſſion is awarded, ſhall be looked upon in the ſame light as debts contracted before any act of bankruptcy.

Within 18 months after the commiſſion iſſued, a ſecond and final dividend ſhall be made, unleſs all the effects were exhauſted by the firſt. And if any ſurplus remains, after paying every creditor his full debt, it ſhall be reſtored to the bankrupt. This is a caſe which ſometimes happens to men in trade, who involuntarily, or at leaſt unwarily, commit acts of bankruptcy, by abſconding and the like, while their effects are more than ſufficient.

ficient to pay the creditors. And if any ſuſpicious or malevolent creditor will take the advantage of ſuch acts, and ſue out a commiſſion, the bankrupt has no remedy, but muſt quietly ſubmit to the effects of his own imprudence, except that, upon ſatisfaction made to all the creditors, the commiſſion may be ſuperſeded. This caſe may alſo happen when a knave is deſirous of defrauding his creditors, and is compelled, by a commiſſion, to do them that juſtice which otherwiſe he wanted to evade. And therefore, though the uſual rule is that all intereſt on debts carrying intereſt ſhall ceaſe from the time of iſſuing the commiſſion, yet in caſe of a ſurplus left after payment of every debt, ſuch intereſt ſhall again revive, and be chargeable on the bankrupt or his repreſentatives.

BANNS *of marriage*, are certain ſolemn notices of matrimonial contracts made, in the pariſh church, before the marriage; that if there be any objection to either party as to prior engagements, &c. there may be an opportunity of making them. The publication of banns (popularly called aſking in the church) was intended as an expedient to prevent clandeſtine marriages; but a licence or diſpenſation is now eaſily procured, ſo that their uſe is defeated.—By the laws of the church, banns are to be publiſhed thrice, on three diſtant days, in the places where the parties live, on pain of nullity of marriage; and excommunications are threatened againſt thoſe who knowing impediments conceal them. See ſtat. 26 Geo. II. cap. 33; and MARRIAGE. The uſe of matrimonial banns is ſaid to have been firſt introduced in the Gallican church, though ſomething like it obtained even in the primitive times; and it is this Tertullian is ſuppoſed to mean by *trinundina promulgatio*.

BANNERETS, an ancient order of knights, or feudal lords, who, poſſeſſing ſeveral large fees, led their vaſſals to battle, under their own flag, or banner, when ſummoned thereto by the king.

Bannerets were ſecond to none but knights of the Garter; they were reputed the next degree below the nobility, and were allowed to bear arms with ſupporters, which none elſe may, under the degree of a baron. In France, it is ſaid, the dignity was hereditary; but in England, it died with the perſon that gained it. The order dwindled on the inſtitution of baronets by king James I. and at length became extinct. The laſt perſon created banneret was Sir John Smith, made ſo after Edghill-fight, for reſcuing the ſtandard of King Charles I.

The form of the banneret's creation was this; on a day of battle, the candidate preſented the flag to his king or general, who, cutting off the train, or ſkirt thereof, and making it a ſquare, returned it again, the proper banner of bannerets; who are hence ſometimes called the knights of the ſquare flag. There ſeems to have been bannerets created either in a different manner, or by others than the ſovereign; ſince king James, in the patent of baronets, gives them precedence to all knights bannerets, except ſuch as are created by the king himſelf in the field; which implies, either that there are ſome of this order created out of the field, or by inferior perſons.

BAPTISM, in theology, formed from the Greek βαπτιζω, of βαπτω, *I dip*, or *plunge*; a rite or ceremony by which perſons are initiated into the profeſſion of the Chriſtian religion.

The Jews practiſed a ceremony, which they called baptiſm, after circumciſion on their proſelytes, long before the coming of Jeſus Chriſt.—In the primitive times this ceremony was performed by immerſion, as it is to this day in the Oriental churches, according to the original ſignification of the word. The practice of the weſtern churches is, to ſprinkle the water on the head or face of the perſon to be baptized, except in the church of Milan, in whoſe ritual it is ordered, that the head of the infant be plunged three times into the water; the miniſter at the ſame time pronouncing the words, "*I baptize thee in the name of the Father, the Son, and the Holy Ghoſt;*" importing that by this ceremony the perſon baptized is received among the profeſſors of that religion, which God, the Father of all, revealed to mankind by the miniſtry of his Son, and confirmed by the miracles of his Spirit.—A triple immerſion was firſt uſed, and continued for a long time: this was to ſignify either the three days that our Saviour lay in the grave, or the three perſons in the Trinity. But it was afterwards laid aſide, becauſe the Arians uſed it: it was then thought proper to plunge but once.—Some are of opinion that the ſprinkling in baptiſm was begun in cold countries. It was introduced into England about the beginning of the ninth century. At the council of Celchyth, in 816, it was ordered, that the prieſt ſhould not only ſprinkle the holy water upon the head of the infant, but likewiſe plunge it in the baſon.—There are abundance of ceremonies delivered by eccleſiaſtical writers, as uſed in baptiſm, which are now diſuſed; as the giving milk and honey to the baptized, in the Eaſt; wine and milk in the Weſt, &c. The quakers diſallow the perpetuity of baptiſm in the Chriſtian church. See QUAKERS. It was alſo wholly rejected by the Valentinians, Manichees, Paulicians, and many other ſects.

Several of the Socinians have maintained, that baptiſm was only to be uſed by thoſe who are converted to Chriſtianity from a different profeſſion; and that though the children of ſuch proſelytes were to be baptized with their parents, all who deſcended from them were to be conſidered as baptized in them; and they urged the practice of proſelyte baptiſm among the Jews in ſupport of this opinion.

Theological authors diſtinguiſh three kinds of baptiſm; 1. Water Baptiſm, which is that above mentioned. 2. Baptiſm of fire, which is the perfect love of God, joined with an earneſt deſire to be baptized; called alſo the baptiſm of the Holy Ghoſt: on occaſion, this may ſupply the place of water baptiſm. 3. Baptiſm of blood; which is the martyrdom of a catechumen.

Baptiſm, in the primitive times, was only adminiſtered at Eaſter and Whitſuntide, except in caſes of neceſſity. The catechumens were not forward in coming to baptiſm: St. Ambroſe was not baptized, before he was elected biſhop of Milan; and ſome of the fathers not till the time of their death. Some deferred it out of a tender conſcience; and others out of too much attachment to the world; it being the prevailing opinion of the primitive times, that baptiſm, whenever conferred, waſhed away all antecedent ſtains and ſins. Divers of the fathers expoſed this ſuperſtitious delicacy to ſuch a degree, that they introduced a different extreme; the ridiculous zeal of ſome people carrying them to baptize even the dead by proxy. The opinion of the neceſſity of baptiſm in order to ſalvation, is grounded on thoſe two ſayings of our Saviour: "he that believeth and is baptized, ſhall be ſaved," and, "except a man be born of water and of the ſpirit, he cannot enter into the kingdom of God."

The cuſtom of ſprinkling children, inſtead of dipping them in the font, which at firſt was allowed in caſe of the weakneſs or ſickneſs of the infant, has ſo far prevailed, that immerſion is at length little practiſed. What principally tended to confirm the practice of affuſion or ſprinkling, was, that ſeveral of our Proteſtant divines, flying into Germany and Switzerland during the bloody reign of queen Mary, and returning home when queen Elizabeth came to the crown, brought back with them a great zeal for the proteſtant churches beyond ſea, where they had been ſheltered and received; and having obſerved, that at Geneva and ſome other places, baptiſm was adminiſtered by ſprinkling, they thought they could not do the church of England a greater piece of ſervice than by introducing a practice dictated by ſo great an oracle as Calvin. This, together with the coldneſs of our northern climate, was what contributed to baniſh entirely the practice of dipping infants into the font.

BAPTISTS, in eccleſiaſtical hiſtory (from βαπτιζω, *I baptize*); a denomination of Chriſtians, diſtinguiſhed from other Chriſtians by their particular opinions reſpecting the mode and the ſubjects of baptiſm.

Inſtead of adminiſtering the ordinance by ſprinkling or pouring water, they maintain that it ought to be adminiſtered only by immerſion. Such, they inſiſt, is the meaning of the word βαπτιζω; ſo that a command to baptize is a command to immerſe. Thus it was underſtood by thoſe who firſt adminiſtered it. John the Baptiſt, and the apoſtles of Chriſt, adminiſtered it in Jordan and other rivers, and places where there was much water. Both the adminiſtrators and the ſubjects are deſcribed as going down into, and coming up again out of, the water; and the baptized are ſaid to be buried in baptiſm, and to be raiſed again: which language could not, they ſay, be properly adopted on ſuppoſition of the ordinance being adminiſtered in any other manner than by immerſion. Thus alſo, they affirm, it was in general adminiſtered in the primitive church. Thus it is now adminiſtered in the Ruſſian and Greek church: and thus it is, at this day, directed to be adminiſtered in the church of England, to all who are thought capable of ſubmitting to it in this manner. With regard to the ſubjects of baptiſm, the baptiſts ſay that this ordinance ought not to be adminiſtrated to children or infants at all, nor to grown-up perſons in general; but to adults only of a certain character and deſcription. Our Saviour's commiſſion to his apoſtles, by which Chriſtian baptiſm was inſtituted, is to go and teach all nations, baptizing them; that is, ſay they, not to baptize all they met with; but firſt to inſtruct them—to teach all nations, or to preach the goſpel to every creature—and whoever receives it, him to baptize in the name of the Father, and of the Son, and of the Holy Ghoſt. To ſuch perſons, and to ſuch only, baptiſm appears to have been adminiſtered by the apoſtles, and the immediate diſciples of Chriſt. They are deſcribed as repenting of their ſins, as believing in Chriſt, and as having gladly received the word. Without theſe qualifications, Peter acquaints thoſe who were converted by his ſermon, that he could not have admitted them to baptiſm. Philip holds the ſame language in his diſcourſe with the eunuch; and Paul treats Lydia, the jailor, and others, in the ſame manner. Without theſe qualifications, Chriſtians in general think it wrong to admit perſons to the Lord's Supper; and, for the ſame reaſons, without theſe qualifications, at leaſt a profeſſion of them, the Baptiſts think it wrong to admit any to baptiſm. Wherefore they withhold it, not only from the impenitently vicious and profane, and from infidels, who have no faith, but alſo from infants and children, who have no knowledge, and are incapable of every action, civil and religious. They further inſiſt, that all poſitive inſtitutions depend entirely upon the will and

and declaration of the inſtitutor; and therefore, that reaſoning by analogy from abrogated Jewiſh rites is to be rejected, and the expreſs command of Chriſt reſpecting the mode and ſubjects of baptiſm ought to be our only rule.

The Baptiſts in England form one of the denominations of Proteſtant Diſſenters. They ſeparate from the eſtabliſhment for the ſame reaſons as their brethren of the other denominations do: and from additional motives derived from their particular tenets reſpecting baptiſm. The conſtitution of their churches, and their modes of worſhip, are congregational or independent: in the exerciſe of which they are protected, in common with other diſſenters, by the act of toleration. Before this act, they were liable to pains and penalties as nonconformiſts, and often for their peculiar ſentiments as Baptiſts. A proclamation was iſſued out againſt them, and ſome of them were burnt in Smithfield in 1538. They bore a conſiderable ſhare in the perſecutions of the laſt and of the preceding centuries: and, as it ſhould ſeem, in thoſe of ſome centuries before; for there were ſeveral among the Lollards and the followers of Wickliff, who diſapproved of infant baptiſm. There were many of this perſuaſion among the Proteſtants and reformers abroad. In Holland, Germany, and the North, they went by the names of Anabaptiſts and Mennonites; and, in Piedmont, and the ſouth, they were found among the Albigenſes and Waldeneſes. See the articles ANABAPTIST, ALBIGENSES, and REFORMATION.

The Baptiſts ſubſiſt under two denominations, viz. the Particular or Calviniſtical, and the General or Arminian. The former is by far the moſt numerous. Some of both donominations allow of mixed communion, viz. of perſons who have been ſprinkled in their infancy, and therefore unbaptized in the view of the Baptiſts; others diſallow it: and ſome of them obſerve the ſeventh day in the week as the ſabbath, apprehending the law that enjoined it, not to have been repealed by Chriſt or his apoſtles. But a difference of opinion reſpecting theſe and other matters, is not peculiar to the Baptiſts; it is common to all Chriſtians, and to all bodies of men who think and judge for themſelves.

See PÆDOBAPTISTS, under which article an account is given of the principal arguments in favour of infant baptiſm.

BARS, in muſic, denote ſtrokes down perpendicularly acroſs the lines of a piece of muſic, including between each two, a certain quantity or meaſure of time, which is various as the time is triple or common.

The uſe of bars in muſic is a modern invention. They cannot be traced higher than the year 1574, and ſeem not to have been in general uſe till the year 1653; ſo that probably this improvement is owing to Mr. Henry Lawes, who publiſhed his Airs and Dialogues in that year. In common time, between each two bars, is included the meaſure of four crotchets; in triple time, three crotchets. Their principal uſe is, to regulate the beating, or meaſure of the muſical time in a concert.

BARBADOES *Tar*, *petroleum Barbadenſe*, is a bitumen of a reddiſh black colour, and thick conſiſtence, approaching to that of common tar. It is found in ſeveral of the American iſlands, and particularly in Barbadoes, where it is greatly eſteemed as a ſubdorific, in diſorders of the breaſt, and as an external diſcutient and anti-paralytic. It in leſs inflammable than the other *petroles*, and leaves on being burnt a conſiderable quantity of aſhes. The oil obtained from it in diſtillation, and a balſam prepared by boiling it with one fourth its weight of flowers of ſulphur, are directed by the London college to be kept in the ſhops. LEWIS's MAT. MED.

BARBARA, in logic, the firſt mode of the firſt figure of ſyllogiſms. A ſyllogiſm in barbara, is that whereof all the propoſitions are univerſal and affirmative; the middle term being the ſubject in the firſt propoſition, and attribute or predicate in the ſecond.—For example:

BAR *Whoever ſuffers a man to ſtarve, whom he ought to ſuſtain, is a murderer:*
BA *Whoever is rich, and refuſes to give alms, ſuffers thoſe to ſtarve, whom he ought to ſuſtain:*
RA *Therefore, whoever is rich, and refuſes to give alms, is a murderer.* See the Syſtem, Part III. Sect. 4.

BARBARISM, in grammar, denotes an offence againſt the purity of ſtyle or language. In general, under barbariſms are comprehended things written, ſpoken, declined, or conjugated wrong; or uſed in a wrong quantity, or in an unuſual ſenſe; as when a word is uſed which is foreign to the language, and not received by the better or purer ſort of writers therein. Barbariſm is often charged, with great juſtice, on modern writers in the learned languages. The Latin books of late ages are full of Angliciſms, Gallicisms, Germanicisms, &c. according to the country of the author. But what ſhall we ſay to Caſp. Scioppius, who accuſes Cicero himſelf of barbariſms in his own language?

There are great diſputes, among critics, concerning barbariſms in the New Teſtament. Many pious perſons are ſtartled at the apprehenſion of any thing like a barbariſm in the inſpired books, as ſuppoſing it an objection to the inſpiration of them; yet this does not hinder but many of the Jews, after Abarbanel and others, ſtill maintain barbariſms in the Old Teſtament; in which they are ſeconded by M. Simon, Le Clerc, and others.

BARBER, one who makes a trade of ſhaving or trimming the beards of other men for money. Anciently, a lute or viol, or ſome ſuch muſical inſtrument, was part of the furniture of a barber's ſhop, which was uſed then to be frequented by perſons above the ordinary level of the people, who reſorted to the barber either for the cure of wounds, or to undergo ſome chirurgical operations, or, as it was then called, to be trimmed, a word that ſignified either ſhaving or cutting and curling the hair; theſe, together with letting blood, were the ancient occupations of the barber ſurgeon. As to the other important branch of ſurgery, the ſetting of fractured limbs, that was practiſed by another claſs of men called bone-ſetters, of whom there are hardly any now remaining. The muſical inſtruments in his ſhop were for the entertainment of waiting cuſtomers; and anſwered the end of a newſpaper, with which at this day thoſe who wait for their turn at the barber's amuſe themſelves. For the origin of the barber's pole, ſee the article APPELLATION.

BARBERRY-TREE, BERBERIS, a pipperiage-buſh, in botany, a genus of plants, belonging to the claſs of *hexandria monogynia*.

The common barberry-buſh grows naturally in the hedges in many parts of England, and is alſo cultivated in gardens for its fruit, which is pickled and uſed for garniſhing diſhes. See BERBERIS.

BARDS, the ancient poets among the Gauls and Britons, who deſcribed and ſung in verſe, the brave actions of the great men of their nation; with deſign to inculcate and recommend virtue, and even ſometimes to put an end to the difference between armies at the point of engagement.

The curioſity of man is great with reſpect to the tranſactions of his own ſpecies; and when ſuch tranſactions are deſcribed in verſe, accompanied with muſic, the performance is enchanting. An ear, a voice, ſkill in inſtrumental muſic, and, above all, a poetical genius, are requiſite to excel in that complicated art. As ſuch talents are rare, the few that poſſeſſed them were highly eſteemed; and hence the profeſſion of a bard, which beſide natural talents, required more culture and exerciſe than any other known art. Bards were capital perſons at every feſtival and at every ſolemnity. Their ſongs, which, by recording the achievements of kings and heroes, animated every hearer, muſt have been the entertainment of every warlike nation. We have Heſiod's authority, that in his time bards were as common as potters or joiners, and as liable to envy. Demodocus is mentioned by Homer as a celebrated bard; and Phemius, another bard, is introduced by him deprecating the wrath of Ulyſſes in the following words:

" O King! to mercy be thy ſoul inclin'd,
" And ſpare the poet's ever-gentle kind:
" A deed like this thy future fame would wrong,
" For dear to gods and men is ſacred ſong.
" Self-taught I ſing; by heav'n, and heav'n alone,
" The genuine ſeeds of poeſy are ſown;
" And (what the gods beſtow) the lofty lay,
" To gods alone, and godlike worth, we pay.
" Save then the poet, and thyſelf reward;
" 'Tis thine to merit, mine is to record." ODYSSEY, viii.

Cicero reports, that at Roman feſtivals, anciently, the virtues and exploits of their great men were ſung. The ſame cuſtom prevailed in Peru and Mexico, as we learn from Garcilaſſo and other authors. We have for our authority Father Gobien, that even the inhabitants of the Marian Iſlands have bards, who are greatly admired, becauſe in their ſongs are celebrated the feats of their anceſtors.

But in no part of the world did the profeſſion of bard appear with ſuch luſtre as in Gaul, in Britain, and in Ireland. Wherever the Celtæ or Gauls are mentioned by ancient writers, we ſeldom fail to hear of their druids and their bards; the inſtitution of which two orders was the capital diſtinction of their manners and policy. The druids were their philoſophers and prieſts; the bards, their poets and recorders of heroic actions: and both theſe orders of men ſeem to have ſubſiſted among them, as chief members of the ſtate, from time immemorial. The Celtæ poſſeſſed, from very remote ages, a formed ſyſtem of diſcipline and manners, which appears to have had a deep and laſting influence. Ammianus Marcellinus gives them this expreſs teſtimony, that there flouriſhed among them the ſtudy of the moſt laudable arts; introduced by the bards, whoſe office it was to ſing in heroic verſe the gallant actions of illuſtrious men: and by the druids, who lived together in colleges or ſocieties, after the Pythagorean manner, and philoſophizing upon the higheſt ſubjects, aſſerted the immortality of the human ſoul. Though Julius Cæſar, in his account of Gaul, does not expreſsly mention the bards; yet it is plain, that, under the title of *Druids*, he comprehends that whole college or order, of which the bards, who, it is probable, were the diſciples of the druids, undoubtedly made a part. It deſerves remark, that, according to his account the druidical inſtitution firſt took riſe in Britain, and paſſed from thence into Gaul; ſo that they who

*** This being an additional Sheet (5 F- 2) to this new Edition of the Work, the BINDER is deſired to be careful in placing it after (5 F--1). If it ſhould be thrown out or miſplaced in the Binding, the Work will be rendered imperfect.

aſpired to be thorough maſters of that learning were wont to reſort to Britain. He adds too, that ſuch as were to be initiated among the druids, were obliged to commit to their memory a great number of verſes, inſomuch that ſome employed 20 years in this courſe of education; and that they did not think it lawful to record theſe poems in writing, but ſacredly handed them down by tradition from race to race.

So ſtrong was the attachment of the Celtic nations to their poetry and their bards, that amidſt all the changes of their government and manners, even long after the order of the druids was extinct, and the natural religion altered, the bards continued to flouriſh; not as a ſet of ſtrolling ſongſters, like the Greek Ἀοιδοι, or rhapſodiſts, in Homer's time, but as an order of men highly reſpected in the ſtate, and ſupported by a public eſtabliſhment. We find them, according to the teſtimonies of Strabo and Diodorus, before the age of Auguſtus Cæſar; and we find them remaining under the ſame name, and exerciſing the ſame functions as of old, in Ireland, and in the north of Scotland, almoſt down to our own times. It is well known, that, in both theſe countries, every *regulus*, or chief, had his own bard, who was conſidered as an officer of rank in his court.

Of the honour in which the bards were held, many inſtances occur in Oſſian's poems. On all important occaſions, they were the ambaſſadors between contending chiefs; and their perſons were held ſacred.—"Cairbor feared to ſtretch his ſword to the bards, though his ſoul was dark. Looſe the bards (ſaid his brother Cathmor) they are the ſons of other times. Their voice ſhall be heard in other ages, when the kings of Temora have failed."—The bards, as well as the druids, were exempted from taxes and military ſervices, even in times of the greateſt danger; and when they attended their patrons in the field, to record and celebrate their great actions, they had a guard aſſigned them for their protection. At all the feſtivals and public aſſemblies they were ſeated near the perſon of the king or chieftain, and ſometimes even above the greateſt nobility and chief officers of the court. Nor was the profeſſion of the bards leſs lucrative than it was honourable. For, beſides the valuable preſents which they occaſionally received from their patrons when they gave them uncommon pleaſure by their performances, they had eſtates in land allotted for ther ſupport. Nay, ſo great was the veneration which the princes of theſe times entertained for the perſon of their poets, and ſo highly were they charmed and delighted with their tuneful ſtrains, that they ſometimes pardoned even their capital crimes for a ſong.

We may very reaſonably ſuppoſe, that a profeſſion that was at once ſo honourable and advantageous, and enjoyed ſo many flattering diſtinctions and deſirable immunities, would not be deſerted. It was indeed very much crowded; and the accounts which we have of the numbers of the bards in ſome countries, particularly in Ireland, are hardly credible. We often read, in the poems of Oſſian, of a hundred bards belonging to one prince, ſinging and playing in concert for his entertainment. Every chief bard, who was called *Allah Redan*, or *doctor in poetry*, was allowed to have 30 bards of inferior note conſtantly about his perſon; and every bard of the ſecond rank was allowed a retinue of 15 poetical diſciples.

Though the ancient Britons of the ſouthern parts of this iſland had originally the ſame taſte and genius for poetry with thoſe of the north, yet none of their poetical compoſitions of this period have been preſerved. Nor have we any reaſon to be ſurpriſed at this. For after the provincial Britons had ſubmitted quietly to the Roman government, yielded up their arms, and had loſt their free and martial ſpirit, they could take little pleaſure in hearing or repeating the ſongs of their bards in honour of the glorious achievements of their brave anceſtors. The Romans too, if they did not practiſe the ſame barbarous police which was long after practiſed by Edward I. of putting the bards to death, would at leaſt diſcourage them, and diſcountenance the repetition of their poems, for very obvious reaſons. Theſe ſons of the ſong being thus perſecuted by their conquerors, and neglected by their countrymen, either abandoned their country or their profeſſion; and their ſongs being no longer heard, were ſoon forgotten.

It is probable that the ancient Britons, as well as many other nations of antiquity, had no idea of poems that were made only to be repeated, and not to be ſung to the ſound of muſical inſtruments. In the firſt ſtages of ſociety in all countries, the two ſiſter arts of poetry and muſic ſeem to have been always united; every poet was a muſician, and ſung his own verſes to the ſound of ſome muſical inſtrument. This, we are directly told by two writers of undoubted credit, was the caſe in Gaul, and conſequently in Britain, in this period. "The bards (ſays Diodorus Siculus) ſung their poems to the ſound of an inſtrument not unlike a lyre." "The bards (according to Ammianus Marcellinus, as above hinted) celebrated the brave actions of illuſtrious men in heroic poems, which they ſung to the ſweet ſounds of the lyre." This account of theſe Greek and Latin writers is confirmed by the general ſtrain, and by many particular paſſages, of the poems of Oſſian: "Beneath his own tree, at intervals, each bard ſat down with his harp. They raiſed the ſong, and touched the ſtring, each to the chief he loved."

The invention of writing made a conſiderable change in the bard-profeſſion. It is now an agreed point, that no poetry is fit to be accompanied with muſic, but what is ſimple: a complicated thought or deſcription requires the utmoſt attention, and leaves none for the muſic; or, if it divide the attention, it makes but a faint impreſſion. The ſimple operas of Quinault bear away the palm from every thing of the kind compoſed by Boileau or Racine. But when a language, in its progreſs to maturity, is enriched with a variety of phraſes fit to expreſs the moſt elevated thoughts, men of genius aſpired to the higher ſtrains of poetry, leaving muſic and ſong to the bards; which diſtinguiſhed the profeſſion of a poet from that of a bard. Homer, in a lax ſenſe, may be termed a bard; for in that character he ſtrolled from feaſt to feaſt. But he was not a bard in the original ſenſe; he, indeed, recited his poems to crowded audiences; but his poems are too complex for muſic, and he probably did not ſing them, or accompany them with the lyre. The Trovadores of Provence were bards in the original ſenſe, and made a capital figure in the days of ignorance, when few could read, and fewer write. In later times, the ſongs of the bards were taken down in writing, which gave every one acceſs to them without a bard; and the profeſſion ſunk by degrees into oblivion. Among the Highlanders of Scotland, reading and writing in their own tongue is not common even at preſent; and that circumſtance ſupported long the bard-profeſſion among them, after being forgotten among the neighbouring nations.

Among the ancient Britiſh bards, the moſt celebrated is the great Merlyn, whoſe true name, according to Lhuyd, is Merdyhm. The genealogical ſonnets of the Iriſh bards are ſtill the chief foundations of the ancient hiſtory of Ireland. In the Highlands of Scotland there are conſiderable remains of many of the compoſitions of their old bards ſtill preſerved. But the moſt genuine, entire, and valuable remains of the works of the ancient bards, and perhaps the nobleſt ſpecimen of uncultivated genius, are the poems of Oſſian the ſon of Fingal, a king of the Highlands of Scotland, who flouriſhed in the ſecond and third century; lately collected by Mr. Macpherſon, and by him tranſlated from the Erſe or Galic language into Engliſh.

BARILLIA, or BARIGLIA, in the glaſs trade, a ſort of potaſhes imported from Spain, inferior in goodneſs to that of the Levant, called *polverine* when looſe, ſmall, and in powder, and *rochetta* when in hard rocky lumps. The frit made of theſe makes fine and clear cryſtal glaſs, eſpecially that from the *rochetta*, or the *polverine* in lumps; but the *barillia* of Spain, though it be uſually fatter, yet makes not a glaſs ſo white but uſually inclining a little to a bluiſh colour.

BARILLA, or BARILHA, the name of a plant cultivated in Spain for its aſhes, from which the pureſt kinds of mineral alkali are obtained. There are four plants, which, in the early part of their growth, bear ſo ſtrong a reſemblance to each other as would deceive any but the farmers and nice obſervers. Theſe four are, *barillo*, *gazul* (or, as ſome call it) *algazul*, *ſoza*, and *ſolicornia* or *ſalicor*. They are all burnt to aſhes; but applied to different uſes, as being poſſeſſed of different qualities. Some of the roguiſh farmers mix more or leſs of the three laſt with the firſt; and it requires a complete knowledge of the colour, taſte, and ſmell of the aſhes to be able to detect their knavery. All theſe aſhes contain a ſtrong alkali; but barilla is the beſt and pureſt, though not in the greateſt quantity. Upon this principle, it is fitteſt for making glaſs and bleaching linen; the others are uſed in making ſoap. Each of them would whiten linen; but all, except barilla, would burn it. A good crop of barilla impoveriſhes the land to ſuch a degree, that it cannot bear good barilla a ſecond time, being quite exhauſted. For this reaſon the richer farmers lay manure upon their ground, and let it lie fallow for a ſeaſon; at the end of which it is ſown afreſh, without any danger, as the weeds that have ſprung up in the year of reſt have carried off all the pernicious effects of the dung. A proper ſucceſſion of crops is thus ſecured by manuring and fallowing the different parts of the farm, each in their turn. The poorer tribe of cultivators cannot purſue the ſame method, for want of capital; and are therefore under the neceſſity of ſowing their lands immediately after manuring, which yields them a profit juſt ſufficient to afford a preſent ſcanty ſubſiſtence, though the quality and price of their barilla be but trifling.

The method uſed in making barilla is the ſame as that followed in Britain in burning kelp. The plant as ſoon as ripe is plucked up and laid in heaps, then ſet on fire. The ſalt juices run out below into a hole made in the ground, where they run into a vitrified lump, which is left about a fortnight to cool. An acre might give about a tun.

BARK, in the anatomy of plants, the exterior part of trees, correſponding to the ſkin of an animal. For its organization, texture, &c. ſee MICROSCOPIC OBJECTS, and Plate III. As animals are furniſhed with a panniculus adipoſus, uſually replete with fat, which inveſts and covers all the fleſhy parts, and ſcreens them from external cold; plants are encompaſſed with a bark replete with fatty juices, by means whereof the cold is kept out, and in winter-time the ſpiculæ of ice prevented from fixing and freezing.

freezing the juices in the veſſels: whence it is, that ſome ſorts of trees remain ever-green the year round, by reaſon their barks contain more oil than can be ſpent and exhaled by the ſun, &c. Ray's Wiſdom of God, &c. Part I. p. 103. Boerhaave mentions eight different ſpecies of juices lodged in the bark, viz. the watery ſap, or chyle, an oil, balm, pitch, reſin, colophony, gum, and gum in reſin.

The bark of trees in general is of a ſpongy texture; and, by many little fibres which paſs through the capillary tubes, whereof the wood conſiſts, it communicates with the pith; ſo that the proper nutriment of the tree, being imbibed by the roots, and carried up through the fine arterial veſſels of the tree by the warmth of the ſoil, &c. to the top of the plant, is uſually ſuppoſed to be there condenſed by the cold air, and in that form returns by its own gravity down the veſſels, which do the office of veins, lying between the wood and inner bark; leaving, as it paſſes by, ſuch parts of its juice as the texture of the bark will receive, and requires for its ſupport.

That ſoft whitiſh rind or ſubſtance between the inner bark and the wood, which Mr. Bradley thinks to do the office of veins, ſome account a third bark, only differing from the others in that its fibres are cloſer; it is this contains the liquid ſap, gums, &c. found in plants in the ſpring and ſummer months. It hardens by little and little, by means of the ſap it tranſmits, and is converted imperceptibly into the woody part of the tree. There are few trees without it; yet it is ſtill found in leſs quantity as the tree is more expoſed to the ſun; that of the oak is ordinarily about an inch thick. It is here that the corruption of trees generally begins; whence thoſe who fell and cut out trees, ought always to take care to leave as little of it on as poſſible.

The bark of roots is ſometimes yellow, as in dock; ſometimes red, as in biſtort: oftenеſt white. It is derived from the ſeed itſelf, being only the extenſion of the parenchyma of the radicle. It is variouſly ſized, being ſometimes very thin, as in the Jeruſalem artichoke, and in moſt trees. Sometimes it is thicker, and makes the greater part of the ſubſtance of the root, as in aſparagus and dandelion. In beet-root, the bark ſcarcely exceeds a good thick ſkin; whereas in a carrot, it is half the ſemidiameter of the root, being in ſome places above an inch over. This too is found common to the generality of roots, that their barks are proportionably thicker at bottom than at top.

The inner part of the bark, we have obſerved, annually lignifies, or turns to wood: the bark of a tree is found each year to divide and diſtribute itſelf two contrary ways: the outer part gives towards the ſkin, till it becomes ſkin itſelf, and at length falls off, like the ſcales or dandriff of our body, or the *exuviæ* of ſerpents; while the inmoſt portion is yearly diſtributed and added to the wood.

The bark is found truly continuous to the body of a tree, as the ſkin of our body is to the fleſh; contrary to the common opinion, which imports, that the bark only ſurrounds the tree, as a ſcabbard does a ſword, or a glove the hand; which ſeems confirmed by the eaſy ſlipping of the bark of willow, and moſt other trees, when full of ſap, from the wood. Their continuity is affected by means of the parenchyma, which is one entire body, running from the bark into the wood, and thus uniting both together. The reaſon why the bark ſlips ſo eaſily from the wood is, that moſt of the parenchymous parts are young veſſels formed every year ſucceſſively between the wood and the bark, and are much in the condition of the tender veſſels or fibres of the embryos in a womb, or egg; a thouſand of which are broken with the ſmalleſt force. The trees only live by the aſcent of the ſap in or between the bark and wood, and that if a circle be drawn round any tree (except, perhaps, aſh) by inciſion to the timber, how thin ſoever the knife be, provided no part of the thickneſs of the bark remain uncut, the tree will die from that part upwards, has been the ſtanding doctrine of naturaliſts of all ages, and is delivered for fact by Pliny, and others. Dr. Plott aſſerts this to be a popular error from the inſtance of a large old elm in Magdalen-college grove, quite diſbarked around, at moſt places two feet, at ſome four feet, from the ground, which yet grew and flouriſhed many years, as well as any tree in the grove. Beſides, it was entirely without pith, being hollow within as a drum: and the ſame is confirmed from the hiſtory of the elm in the Thuilleries, related by M. Parent, which lived, and put out leaves, though entirely ſtripped of bark from top to bottom. Add, that the plane and cork trees diveſt themſelves yearly of all their old bark, and acquire a new one, as ſnakes do their ſkins: and in the change from one to the other, it is evidently not by the bark that they are nouriſhed. Some infer from hence, that the bark never feeds the wood. Dr. Plott is more reſerved in his concluſion, arguing only, that hence it ſeems to follow, that there muſt be other veſſels, beſides the ſap-veſſels of the bark, capable of the office of conveying ſap. It is probable when the ordinary conveyance fails, ſome of the woody part, which had all once been ſap-veſſels, reſumes its ancient office; or, as the author laſt mentioned conjectures, they ſtill ſo far retain their office of conveying ſap, as to keep a tree alive, though not to augment it; which may, perhaps, be one different uſe of thoſe ſap-veſſels in wood from thoſe in the bark, the former being ſufficient for the continuation of a tree, and the latter ſerving only for its augmentation. Plin. Hiſt. Nat. lib. xvii. c. 24. Phil. Tranſ. No. 43. Hiſt. Acad. Scien. 1709, and 1711. Plott's Nat. Hiſt. Oxf. c. vi. § 65.

Mr. Brotherton has given ſome new experiments, which ſeem to decide the controverſy, and ſhew that the bark is not the vehicle of vegetation: he hacked a crab-tree round with a hatchet, ſo as, beſides cutting off the bark, to cut pretty deep into the wood, for the breadth of about four inches; yet the ſame year it was obſerved to increaſe very conſiderably in thickneſs above the ſaid hacking, and to ſhoot in length of wood about one foot: the next year it alſo grew conſiderably, and ſhot in length five inches; the third year it died to the very root. The like was found in another tree, part of whoſe bark was eaten off by the canker: the lower part ſtood without increaſe, and by degrees the wood rotted: the upper part increaſed to the third year, and then died alſo.

M. Magnol mentions an olive-tree, from which a circular ring of bark, being cut away, the tree that year bore, above the place of inciſion, double the quantity of flowers and fruit which it uſed to bear. Mr. Reneaume relates a fact nearly a-kin to this. In the country about Aix and Marſeilles, when an olive-tree grows old, and almoſt ready for felling, they have a method of making it firſt yield all the fruit which it is capable of producing, by cutting a circular ring of bark, an inch broad, from one of its young branches, and in its place putting an equal ring of bark taken from the branch of a young bearing olive-tree; the effect of this engraftment is, that the branches of the old tree bear plentifully the enſuing year, and thoſe of the young one die away. Hiſt. Acad. Sc. 1711. From the whole, Mr. Brotherton concludes, that the ſap, moſt of it, if not all, aſcends in the veſſels of the woody part, and not by the bark, nor between the bark and the wood. Phil. Tranſ. No. 187, p. 312.

Mr. Leewenhoeck, on the other hand, has given ſeveral experiments and obſervations with the microſcope, to ſhew that the bark of trees is produced from the wood, and not the wood from the bark. Philoſ. Tranſ. No. 202.

It is very remarkable, that trees ſtripped in the time of the ſap, and ſuffered to die, afford timber heavier, made uniformly denſe, ſtronger, and fitter for ſervice, than if the tree had been cut down in its healthy ſtate. Something of a like nature has been obſerved by Vitruvius and Evelyn. Mem. Acad. Scienc. 1738. The bark has its peculiar diſeaſes, and is infected with inſects peculiar to it. Moſs is a diſeaſe of the bark. Wounds of the bark often prove mortal.

Of the bark of willows and linden trees is ordinarily made a kind of ropes. The Siameſe make their cordage of the bark of the cocoa-tree, which is alſo the caſe in moſt of the Aſiatic and African nations. In reality, the flax and hemp, with all their toughneſs, are only the ſap-veſſels, or ligneous fibres of the bark of thoſe plants.

There are a great many kinds of barks in uſe in the ſeveral arts, ſome in Agriculture, ſome in Medicine, as the *quinquina*, or Jeſuit's bark, *macer*, *chacarilla*, *&c.* others in dying, as the bark of the alder; others in ſpicery, as cinnamon, *caſſia lignea*; others are uſeful on other occaſions, as cork; that of a kind of birch is uſed by the Indians for canoes capable of holding twenty-four perſons. The bark of the oak has been long uſed in tanning leather, and even thought eſſential to that operation: but a different ſubſtance has been lately diſcovered, which anſwers the purpoſe full as well, and may be procured at a much cheaper rate; we mean oak ſawduſt, or the chips of oak reduced to powder. This valuable ſecret was purchaſed by the ſociety for the encouragement of arts, &c. See the article TAN.

The ancients wrote their books on barks, eſpecially thoſe of the aſh, and *tilia* or lime-tree; not on the exterior or outer bark, but on the inner and finer, called *philyra*; which are of ſo durable a texture, that there are manuſcripts on it, ſtill extant, a thouſand years old.

In the Eaſt Indies, they manufacture the bark of a certain tree into a kind of ſtuff or cloth. It is ſpun and dreſſed much after the manner of hemp. The long filaments ſeparated from it, upon beating and ſteeping it in water, compoſe a thread, of a middle kind between ſilk and common thread, neither ſo ſoft nor bright as ſilk, nor ſo hard or flat as hemp. See Neuman's Works, p. 428, note. Some of theſe ſtuffs are pure bark, and are called pinaſſes, biambonnes, &c. In others they mix ſilk with the bark, and call them ginghams and niſſas: the fountalungees too are part ſilk, part bark, and are only diſtinguiſhed by being ſtriped. Bark alſo makes a good manure, eſpecially that of oak, which is rich in ſalt; but the better ſort is reſerved for tanning.

In the iſland of Otaheite, the natives make their cloth, which is of three kinds, of the bark of three different trees; the paper-mulberry above mentioned, the bread fruit-tree, and the cocoa-tree. That made of the mulberry is the fineſt and whiteſt, and worn chiefly by the principal people. See BANKES's GEOGRAPHY.

BARKING *of trees*, is the peeling off or ſtripping the bark from the wood. The month of May is the ſeaſon for barking trees

of trees, becauſe then the ſap looſens the bark from the wood; which it is very hard to effect in any other time, unleſs the ſeaſon be very wet; heat and dryneſs being always oppoſite thereto. Maliciouſly barking of apple-trees, or other fruit-trees, is made felony by 37 Hen. VIII. c. 6.

BARKING is alſo a name given to the cry of dogs and foxes. The term is alſo applied to certain quaint noiſes made by ſick perſons in ſome diſeaſes. In cynic ſpaſms, and epileptic fits, the patient ſometimes ſnarls, howls and barks, with all the notes of a dog. But it is in the hydrophobia that barking has been oftenеſt obſerved: perſons ſeized with this are apt to rave, bite, ſnarl, and make a harſh noiſe in their throats, which is called barking.—Vide Phil. Tranſ. No. 280, No. 323, No. 207, and No. 242. See alſo the Syſtem of MEDICINE, Genus 47.

BARK, or *Jeſuit's Bark*, is a name given by way of eminence to the quinquina or cinchona. For a copious account of its nature and medicinal uſes, ſee the article CINCHONA.

BARLEY, in *Botany*, a gramineous, frumentaceous herb, whoſe ſeeds are of the larger ſort, being covered with a huſk, growing in a ſpike, and the grains bearded. The principal uſe of barley among us is for making beer, in order to which it is firſt malted. See BREWING. Barley has alſo its medicinal virtues, in which it reſembles oats: the wort of malt is an excellent antiſcorbutic. For a copious account of the moſt approved methods of cultivating barley, ſee the Syſtem of AGRICULTURE, Sect. IV.

The Spaniards, among whom malt liquors are little known, feed their horſes with barley as we do with oats. In Scotland, barley is a common ingredient in broths; and the conſumption of it for that purpoſe is very conſiderable, barley-broth being a diſh as frequent there as that of ſoup in France.

Pearl Barley, and French Barley; theſe are barley freed of the huſk by a mill: the diſtinction between the two being, that the pearl barley is reduced to the ſize of ſmall ſhot, all but the very heart of the grain being ground away.

Barley-water is a decoction of either of theſe, and is reputed ſoft and lubricating, of frequent uſe in phyſic.

This well-known decoction is a very uſeful drink in many diſorders; and is recommended with nitre, by ſome authors of reputation, in ſlow fevers.

BARM, otherwiſe called *Yeaſt*; the head or working producing by the fermentation of ale or beer. It is the froth that forms on the ſurface of the beer or wine of grains during their fermentation; which, mixed with dough, raiſes it more quickly and better than leaven, and makes the lighteſt bread.

BAROMETER, a machine for meaſuring the weight of the atmoſphere, and the variations therein, in order chiefly to determine the changes of weather and the heights of mountains, &c. to which uſe it was firſt applied by M. Paſcal, in leſs than four years after the invention of it. The word is compounded of βαρος, weight, and μετρον, meaſure. The barometer is frequently confounded with the baroſcope, though ſomewhat improperly; the latter, in ſtrictneſs, being a machine that barely ſhews an alteration in the weight of the atmoſphere: but it is one thing to know that the air is heavier at one time than another, and another to meaſure how much the difference is; which is the buſineſs of the barometer. The barometer is founded on the Torricellian experiment, as it is called, from its inventor Torricelli, in 1643.

The common barometer conſiſts of a glaſs tube hermetically ſealed at one end, and filled with quickſilver well defecated and purged of its air. The finger being then placed on the open end, in immediate contact with the mercury, ſo as not to admit the leaſt particle of air, the tube is inverted, and the lower end plunged into a baſon of the ſame prepared mercury; then upon removing the finger, the mercury in the tube will join that in the baſon, and the mercurial column in the tube will ſubſide to the height of 29 or 30 inches, according to the ſtate of the atmoſphere at that time. As the weight of the atmoſphere diminiſhes, the mercury in the tube will here deſcend; on the contrary, as it increaſes the mercury will again aſcend: the column of mercury ſuſpended in the tube being always equal to the weight of the incumbent atmoſphere. This is the principle on which all barometers are conſtructed.

BARON, a perſon who holds a barony. The origin and primary import of this term is much conteſted.

The term *Baron* is more particularly uſed, among us, for a lord or peer of the loweſt claſs; or a degree of nobility next below that of a viſcount, and above that of a knight or a baronet.

In ancient records the word baron included all the nobility of England, becauſe regularly all noblemen were barons, though they had alſo a higher dignity. But it hath ſometimes happened, that, when an ancient baron hath been raiſed to a new degree of peerage, in the courſe of a few generations the two titles have deſcended differently: one perhaps to the male deſcendents, the other to the heirs general; whereby the earldom or other ſuperior title hath ſubſiſted without a barony; and there are alſo modern inſtances, where earls and viſcounts have been created without annexing a barony to their own honours; ſo that now the rule doth not hold univerſally that all peers are barons.

The original and antiquity of barons has occaſioned great inquiries among our Engliſh antiquarians. The moſt probable opinion is ſuppoſed to be, that they were the ſame with our preſent lords of manors; to which the name of court baron (which is the lord's court, and incident to every manor) gives ſome countenance. It is ſaid the original name of this dignity in England was *vavaſſour*, which by the Saxons was changed into *thane*, and by the Normans into *baron*. It may be collected from King John's magna charta, that originally all lords of manors, or barons, had ſeats in the great council or parliament: but ſuch is the deficiency of public records, that the firſt precept to be found is of no higher date than the 49th year of King Henry III.; which, although it was iſſued out in the king's name, was neither by his authority nor by his direction: for, not only the king himſelf, but his ſon Prince Edward, and moſt of the nobility who ſtood loyal to him, were then priſoners in the hands of the rebellious barons; having been ſo made in the month of May preceding, at the battle of Lewes, and ſo continued until the memorable battle of Eveſham, which happened in Auguſt the year following; when, by the happy eſcape of Prince Edward, he reſcued the king and his adherents out of the hands of Simon Mountfort, Earl of Leiceſter. It cannot be doubted but that ſeveral parliaments were held by King Henry III. and King Edward I.; yet no record is to be found giving any account thereof (except the 5th of King Edward I.) until the 22d year of the reign of the laſt-mentioned king.

Before the 49th of Hen. III. the ancient parliaments conſiſted of the archbiſhops, biſhops, abbots, earls, and barons. Of theſe barons there were two ſorts: the greater barons, or the king's chief tenants, who held of him *in capite* by barony; and the leſſer barons, who held of the firſt by military ſervice *in capite*. The former had ſummons to parliament by ſeveral writs; and the latter (*i. e.* all thoſe who were poſſeſſed of thirteen knights fees and a quarter) had a general ſummons from the ſheriff in each county. Thus things continued till the 49th of Henry III. But then, inſtead of keeping to the old form, the prevailing powers thought fit to ſummon, not all, but only thoſe of the greater barons who were of their party; and, inſtead of the leſſer barons who came with large retinues, to ſend their precepts to the ſheriffs of each county, to cauſe two knights in every ſhire to be choſen, and one or two burgeſſes for each borough, to repreſent the body of the people reſiding in thoſe counties and boroughs; which gave riſe to the ſeparation into two houſes of parliament. By degrees the title came to be confined to the greater barons, or lords of parliament only; and there were no other barons among the peerage but ſuch as were ſummoned by writ, in reſpect of the tenure of their lands or baronies, till Richard II. firſt made it a mere title of honour, by conferring it on divers perſons by his letters patent.

When a baron is called up to the houſe of peers by writ of ſummons, the writ is in the king's name, and he is directed to come to the parliament appointed to be held at a certain time and place, and there to treat and adviſe with his majeſty, the prelates, and nobility, about the weighty affairs of the nation. The ceremony of the admiſſion of a baron into the houſe of peers is thus: He is brought into the houſe between two barons, who conduct him up to the Lord Chancellor, his patent or writ of ſummons being carried by a king at arms, who preſents it to the Lord Chancellor, who reads it, and then congratulates him on his becoming a member of the houſe of peers, and inveſts him with his parliamentary robe. The patent is then delivered to the clerk of the parliament, and the oaths are adminiſtered to the new peer, who is then conducted to his ſeat on the barons' bench. Some barons hold their ſeats by tenure. The firſt who was raiſed to this dignity by patent was John de Beauchamp, of Holt Caſtle, created Baron of Kidderminſter in Worceſterſhire, to him and his heirs-male, by King Richard II. in the 11th year of his reign. He inveſted him with a mantle and cap. The coronation-robes of a baron are the ſame as an earl's, except that he has only two rows of ſpots on each ſhoulder. In like manner, his parliamentary robes have but two guards of white fur, with rows of gold lace. In other reſpects they are the ſame as other peers. King Charles II. granted a coronet to the barons. It has ſix pearls, ſet at equal diſtances on the chaplet. His cap is the ſame as a viſcount's. His ſtyle is Right Honourable; and he is ſtyled by the king or queen, Right Truſty and Well Beloved.

For rank in point of creation, &c. of the reſpective barons of Great Britain and Ireland, ſee the Syſtem of PEERAGE. For their Arms, Mottos, &c. ſee the Plates annexed.

BARONS of the exchequer are judges, four in number, one of whom is called the chief baron, and the other three puiſne barons, to whom the adminiſtration of juſtice is committed in cauſes between the king and his ſubjects, touching matters belonging to the exchequer, and the king's revenue. They are called barons, becauſe barons of the realm were uſed to be employed in that office. Their office is alſo to look to the accounts of the king; to which end they have auditors under them; as well as to decide cauſes relating to the revenue, brought by any

means into the exchequer; ſo that, of late, they have been conſtantly perſons learned in the law. See COURT.

Barons of the cinque ports, are members of the houſe of commons, elected by the five ports, two for each port. See CINQUE PORTS. Thoſe who have been mayors of Corſe-Caſtle, in Dorſetſhire, are alſo denominated barons: as were, formerly, the chief citizens of London.

BARONET, a dignity or degree of honour next beneath a baron, and above a knight; having precedency of all knights excepting thoſe of the garter, and being the only knighthood that is hereditary. The dignity of baronet is given by patent, and is the loweſt degree of honour that is hereditary. The order was founded by king James I. at the ſuggeſtion of Sir Robert Cotton, in 1611, when 200 baronets were created at once; to which number it was intended they ſhould always be reſtrained: but it is now enlarged at the king's pleaſure, without limitation.

They had ſeveral conſiderable privileges given them, with an *habendam* to them and their heirs male. They were allowed to charge their coat with the arms of Ulſter, which are, in a field argent, ſiniſter hand, gules; and that upon condition of their defending the province of Ulſter in Ireland againſt the rebels, who then haraſſed it extremely: to which end they were each to raiſe and keep up 30 ſoldiers at their own expence for three years together, or to pay into the exchequer a ſum ſufficient to do it; which at 8d. per day per head, was 109*l*. So that, including fees, the expence of this dignity may be about 1200*l*. ſterling. To be qualified for it, one muſt be a gentleman born, and have a clear eſtate of 1000*l*. per annum.

Baronets take place according to the dates of their patents; by the terms of which no honour is to be erected between barons and baronets. The title *Sir* is granted them by a peculiar clauſe in their patents, though they be not dubbed knights: but both a baronet, and his eldeſt ſon, being of full age, may claim knighthood.—The firſt baronet who was created was Sir Nicholas Bacon, of Redgrave in Suffolk, whoſe ſucceſſor is therefore ſtyled *Primus Baronetorum Angliæ*.

BARONETS of *Scotland*, called alſo Baronets of Nova Scotia. The order of knights-baronets was alſo deſigned to be eſtabliſhed in Scotland in the year 1621, by king James I. for the plantation and cultivation of the province of Nova Scotia in America; but it was not actually inſtituted till the year 1625, by his ſon Charles I. when the firſt perſon dignified with this title was Sir Robert Gordon of Gordonſtone, a younger ſon of the Earl of Sutherland. The king granted a certain portion of land in Acadia or New Scotland, to each of them, which they were to hold of Sir William Alexander (afterwards Earl of Stirling) for their encouragement who ſhould hazard their lives for the good and increaſe of that plantation, with precedency to them, and their heirs-male for ever, before all knights called *equites aurati*, and all leſſer barons called lairds, and all other gentlemen, except Sir William Alexander, his majeſty's lieutenant in Nova Scotia, his heirs, their wives and children; that the title of *Sir* ſhould be prefixed to their Chriſtian name, and Baronet added to their ſurname; and that their own and their eldeſt ſons' wives ſhould enjoy the title of Lady, Madam, or Dame.—His majeſty was ſo deſirous of adding every mark of dignity to this his favourite order, that, four years after its inſtitution, he iſſued a royal warrant, granting them the privilege of wearing an orange ribbon and a medal; which laſt was preſented to each of them by the king himſelf, according to the words of the warrant. All the privileges of the order, particularly this of wearing the medal, were confirmed, at the king's requeſt, by the conventionof eſtates, in the year 1690; and in order to eſtabliſh them on the moſt ſolid foundation, they were again confirmed by an act of the parliament of Scotland, in the year 1693. This mark of diſtinction fell to the ground, with all the other honours of Scotland, during the uſurpation of the long parliament and of Oliver Cromwel. It continued in general, though not total diſuſe, after the Reſtoration. There have been former meetings of the order to revive the uſe of it, one in the year 1721, and another in 1734. Theſe meetings proved ineffectual, becauſe the proper ſteps towards its revival were not taken; but under the auſpices of our illuſtrious monarch George III. ſuch meaſures were concerted in the year 1775 as have effectually eſtabliſhed this honourable dignity.

BARONETS of Ireland. This order was likewiſe inſtituted by King James I. in the 18th year of his reign, for the ſame purpoſe, and with the ſame privileges, within the kingdom of Ireland as he had conferred on the like order in England; for which the Iriſh baronets paid the ſame fees into the treaſury of Ireland. The firſt of that kingdom who was advanced to this hereditary dignity was Sir Francis Blundell, then ſecretary for the affairs of Ireland. Since his time, ſeveral have been created, no number being limited.

BARRACKS, or BARACKS, places for ſoldiers to lodge in, eſpecially in garriſons.—Barracks, when damp, are greatly prejudicial to the health of the ſoldiers lodged in them; occaſioning dyſenteries, intermitting fevers, coughs, rheumatic pains, &c. For which reaſon, quarter-maſters ought to be careful in examining every barrack offered by the magiſtrates of a place; rejecting all ground-floors in houſes that have either been uninhabited, or have any ſigns of moiſture.

BARREL, a certain quantity, or weight, of ſeveral merchandizes, which is various as the commodities vary. The Engliſh barrel, wine meaſure, contains the eighth part of a ton, the fourth part of a pipe, and the moiety of a hogſhead, that is, thirty-one gallons and a half; of beer it contains thirty-ſix gallons; and of ale thirty-two gallons. The barrel of beer, vinegar, or liquid preparing for vinegar, is to contain 34 gallons, according to the ſtandard of the ale quart. 10 and 11 W. III. cap. 21.

The barrel of herrings is to contain 32 gallons, wine meaſure; being about 28 gallons, old ſtandard: uſually amounting to about 1000 full herrings, 13 Eliz. cap. 11. The barrel of ſalmon is to contain 42 gallons, 5 G. cap. 18.—And the barrel of eels, the ſame, 22 Ed. IV. cap. 2. The barrel of ſoap is to contain 256 pounds, 10 A. cap. 19. The barrel, or barrilla, of Florence, is a liquid meaſure, containing 20 flaſques, flaſks, or one-third of a ſtar or ſtaio.

BARREN-CORN, the name given to a diſtemper in corn by M. Aimer, who firſt obſerved it. It is moſt common in wheat and rye; the ears of which are long, lean, and white; in ſome the ſtamina are dry, tranſparent, and horned: the female organs are ſmall, whiter, and leſs velvetty than in healthy ears; in others the filaments are ſmaller, the apices are void of farina, and the ſtigmata badly unfolded. It is owing either to the too ſudden growth of the corn; to froſt, or to hot gleams of ſun-ſhine after hard ſhowers; and ſometimes, though very rarely, to inſects. Count Ginnani imputes this diſeaſe of corn to the faultineſs of the ſoil; and he recommends particular attention to the amendment of it by ſuch means as are beſt ſuitable to its nature; and he alſo directs to change the ſeed every year.

BARRETRY, in law, is the offence of frequently exciting and ſtirring up ſuits and quarrels between his Majeſty's ſubjects, either at law or otherwiſe. The puniſhment for this offence, in a common perſon, is by fine and impriſonment: but if the offender (as too frequently is the caſe) belongs to the profeſſion of the law, a barreter, who is thus able as well as willing to do miſchief, ought alſo to be diſabled from practiſing for the future. And indeed it is enacted by ſtatute 12 Geo. I. c. 22, that if any one, who hath been convicted of forgery, perjury, ſubornation of perjury, or common barretry, ſhall practiſe as an attorney, ſolicitor, or agent in any ſuit; the court, upon complaint, ſhall examine it in a ſummary way; and, if proved, ſhall direct the offender to be tranſported for ſeven years. Hereunto alſo may be referred another offence, of equal malignity and audaciouſneſs; that of ſuing another in the name of a fictitious plaintiff, either one not in being at all, or one who is ignorant of the ſuit. This offence, if committed in any of the king's ſuperior courts, is left, as a high contempt, to be puniſhed at their diſcretion; but in courts of a lower degree, where the crime is equally pernicious, but the authority of the judges not equally extenſive, it is directed, by the ſtatute 8 Eliz. c. 2, to be puniſhed by ſix months' impriſonment, and treble damages to the party injured.

BARRISTER, is a counſellor learned in the law, admitted to plead at the bar, and there to take upon him the protection and defence of clients. They are termed *juriſconſulti*; and in other countries called *licentiati in jure*: and anciently barriſters at law were called apprentices of the law, in Latin *apprentici juris nobilioris*. The time before they ought to be called to the bar by the ancient orders, was eight years, now reduced to five; and the exerciſes done by them (if they were not called *ex gratia*) were twelve grand moots, performed in the inns of Chancery in the time of the grand readings, and 24 petty moots in the term times, before the readers of the reſpective inns: and a barriſter newly called is to attend, the ſix (or four) next long vacations, the exerciſe of the houſe, viz. in Lent and Summer, and is thereupon for thoſe three (or two) years ſtyled a vacation barriſter. Alſo they are called utter barriſters, i. e. pleaders outſter the bar, to diſtinguiſh them from benchers, or thoſe that have been readers, who are ſometimes admitted to plead within the bar, as the king, queen, or prince's counſel are.

BARROWS, in ancient topography, artificial hillocks or mounts, met with in many parts of the world, intended as repoſitories for the dead, and formed either of ſtone heaped up, or of the earth. For the former more generally known by the name of cairns, ſee CAIRNS.—Of the latter Dr. Plott takes notice of two ſorts in Oxfordſhire: one placed on the military ways; the other in the fields, meadows, or woods; the firſt ſort doubtleſs of Roman erection, the other more probably erected by the Britons or Danes. We have an examination of the barrows in Cornwall by Dr. Williams, in the Phil. Tranſ. No. 458, from whoſe obſervations we find that they are compoſed of foreign or adventitious earth; that is, ſuch as does not riſe on the place, but is brought from ſome diſtance.—Monuments of this kind are alſo very frequent in Scotland. On digging into the barrows, urns have been found in ſome of them, made of calcined earth, and containing burnt bones and aſhes; in others, ſtone cheſts containing bones entire; in others, bones neither lodged in cheſts nor depoſited in urns.

Ancient Greece and Latium concurred in the ſame practice with the natives of this iſland. Patroclus among the Greeks, and

Hector among the Trojans, received but the ſame funeral honours with our Caledonian heroes; and the aſhes of Dercennus, the Laurentine monarch, had the ſame ſimple protection. The urn and pall of the Trojan warrior might perhaps be more ſuperb than thoſe of a Britiſh leader: the riſing monument of each had the common materials from our mother earth.

The ſnowy bones his friends and brothers place,
With tears collected, in a golden vaſe.
The golden vaſe in purple palls they roll'd,
Of ſofteſt texture and inwrought with gold.
Laſt, o'er the urn the ſacred earth they ſpread,
And rais'd a tomb, memorial of the dead.

Pope's Homer's Iliad, xxiv. 1003.

Or, as it is more ſtrongly expreſſed by the ſame elegant tranſlator, in the account of the funeral of Patroclus:

High in the midſt they heap thy ſwelling bed
Of raiſing earth, memorial of the dead. Ib. xxiii. 309.

BARTERING, the act of trucking or exchanging one commodity for another of like value. The word comes from the Spaniſh *barater*, to deceive, or circumvent in bargaining; perhaps becauſe thoſe who deal this way uſually endeavour to over-reach one another.

This is alſo called *bartry*, 13 Eliz. cap. 7. In order to ſolve all queſtions that occur under this article, ſee the Syſtem of ARITHMETIC, Chap. XI. throughout.

ST. BARTHOLOMEW's-DAY, a feſtival of the Chriſtian church, celebrated on the 24th of Auguſt. St. Bartholomew was one of the twelve Apoſtles; and is eſteemed to be the ſame as Nathaniel, one of the firſt diſciples that came to Chriſt.

It is thought this apoſtle travelled as far as India, to propagate the goſpel; for Euſebius relates, that a famous philoſopher and Chriſtian, named *Pantænus*, deſiring to imitate the apoſtolical zeal in propagating the faith, and travelling for that purpoſe as far as India, found there, among thoſe who yet retained the knowledge of Chriſt, the goſpel of St. Matthew, written, as the tradition aſſerts, by St. Bartholomew, one of the twelve apoſtles, when he preached the goſpel in that country. From thence he returned to the more northern and weſtern parts of Aſia, and preached to the people of Hierapolis; then in Lycaonia; and laſtly at Albania, a city upon the Caſpian Sea; where his endeavours to reclaim the people from idolatry were crowned with martyrdom, he being (according to ſome writers) flayed alive, and crucified with his head downwards.—There is mention made of a Goſpel of St. Bartholomew, in the preface to Origen's Homilies on St. Luke, and in the preface to St. Jerome's Commentary on St. Matthew: but it is generally looked upon as ſpurious, and is placed by pope Gelaſius among the apocryphal books.

BARUCH *(The Prophecy of)*, one of the apocryphal books, ſubjoined to the canon of the Old Teſtament. Baruch was the ſon of Neriah, who was the diſciple and amanuenſis of the prophet Jeremiah. It has been reckoned part of Jeremiah's prophecy, and is often cited by the ancient fathers as ſuch. Joſephus tells us, Baruch was deſcended of a noble family; and it is ſaid in the book itſelf, that he wrote this prophecy at Babylon; but at what time is uncertain. It is difficult to determine in what language this prophecy was originally written. There are extant three copies of it; one in Greek, the other two in Syriac; but which of theſe is, or whether any one of them be, the original is uncertain.

BASALTES (from *baſal*, "iron;" or *βασανιζω*, *diligenter examino*) in mineralogy, a heavy, hard ſtone, chiefly black or green, conſiſting of priſmatic cryſtals, the number of whoſe ſides is uncertain. The Engliſh miners call it *cockle*; the German *ſchoerl*. Its ſpecific gravity is to that of water as 3000 or upwards to 1000. It frequently contains iron; and conſiſts either of particles of an indeterminate figure, or of a ſparry, ſtrained, or fibrous texture. It has a flinty hardneſs, is inſoluble by acids, and is fuſible by fire. The following is an analyſis of ſome baſaltes by Mr. Bergman:

Comparative analyſis of baſaltes and lava.

Baſaltes, 100 parts contains		Lava, 100 parts contains	
Siliceous earth	50		
Argillaceous	15	Siliceous earth	49
Calcareous	8	Argillaceous	36
Manganeſe	2	Calcareous	1
Iron	25	Iron	14

The moſt remarkable property of this ſubſtance is its figure, being never found in ſtrata, like other marbles, but always ſtanding up in the form of regular angular columns, compoſed of a number of joints, one placed upon, and nicely fitted to, another, as if formed by the hands of a ſkilful workman.

Baſaltes was originally found in columns in Ethiopia, and fragments of it in the river Tmolus, and ſome other places. We now have it frequently, both in columns and in ſmall pieces, in Spain, Ruſſia, Poland, near Dreſden, and in Sileſia; but the nobleſt ſtore in the world ſeems to be that called the Giant's Cauſeway in Ireland, and Staffa, one of the weſtern iſles of Scotland. Great quantities of baſaltes are likewiſe found in the neighbourhood of mount Ætna in Sicily, of Heela in Ireland, and of the volcano in the iſland of Bourbon. Theſe are the only three active volcanos in whoſe neighbourhood it is to be met with; but it is alſo found in the extinguiſhed volcanos in Italy, though not in the neighbourhood of Veſuvius.

In Ireland the baſaltes riſes far up the country, runs into the ſea, croſſes at the bottom, and riſes again on the oppoſite land. In Staffa the whole end of the iſland is ſupported by natural ranges of pillars, moſtly about 50 feet high, ſtanding in natural colonnades, according as the bays and points of land have formed themſelves, upon a firm baſis of ſolid unformed rock. Above theſe, the ſtratum, which reaches to the ſoil or ſurface of the iſland, varies in thickneſs, as the iſland itſelf is formed into hills or vallies, each hill which hangs over the vallies below, forming an ample pediment. Some of theſe, above 60 feet in thickneſs from the baſe to the point, are formed by the ſloping of the hill on each ſide, almoſt into the ſhape of thoſe uſed in architecture.

For a particular account of the pillars or columns of the giant's cauſeway, ſee the article CAUSEWAY.

The origin and formation of this marble has much puzzled the world; but we may conſider, that many of the known foſſile bodies have a property, like ſalts, of arranging themſelves into different figures at the time of their firſt coaleſcence into a maſs. This is from the ſame laws in nature with that of ſalts; and we are well aſſured by daily experience, that cryſtal and ſpar, according to this natural determination, even form regularly angular figures, when all the proper accidents have concurred to their concretion. The moſt common figures of cryſtals are the hexangular columns; and thoſe of ſpar, either trigonal columns, or parallelopipeds. The combinations and mixtures of theſe, in different degrees, may naturally produce mixed figures, according to theſe degrees; and a third ſubſtance, though in itſelf not diſpoſed by nature to aſſume or arrange itſelf into any particular figure, if mixed with theſe, may be able to ſpread, extend, and enlarge the figures they concrete into, or otherwiſe alter them.

This ſubſtance has been referred by ſome authors, in imitation of the ancients, to the genus of marbles; though differing from them in many eſſential qualities. The baſaltes is vitreous, analogous in ſubſtance to the horny ſtones. It reſiſts aquafortis, and the chiſſel, and only yields to a violent fire, and the engraver's wheel. When wrought in this manner it acquires the poliſh of the ancient baſaltes; named by the Italians *marmo paragone*. M. Deſmauſt, having accurately examined the baſaltes, which are found in great quantities at Auvergne, attributes their origin to the matter of volcanos refrigerated from fuſion; and he was naturally led to this hypotheſis, by diſcovering that they were placed on beds of lavas, and ſcoriæ, cloſe to the opening of an extinguiſhed volcano. M. Raſpe has adopted this hypotheſis, and confirmed it by his own obſervations on the baſalt hills, in the neighbourhood of Caſſel, and in other places; this ſubſtance being generally found near the lavas of volcanos; and the whole iſland of Sicily, chiefly on the ſide of mount Ætna, abounding with it. This opinion is farther ſupported by the vitreous ſubſtance of theſe ſtones; the want of marine bodies, and from the circumſtance attending ſome melted metals, which, when hardened, appear in cryſtallizations not unlike thoſe of watery congelations. Hiſt. de l'Acad. Roy. des Sciences, at Paris, for 1771. Phil. Tranſ. vol. lxi. No. 54. Ferber's Travels through Italy, tranſlated by Mr. Raſpe, 1778.

BASE, in chymiſtry: any body which is diſſolved by another body which it receives and fixes, and with which it forms a compound, may be called the baſis of that compound. Thus, for example, the baſis of neutral ſalts are the alkaline, earthy, and metallic matters, which are ſaturated by the ſeveral acids, and form with them theſe neutral ſalts. It is proper for the conveniency of chymical language to retain this manner of expreſſion; but theſe baſes muſt not be conſidered as inactive, and only yielding to the action of the acids which they fix, and to which they give a body and conſiſtence. In every combination and ſolution, the ſeveral bodies which unite are equally active, their action being reciprocal. They diſſolve each other; ſo that it is as proper to ſay (as Mr. Gellert obſerves) that a metal or an earth diſſolves an acid, as that an acid diſſolves a metal or an earth: though this latter mode of expreſſion is moſt common. Probably this diſſolving power which the more weighty and fixed bodies have, is really much ſtronger than that of bodies leſs weighty and fixed. It certainly is ſo, if the tendency to unite be only the effects of the general attraction, or the gravitation of all paticles of matter to each other.

BASE, in geometry, the loweſt ſide of the perimeter of a figure: thus, the baſe of a triangle may be ſaid of any of its ſides, but more properly of the loweſt, or that which is parallel to the horizon. In rectangled triangles, the baſe is properly that ſide oppoſite to the right-angle. See the Syſtem, Part I. Sect. I. Baſe of a ſolid figure, the loweſt ſide, or that on which it ſtands. Baſe of a conic ſection, a right-line in the hyperbola and parabola, ariſing from the common interſection of the ſecant plain and the baſe of the cone. See the Syſtem, Part II. Sect. III. and IV.

BASE, in architecture, is uſed for any body which bears another, but particularly for the lower part of a column and pedeſtal.—The ancients, in the early times of architecture, uſed no baſes. The Doric columns in the temple of Minerva at Athens have none, but ſtand immediately upon the floor of the porch. Columns afterwards

wards came to be ſupported on ſquare pieces called *plinths*, and after that on pedeſtals. When we ſee a column, of whatſoever order, on a pedeſtal, the baſe is that part which comes between the top of the peſtedal and the bottom of the ſhaft of the column; when there is no peſtedal, it is the part between the bottom of the column and the plinth: ſome have included the plinth as a part of the baſe; but it is properly the piece on which the baſe ſtands as the column ſtands upon that.—The pedeſtal alſo has its baſe as well as the column, and the pilaſter. The baſe of columns is differently formed in the different orders; but in general it is compoſed of certain ſpires or circles, and was thence in early times called the ſpire of a column. Theſe circles were in this caſe ſuppoſed to repreſent the folds of a ſnake as it lies rolled up; but they are properly the repreſentations of ſeveral larger and ſmaller rings or circles of iron with which the trunks of trees, which were the ancient columns, were ſurrounded to prevent their burſting; theſe were rude and irregular, but the ſculptor who imitated them in ſtone found the way to make them elegant. See the Syſtem of ARCHITECTURE, Sect. V. throughout, and the ſeveral figures in Plate VI.

BASILICON, or BASILICUM, in pharmacy is the denomination of an officinal unguent or plaſter; called alſo *tetrapharmicum* as being compoſed of four ſimples, viz. reſin, wax, pitch, and oil-olive.

BASS, the loweſt in the four parts of muſic; of uncertain etymology; whether from the Greek word *βασις, a foundation*, or from the Italian adjective *baſſo*, ſignifying *low*. Of all the parts it is the moſt important, and it is upon this that the chords proper to conſtitute a particular harmony are determined. Hence the maxim among muſicians, that when the baſs is properly formed, the harmony can ſcarcely be bad. Baſſes are of different kinds. For rules, &c. reſpecting the baſſes in general, ſee the Syſtem of MUSIC, Part II. Sect. V. to XI.

BASSO *Relievo*, or BAS *Relief*, a piece of ſculpture, the figures whereof do not project far, or ſtand out from the ground, with their full proportion.

M. Hellot, in the Mem. Acad. des Scienc. an. 1745, communicates a method of making raiſed figures of gold, on works of gold or ſilver, found among the papers of M. Du Fay, who had ſeen ſeveral trials of it. See the proceſs in the memoir above referred to, and the Commerc. Phil. Techn. 4to. p. 80.

M. Felibien diſtinguiſhes three kinds of relievos: in the firſt the front figures appear almoſt with their full relievo, called *alto relievo*; in the ſecond, they do but ſtand out one-half, called *mezzo relievo*; and in the third, much leſs, which is the proper *baſſo relievo*, as in coins, vaſes, &c.

BASTARD, a natural child, or one begotten and born out of lawful wedlock.

The civil and canon laws do not allow a child to remain a baſtard, if the parents afterwards intermarry: and herein they differ moſt materially from our law; which though not ſo ſtrict as to require that the child ſhall be begotten, yet makes it an indiſpenſable condition that it ſhall be born, after lawful wedlock. And the reaſon of our law is ſurely much ſuperior to that of the Roman, if we conſider the principal end and deſign of eſtabliſhing the contract of marriage, taken in a civil light; abſtractedly from any religious view, which has nothing to do with the legitimacy or illegitimacy of the children. The main end and deſign of marriage, therefore, being to aſcertain and fix upon ſome certain perſon, to whom the care, the protection, the maintenance, and the education of the children, ſhould belong; this end is undoubtedly better anſwered by legitimating all iſſue born after wedlock, than by legitimating all iſſue of the ſame parties, even born before wedlock, ſo as wedlock afterwards enſues: 1. Becauſe of the very great uncertainty there will generally be, in the proof that the iſſue was really begotten by the ſame man; whereas, by confining the proof to the birth, and not to the begetting, our law has rendered it perfectly certain what child is legitimate, and who is to take care of the child. 2. Becauſe, by the Roman law, a child may be continued a baſtard, or made legitimate at the option of the father and mother, by a marriage *ex poſt facto*; thereby opening a door to many frauds and partialities, which by our law are prevented. 3. Becauſe by thoſe laws a man may remain a baſtard till 40 years of age, and then become legitimate by the ſubſequent marriage of his parents; whereby the main end of marriage, the protection of infants, is totally fruſtrated. 4. Becauſe this rule of the Roman law admits of no limitation as to the time, or number, of baſtards to be ſo legitimated; but a dozen of them may, 20 years after their birth, by the ſubſequent marriage of their parents, be admitted to all the privileges of legitimate children. This is plainly a great diſcouragement to the matrimonial ſtate; to which one main inducement is uſually not only the deſire of having children, but alſo the deſire of procreating lawful heirs. Whereas our conſtitution guards againſt this indecency, and at the ſame time gives ſufficient allowance to the frailties of human nature. For if a child be begotten while the parents are ſingle, and they will endeavour to make an early reparation for the offence, by marrying within a few months after, our law is ſo indulgent as not to baſtardize the child, if it be born, though not begotten, in lawful wedlock; for this is an incident that can happen but once; ſince all future children will be begotten, as well as born, within the rules of honour and civil ſociety. From what has been ſaid it appears, that all children born before matrimony are baſtards by our law: and ſo it is of all children born ſo long after the death of the huſband, that, by the uſual courſe of geſtation, they could not be begotten by him. But this being a matter of ſome uncertainty, the law is not exact as to a few days. But if a man dies, and his widow ſoon after marries again, and a child is born within ſuch a time as that by the courſe of nature it might have been the child of either huſband: in this caſe, he is ſaid to be more than ordinarily legitimate; for he may, when he arrives to years of diſcretion, chooſe which of the fathers he pleaſes.

As baſtards may be born before the coverture or marriage-ſtate is begun, or after it is determined, ſo alſo children born during wedlock may in ſome circumſtances be baſtards. As if the huſband be out of the kingdom of England (or, as the law looſely phraſes it, *extra quatuor maria*) for above nine months, ſo that no acceſs to his wife can be preſumed, her iſſue during that period ſhall be baſtards. But generally during the coverture, acceſs of the huſband ſhall be preſumed, unleſs the contrary ſhall be ſhown; which is ſuch a negative as can only be proved by ſhowing him to be elſewhere; for the general rule is, *præſumitur pro legitimatione*. In a divorce, *à menſa et thoro*, if the wife breeds children, they are baſtards; for the law will preſume the huſband and wife conformable to the ſentence of ſeparation, unleſs acceſs be proved: but in a voluntary ſeparation by agreement, the law will ſuppoſe acceſs, unleſs the negative be ſhewn. So alſo, if there is an apparent impoſſibility of procreation on the part of the huſband, as if he be only eight years old, or the like, there the iſſue of the wife ſhall be baſtards. Likewiſe, in caſe of divorce in the ſpiritual court *à vinculo matrimonii*, all the iſſue born during the coverture are baſtards; becauſe ſuch divorce is always upon ſome cauſe that rendered the marriage unlawful and null from the beginning.

As to the rights and incapacities which appertain to a baſtard: The former are very few, being only ſuch as he can acquire; for he can inherit nothing, being looked upon as the ſon of nobody, and ſometimes called *filius nullius*, ſometimes *filius populi*. The incapacity of a baſtard conſiſts principally in this, that he cannot be heir to any one; for being *nullius filius*, he is therefore of kin to nobody, and has no anceſtor from whom any inheritable blood can be derived: Therefore, if there be no other claimant upon an inheritance than ſuch illegitimate child, it ſhall eſcheat to the lord. And as baſtards cannot be heirs themſelves, ſo neither can they have any heirs but thoſe of their own bodies. For as all collateral kindred conſiſts in being derived from the ſame common anceſtor, and as a baſtard has no legal anceſtors, he can have no collateral kindred; and conſequently can have no legal heirs, but ſuch as claim by a lineal deſcent from himſelf. And therefore, if a baſtard purchaſes land, and dies ſeiſed thereof without iſſue, and inteſtate, the land ſhall eſcheat to the lord of the fee. A baſtard was alſo, in ſtrictneſs, incapable of holy orders; and though that were diſpenſed with, yet he was utterly diſqualified from holding any dignity in the church; but this doctrine ſeems now obſolete; and in all other reſpects, there is no diſtinction between a baſtard and another man. And really any other diſtinction but that of not inheriting, which civil policy renders neceſſary, would, with regard to the innocent offſpring of his parent's crimes, be odious, unjuſt, and cruel to the laſt degree; and yet the civil law, ſo boaſted of for its equitable deciſions, made baſtards in ſome caſes incapable even of a gift from their parents. A baſtard may, laſtly, be made legitimate, and capable of inheriting, by the tranſcendant power of an act of parliament, and not otherwiſe; as was done in the caſe of John of Gaunt's baſtard children, by a ſtatute of Richard II.

As to the puniſhment for having baſtard children: By the ſtatute 18 Eliz. c. 3, two juſtices may take order for the puniſhment of the mother and reputed father: but what that puniſhment ſhall be, is not therein aſcertained: though the cotemporary expoſition was, that a corporal puniſhment was intended. By ſtatute 7 Jac. I. c. 4, a ſpecific puniſhment (viz. commitment to the houſe of correction) is inflicted on the woman only. But, in both caſes, it ſeems that the penalty can only be inflicted, if the baſtard becomes chargeable to the pariſh; for otherwiſe the very maintenance of the child is conſidered as a degree of puniſhment. By the laſt mentioned ſtatute, the juſtices may commit the mother to the houſe of correction, there to be puniſhed and ſet on work for one year; and in caſe of a ſecond offence, till ſhe finds ſureties never to offend again.

If a baſtard be got under the umbrage of a certain oak in Knollwood in Staffordſhire, belonging to the manor of Terley-caſtle, no puniſhment can be inflicted, nor can the lord or the biſhop take cognizance of it. *Plot. Nat. Hiſt. Staff. p.* 279.

It is enacted by ſtatute 21 Jac. I. c. 27, that if any woman be delivered of a child, which if born alive ſhould by law be baſtard, and endeavours privately to conceal its death, by burying the child, or the like, the mother ſo offending ſhall ſuffer death, as in the caſe of murder, unleſs ſhe can prove by one witneſs at leaſt that the child was actually born dead. This law, which favours pretty ſtrongly of ſeverity, in making the concealment of the death almoſt concluſive evidence of the child's being murdered by the mother, is nevertheleſs to be alſo met with in the criminal codes of many other nations of Europe, as the Danes, the Swedes, and the

French

French: but it has of late years been uſual with us, upon trials for this offence, to require ſome ſort of preſumptive evidence that the child was born alive, before the other conſtrained preſumption (that the child, whoſe death is concealed, was therefore killed by its parent) is admitted to convict the priſoner.

BASTARDY, is a defect of birth, objected to one born out of wedlock. Euſtathius will have baſtards among the Greeks to have been in equal favour with legitimate children, as low as the Trojan war; but the courſe of antiquity ſeems againſt him. Potter and others ſhow that there never was a time when baſtardy was not in diſgrace. In the time of William the Conqueror, however, baſtardy ſeems not to have implied any reproach, if we may judge from the circumſtance of that monarch himſelf, not ſcrupling to aſſume the appellation of Baſtard. His epiſtle to Alan, count of Bretagne, begins, *Ego Willielmus cognomento Baſtardus.* Cange. Gloſſ. Lat. T. 1. p. 502.

BASTILE, denotes a ſmall antique caſtle, fortified with turrets. Such was the baſtile of Paris prior to its demolition, which ſeems the only caſtle that had retained the name. It was begun to be built in 1369, by order of Charles V. and was finiſhed in 1383, under the reign of his ſucceſſor.—Its chief uſe was for the cuſtody of ſtate-priſoners; or, more properly ſpeaking, for the clandeſtine purpoſes of unfeeling deſpotiſm.

The lieutenant-general of the police of Paris was the ſub-delegate of the miniſtry for the department of the Baſtile. He had under him a titular commiſſary, who was called the commiſſary of the Baſtile. He had a fixed ſalary for drawing up what were called inſtructions, but he did not this excluſively. He had no inſpection nor function but in caſes where he received orders; the reaſon of which was, that all that was done in this caſtle was arbitrary.

The priſoner was conducted into an apartment, where he was locked up within three doors. They who had no ſervants made their own bed and fire. The hour of dining was eleven, and of ſupping ſix.

When a perſon had obtained leave to write to the lieutenant of the police, he might aſk his permiſſion to write to his family, and to receive their anſwers; to have with him his ſervant, or an attendant, &c. which requeſts were either granted or refuſed according to circumſtances. Nothing could be obtained but through this channel. In this caſtle, all was myſtery, trick, artifice, ſnare, and treachery. The officers, attendants, turnkeys, and valets, often attempted to draw a man to ſpeak againſt the government, and then inform of all.

The priſoner was obliged to aſk for every thing, even for permiſſion to be ſhaved. This office was performed by the ſurgeon, who alſo furniſhed ſick or indiſpoſed priſoners with ſugar, coffee, tea, chocolate, confections, and the neceſſary remedies.

There was a commiſſion of interrogatory executed by the lieutenant of the police, a counſellor of ſtate, a maſter of requeſts, a counſellor or a commiſſioner of the Châtelet. When the lieutenant of the police did not himſelf interrogate, he uſually came at the end of the examination.

Theſe commiſſioners were purely paſſive beings. Frequently they attempted to frighten a priſoner, by laying ſnares for him, and employing the meaneſt artifices to extort a confeſſion from him. They would pretend proofs, and exhibit papers without ſuffering him to read them; aſſerting that they were inſtruments of unavoidable conviction. Their interrogatories were always vague; turning not only on the priſoner's words and actions, but on his moſt ſecret thoughts, and on the diſcourſe and conduct of perſons of his acquaintance, whom they might have wiſhed to bring into queſtion.

The examiners would tell a priſoner that his life was at ſtake; that his fate depended upon himſelf; that if he would make a fair declaration, they were authoriſed to promiſe him a ſpeedy releaſe; but if he refuſed to confeſs, he would be given up to a ſpecial commiſſion; that they were in poſſeſſion of deciſive documents, of authentic proofs, more than ſufficient to ruin him; that his accomplices had diſcovered all; that the government had unknown reſources, of which he could have no ſuſpicion. They fatigued priſoners by varied and infinitely multiplied interrogatories. According to the perſons, they employed promiſes, careſſes, and menaces. Sometimes they uſed inſults, and treated the unhappy ſufferers with an inſolence that filled up the meaſure of that tyranny of which they were the baſe inſtruments.

If the priſoner made the required confeſſion, the commiſſioners would then tell him that they had no preciſe authority for his enlargement, but that they had every reaſon to expect it; that they were going to ſolicit it, &c. The priſoner's confeſſions, far from bettering his condition, frequently gave occaſion to new interrogatories, often lengthened his confinement, drew in the perſons with whom he might have had connections, and expoſed himſelf to new vexations.

Although there were rules for all occaſions, yet every thing was ſubject to exceptions, ariſing from influence, recommendations, protection, intrigue, &c. becauſe the firſt principle in this place was arbitrary will. Very frequently, perſons confined on the ſame account were treated very differently, according as their recommendations were more or leſs conſiderable.

When a priſoner who was known and protected had entirely loſt his health, and his life was thought in danger, he was always ſent out; the miniſtry not chooſing that perſons well known ſhould die in the baſtile. If a priſoner died there, he was interred in the pariſh of St. Paul, under the name of a domeſtic; and this falſity was written in the regiſter of deaths, in order to deceive poſterity. There was another regiſter, in which the true names of the deceaſed are entered; but it was not without great difficulty that extracts could be procured from it. The commiſſary of the Baſtile was firſt informed of the uſe the family intended to make of the extract.

Nowhere elſe on earth, perhaps, has human miſery, by human means, been rendered ſo laſting, ſo complete, or ſo remedileſs, as in this moſt horrid of dungeons. This the following caſe may ſuffice to evince; the particulars of which are tranſlated from that elegant and energetic writer M. Mercier. The heinous offence, which merited an impriſonment ſurpaſſing torture, and rendering death a bleſſing, though for obvious reaſons not ſpecified by our author, is known, from other ſources, to have conſiſted in ſome unguarded expreſſions implying diſreſpect concerning the Gallic monarch Louis XV.

Upon the acceſſion of Louis XVI. to the throne, the miniſters then in office, and moved by humanity, began their adminiſtration with an act of clemency and juſtice; they inſpected the regiſters of the Baſtile, and ſet many priſoners at liberty. Among thoſe there were an old man who had groaned in confinement for 47 years between four thick and cold ſtone-walls. Hardened by adverſity, which ſtrengthens both the mind and the conſtitution, when they are not overpowered by it, he had reſiſted the horrors of his long impriſonment with an invincible and manly ſpirit. His locks, white, thin, and ſcattered, had almoſt acquired the rigidity of iron; whilſt his body, environed for ſo long a time by a coffin of ſtone, had borrowed from it a firm and compact habit. The narrow door of his tomb, turning upon its grating hinges, opened not as uſual by halves; and an unknown voice announced his liberty, and bade him depart. Believing this to be a dream, he heſitated; but at length roſe up and walked forth with trembling ſteps, amazed at the ſpace he traverſed: The ſtairs of the priſon, the halls, the court, ſeemed to him vaſt, immenſe, and almoſt without bounds. He ſtopped from time to time, and gazed around like a bewildered traveller: His viſion was with difficulty reconciled to the clear light of day: He contemplated the heavens as a new object: His eyes remained fixed, and he could not even weep. Stupified with the newly acquired power of changing his poſition, his limbs, like his tongue, refuſed, in ſpite of his efforts, to perform their office; at length he got through the formidable gate.

When he felt the motion of the carriage prepared to tranſport him to his former habitation, he ſcreamed out, and uttered ſome inarticulate ſounds; and as he could not bear his new movement, he was obliged to deſcend. Supported by a benevolent arm, he ſought out the ſtreet where he had formerly reſided: he found it, but no trace of his houſe remained; one of the public edifices occupied the ſpot where it had ſtood. The crowd around, offering only unknown features to his view, made him feel the exceſs of his calamities even more than he would have done in the dreadful ſolitude that he had left.

Overcome with ſorrow, he preſented himſelf before the miniſter, to whoſe humanity he owed that liberty which was now a burden to him. Bowing down, he ſaid, "Reſtore me again to that priſon from which you have taken me: I cannot ſurvive the loſs of my neareſt relations; of my friends; and, in one word, of a whole generation: It is impoſſible in the ſame moment to be informed of this univerſal deſtruction, and not to wiſh for death? This general mortality, which to the reſt of mankind comes ſlowly and by degrees, has to me been inſtantaneous, the operation of a moment. Whilſt ſecluded from ſociety, I lived with myſelf only; but here I neither can live with myſelf nor with this new race, to whom my anguiſh and deſpair appear only as a dream. There is nothing terrible in dying; but it is dreadful indeed to be the laſt." The miniſter was melted; he cauſed an old domeſtic to attend this unfortunate perſon, as only he could talk to him of his family. This diſcourſe was the ſingle conſolation that he received: for he ſhunned all intercourſe with a new race, born ſince he had been exiled from the world; and he paſſed his time in the midſt of Paris in the ſame ſolitude as he had done while confined in a dungeon for almoſt half a century. But the chagrin and mortification of meeting no perſon who could ſay to him, We were formerly known to one another, put an end to his exiſtence.

This horrid dungeon was at length, in the year 1789, aſſaulted by the populace of Paris, joined by the military force, who made a breach in the gates, and captured the place. The Marquis de Launay, the governor of the Baſtile, was ſeized and beheaded, and his head carried on a pike through the ſtreets of Paris.

BASTION, in the modern fortification, a huge maſs of earth faced uſually with ſod, ſometimes with brick, and rarely with ſtone, ſtanding out from a rampart whereof it is a principal part, and is what, in the ancient fortification, was called a bulwark.

A baſtion,

A *Baſtion* conſiſts of two faces and two flanks, and an opening towards the centre of the place, called the *gorge*. For a further account of this branch of Fortification, ſee the Syſtem, Sect. I. under the head Definitions. See alſo No. 13, 14, and 15. For demonſtration of the various principles, ſee the two plates annexed.

BAT, the Engliſh name of the genus *Veſpertilio*, in the ſyſtem of mammalia. For deſcription of the genus and moſt remarkable ſpecies, ſee VESPERTILIO.

BATH, *Balneum*, a convenient receptacle of water for perſons to waſh or plunge in, either for health or pleaſure.—Baths are diſtinguiſhed into *hot* and *cold*: and theſe again are either natural or artificial. The natural hot-baths, called by the ancients *thermæ*, owe their origin partly to the admixture of ſulphureous particles, while the water is paſſing through its ſubterraneous canals, or rather while it creeps through beds and mines of ſulphur, &c. and partly to the fumes and vapours exhaling through the pores of the earth where ſulphur is either pure or impure, as in coals, amber, &c.—Though in moſt hot-baths there are likewiſe mixed particles of iron, alum, nitre, and other mineral bodies, which give them an acid aſtringent taſte.

The artificial hot-baths conſiſt either of water or of ſome other fluid made hot by art. The cold-bath conſiſts of water, either freſh or ſalt, in its natural degree of heat; or it may be made colder by art, as by a mixture of nitre, ſal-ammoniac, &c. The chief hot-baths in our country, are thoſe of Bath and Briſtol, in Somerſetſhire; and thoſe others of Buxton and Matlock, in Derbyſhire: which latter, however, are rather warm or tepid, than hot.

In the city of Bath there are four hot-baths; one triangular, called the *croſs-bath*, from a croſs that formerly ſtood in the midſt of it; the heat of which is more gentle than that of the others, becauſe it has fewer ſprings.—The ſecond is the *hot-bath*, which heretofore was much hotter than the reſt, when it was not ſo large as it now is.—The other two are the *king's* and *queen's-bath*, divided only by a wall; the laſt having no ſpring, but receiving the water from the *king's-bath*, which is about ſixty feet ſquare, and has in the middle of it many hot ſprings, which render its healing qualities more effectual.—Each of theſe is furniſhed with a pump to throw out water upon the diſeaſed, where that is required.

The uſe of theſe baths is found beneficial in diſeaſes of the head, as palſies, &c. in cuticular diſeaſes, as leproſies, &c. obſtructions and conſtipations of the bowels, the ſcurvy and ſtone, and in moſt diſeaſes of women and children. The baths have performed many cures, and are commonly uſed as a laſt remedy in obſtinate chronic diſeaſes; where they ſucceed well, if they agree with the conſtitution of the patient: but whether they will agree or not, cannot be known without trial. For a copious account of the qualities, properties, and medicinal uſes of theſe Waters, and thoſe of Bath in particular, together with the quantity, and the ſeaſons of the year, in which they ſhould be taken, as moſt effectually adopted to the ſeveral Diſeaſes for which they are recommended, ſee the article *Bath* WATERS.

As to the origin of thoſe hot waters, of which the natural hot-baths are formed, we are very much in the dark. All that can be affirmed with certainty is, that where there are volcanoes, there alſo are hot ſprings in great abundance; but how the heat of the volcano ſhould be conſtantly communicated to the waters of a ſpring for many ages, during a great part of which the volcano itſelf has lain in a dormant ſtate, ſeems almoſt beyond the reach of inveſtigation. Another thing that creates a great difficulty is, that the fire of a volcano muſt lie very deep in the earth, and moſt probably ſhift from place to place; but the waters of a ſpring muſt always iſſue from a place ſituated lower than the origin of the ſpring itſelf. Beſides, though we ſhould ſuppoſe the water to come from the top of a volcano itſelf, and conſequently boiling hot, it could not be ſuppoſed to percolate far through cold earth, without loſing all the heat it acquired from the volcano. From ſome obſervations, however, it certainly does appear, that there are ſome ſpots on the earth which have a power of producing heat within themſelves, independent of any thing foreign; and that water is ſo far from being able to deſtroy this power, that it ſeems rather to promote and continue it. We know that water hath this effect upon a mixture of iron filings and ſulphur; but whatever quantities of ſimilar ſubſtances we may ſuppoſe to be contained in the earth, we muſt alſo ſuppoſe to be deſtroyed by one great conflagration ſoon after they have begun to act upon each other, ſo that by their means no laſting heat in waters could be produced. Dr. Stukely indeed would ſolve this, and ſeveral other phenomena, by making the fire and ſmoke of volcanoes the effects of electricity; but here ſufficient proof is wanting; for electricity, even in its moſt powerful ſtate, is not very apt to ſet bodies on fire. The thought, however, deſerves attention; for if electricity is capable of ſetting a volcano on fire, it is undoubtedly capable of producing ſolfaterras where it meets with proper materials, and from them ſprings of any degree of heat.

Cold-BATHS were long baniſhed out of medicine, though the ancients had them, in the greateſt eſteem; but the improvements accruing to phyſic from geometry and mechanics have brought them into uſe again; and the preſent age can boaſt abundance of noble cures performed by them, and ſuch as were long attempted in vain by the moſt powerful medicines. The *cold-bath* is found one of the moſt univerſal and innocent remedies yet diſcovered. It is ſerviceable in moſt chronic diſtempers; and is reckoned ſo ſafe, that phyſicians ſometimes preſcribe it in a beginning *phthiſis*, or conſumption, when the lungs are but ſlightly affected.

The effect of cold-bathing is attributed not only to its chilineſs, and conſtringing power, but in ſome meaſure to the weight of the water.—For ſuppoſe a perſon immerged two feet, and the *area* of his ſkin to be fifteen feet, he ſuſtains a weight of water, added to that of the air, = 2280lb. For 2, the number of cubical feet of water preſſing upon a foot ſquare of the ſkin × 76, the number of pounds in a cubical foot of water, is = 152; which × 15, the ſuppoſed number of ſquare feet on the ſurface of the body, is = 2280lb. troy.—Beſides, the water in bathing enters the body, and mixes with the blood, and dilutes this as well as the other juices. The riſe and progreſs of *cold-bathing*, and the cures effected thereby, are deſcribed at large in Sir J. Floyer's, and Dr. Baynard's Hiſtory of Cold-Bathing.

In tender conſtitutions, and ſome diſeaſes, a moderate *warm-bath* ſhould be uſed before the *cold-bath*, the approach to which ought to be gradual. People of rigid fibres, and unſound *viſcera*, are injured by the *cold-bath*; fat people are little benefited by it; and, in general, nobody ought to go into it before a gentle glow be excited by moderate exercile, when the ſtomach is moſt empty; and ſuch evacuations as the patient's conſtitution require ought to precede the uſe of it; which is beneficial, and may ſafely be continued, when an univerſal glow ſucceeds the coming out of it. The *cold-bath* is hurtful, and ought to be diſcontinued, when the patient continues to be cold and numb after coming out of it, notwithſtanding all precautions to prevent it. Even where immerſion in the *cold-bath* is ſtrengthening, a continuance in it is weakening, and in proportion to its duration.

Artificial BATHS, are various, according to the various occaſions; ſome aqueous, others vaporous, others dry, &c. *Aqueous* BATHS are thoſe prepared from common plants, and other ſubſtances of emollient, reſolvent, and nervine kinds. *Aqueous-baths* ſometimes conſiſt of milk and emollient herbs, with roſe-water, &c. when the deſign is to humectate; at other times of bran and water, when the deſign is only to cleanſe: ſometimes again they are made of a decoction of roots and plants, with an addition of ſpirit of wine, when a perſon bathes for a great pain or tumour, &c.

BATHS, *in vapour*, the fume or ſteam of ſome decoction is received upon the body to promote a perſpiration.—Theſe are alſo by ſome called *Balnea Laconica*. *Vapour baths* are, when the patient is not plunged into what is prepared for the *bath*, but only receives its ſteam upon thoſe parts of his body which require it: as in ſome diſtempers of the fundament and womb, where the patient ſits and receives the fumes of ſome proper fomentation, &c. To theſe may be added the *bagnio*, where people are made to ſweat by the heat of a room, and pouring on of hot water: after which they generally go into a *hot-bath*, or BAGNIO.

Metalline BATHS, thoſe made of water impregnated with the *ſcoriæ* of metals. The moſt common and uſeful of this kind are thoſe prepared with the *ſcoriæ* of iron, which abound with the earthy, ſaline, and ſulphureous ſubſtance of the metal; and theſe are of excellent ſervice for ſtrengthening and bracing up the part to which they are applied, and recovering weak and decayed limbs; ſtopping various kinds of bleeding; and reſtoring the menſtrual and hæmorrhoidal flux, where obſtructed; inſomuch that they may well be ſubſtituted for the natural iron baths.

Adjacent to the ſmelting huts where metals are run from their ore, are to be found large quantities of the ſlag of copper, antimony, and cobalt, which abounding with ſulphur, vitriolic ſalt, and an earthy principle, make ſerviceable baths, for ſtrengthening the loſt tone of the fibres, and relaxing them when they are too ſtiff. Theſe baths have likewiſe a deterſive and cleanſing virtue; ſo that, with prudence, and due regard to circumſtances, they may be uſed on many occaſions. The way of making theſe artificial baths is, either to take the ſlags as they come hot from the furnace, or elſe to heat them afreſh, and throw them into hot water; which is afterwards to be uſed either in the way of bath, or fomentation, occaſionally. There are other artificial baths, prepared of allum and quick-lime, by boiling them together in fine rain water. Such baths are highly ſerviceable in paralytic diſorders, and weakneſs of limbs.

BATH, in *Chymiſtry*, ſeveral matters employed to tranſmit heat are called baths, but the ſubſtances moſt frequently uſed by chymiſts for this purpoſe are *water* and *ſand*. When water is employed, it is called BALNEUM *mariæ*, or WATER *bath*; which is very much uſed, very convenient for many operations; and may be employed ſucceſsfully for all degrees of heat inferior to that of boiling water. See Col. Acad. Part. Etr. tom. vi. p. 377. As water, when expoſed to fire in any veſſel from which it can evaporate, does only receive a determinate degree of heat, which always remains the ſame, when once it has arrived to the boiling heat, it follows, that by the *water-bath*, a degree of heat always may be tranſmitted with certainty. Farther, this degree of heat being incapable of burning, or of communicating an empyreumatic quality to matters ſuſceptible of it, the *water-bath* has alſo the advantage of not expoſing ſubſtances to this inconvenience. When veſſels in which DISTILLATIONS and DIGESTIONS are made, are placed in *ſand*, then a SAND-*bath* is formed. This intermediate ſubſtance of

ſand is very convenient to moderate the too great activity of the naked fire, and to tranſmit any degree of heat, from the weakeſt to a red heat. As this bath is attended with leſs trouble, and requires leſs apparatus than the water-baths, it is much uſed in laboratories; nothing is requiſite for the ſand-bath, but an earthen or iron veſſel filled with fine ſand, which is fitted into a furnace, and capable of containing the cucurbits, retorts, matraſſes, or other veſſels containing the matter to be operated upon. For repreſentation of a plan of a Wind Furnace, when deſigned for a Sand Bath, ſee the Plate of Chymical Apparatus, annexed to the Syſtem, Fig. 5.

Knights of the BATH, a military order in England, inſtituted by Richard II. who ordained that there ſhould be no more than four; however, his ſucceſſor, Henry IV. increaſed them to forty-ſix.—For an account of this inſtitution, its ſuſpenſion, revival, inſignia, motto, &c. ſee the article KNIGHTHOOD. For repreſentation of the inſignia of the Order, ſee the Syſtem of HERALDRY, Plate VI.

BATHING, the act of uſing or applying a bath; that is, of immerging the body, or part of it in water, or other fluid. See BATH.

Bathing, among the Turks, as among the ancients, makes a part of diet and luxury; and in every town, and even village, there is a public bath. Indeed, the neceſſity of cleanlineſs, in a climate where one perſpires ſo copiouſly, has rendered bathing indiſpenſable; the comfort it produces preſerves the uſe of it; and Mahomet, who knew its utility, has reduced it to a precept. The baths ſo ſtrongly recommended by the ancients, are yet the delight of the Egyptians. It is by means of them that they prevent or diſpel rheumatiſms, catarrhs, and ſuch cutaneous diſorders as are produced by want of perſpiration. There are no people who make more frequent uſe of them than the Egyptians, and there is no country where there are fewer aſthmatic people. The aſthma is ſcarcely known there.

The women are paſſionately fond of theſe baths. They frequent them at leaſt once a week, and take with them ſlaves properly qualified for the purpoſe. More luxurious than the men, after undergoing the uſual preparations, they waſh their bodies, and above all their heads, with roſe-water. It is there that female head-dreſſers form their long black hair into treſſes, which they mix with precious eſſences inſtead of powder and pomatum. It is there that they blacken the edge of their eye-lids, and lengthen their eye-brows with cohel, a preparation of tin burnt with gall-nuts; it is there they ſtain the finger and toe-nails with the leaves of henne, a ſhrub common in Egypt, and which gives them a golden colour. The linen and clothing they make uſe of are paſſed through the ſweet ſteam of the wood of aloes; and when the work of the toilet is at an end, they remain in the outer apartment, and paſs the day in entertainments. Females entertain them with voluptuous ſongs and dances, or tell them tales of love.

Among us, bathing is become only a part of medicine, and rarely practiſed but under direction of the phyſicians. Great diſtinction is now made between thoſe who are fit, and thoſe unfit, to undergo the operation, and many rules and preſcriptions given for the more ſucceſsful uſe of it.

Bathing is either cold, or hot, or warm, ſimple, or mixed, according to the temperature and condition of the fluids. *Bathing* in waters too hot, heats and expands the blood and humours to exceſs; whence palpitations of the heart, pains in the head, faintneſs, &c. The miſchief is ſtill greater if the body be full of blood, or turgid with ill juices. The waters uſed for bathing are either pure and ſimple, or ſuch as abound with heterogeneous parts of different kinds. Thoſe fitteſt for medicinal purpoſes are the pureſt, lighteſt, ſimpleſt, and moſt free from all participations of mineral or metallic parts.

Bathing is not to be practiſed without great care and precaution, in melancholic, œdematous, or paralytic caſes. As to the *phthiſis*, authors are divided: ſome abſolutely reject the uſe of baths for this diſorder; others allow it, provided the water be only of a moderate degree of warmth, and the body be previouſly prepared by laxatives and venæſection. Different baths have different effects, according to the ingredients of their waters: thoſe of the vitriolic kind are ſaid to fix the morbific matter in arthritic diſorders and render them ſtill more obſtinate. They are alſo leſs proper where the body is foul, and the *viſcera* is weak or obſtructed, being apt to render ſuch patients hydropic.

Sulphureous and aluminous *baths* are commended againſt an incontinency of urine; but prove hurtful to cachectic habits.

The Carolina baths have this quality beyond other hot waters, that they do not ſoften the body, but rather by reaſon of the copious earthy and aſtringent matter they contain, bind up the parts, ſtrengthen thoſe which are weak, block up the pores, and thus produce a contrary effect to other hot ſprings. Hence they are prejudicial to people of a tender and delicate habit, when the body is foul, or affected with ſpaſmodic, hypochondriac, or colic diſorders, and in many other caſes. They are of uſe where the limbs are to be ſtrengthened, the ligaments and tendons to be gently excited to motion, and the body to be dried.

The uſefulneſs and miſchievouſneſs of *bathing* form a complicated conſideration, only to be decided by taking the nation, climate, habit, the time of the day, ſeaſon of the year, diſorder, &c. of the perſon, and the particular quality and ingredients of the water, into conſideration. In general, hot or warm *bathing* tends to relax the ſkin, promote perſpiration, cleanſe the body, dilute the blood, and carry off cuticular foulneſſes by the pores. To conceive the manner of this operation, it is to be obſerved, that when the body is plunged in a pure, light, and ſimple warm water, it muſt neceſſarily undergo the following changes:

1. The heat neceſſarily rarifies and expands the blood and all the juices, and thus dilates the whole ſyſtem of the veſſels: the conſequence of which is, that the pulſe, or contractive ſtrokes of the arteries, increaſes; whence the blood circulates with greater force, and the external parts of the body become red, and begin to ſweat.

2. By the gravity of the water, the body, plunged therein, is greatly altered, as its ſurface in that caſe ſuſtains a violent preſſure, which ſqueezes the blood forcibly in upon the *viſcera*. See BATH. But the additional preſſure in common cold-bathing is very inconſiderable, and therefore the contraction of the fibres is principally owing to the ſtimulus of cold. Thus whilſt the veſſels are compreſſed from without, and dilated from within, the inteſtine motion of the conſtituent parts of the blood is increaſed, and conſequently the viſcid juices are thus diſſolved, obſtructions overcome, and the humours are better fitted to paſs through all the ſecretory and excretory ducts.

Thence, as by the water's gravity the parts are compreſſed from without, and blood driven plentifully upon the heart, the lungs, the brain, and the larger veſſels, we ſee why, if the bath be too hot, it cauſes palpitations of the heart, oppreſſions in the *viſcera*, or ſometimes fainting; and again why, when the body is foul, or full of bad juices, it produces continued fevers, or inveterate intermittents, if the firſt paſſages abound with crudities.

Theſe ill effects are more frequently obſerved from the hot ſprings, which have alſo an aſtringent quality, as the violently hot Caroline ſpring evidently has.

3. Another change upon the body enſues from the moiſture of the bath, which, aſſiſted with a temperate heat, procures a great ſuppleneſs of the ſkin and fibres; inſomuch that, upon coming out of the water, the whole habit of the body ſwells conſiderably, is looſened in its texture, and opened in its pores and veſſels; whilſt the blood and juices have a more free paſſage to the ſurface. Hence it is, that if a perſon go directly out of the warm-bath to bed, he preſently begins to ſweat plentifully, which is the beſt effect that can proceed from bathing, and of great ſervice in the cure of diſeaſes.

Bathing is found more eſpecially beneficial to thoſe of a moiſt habit, and who have ſtore of humours in their veſſels and pores, as it colliquates the humours, and promotes their diſcharge. In the ſummer it ſerves to cleanſe the ſkin from ſweat, and keep the pores open; in winter to promote perſpiration. It is uſed with good effect in many chronic diſorders, in atrophies, the ſtone, &c. It is a good palliative in the *coryza*; but uſeleſs in the jaundice, and hurtful in the *aſcites* and *ſciatica*, and generally to all in a time of plague. By its promoting perſpiration, it becomes noxious to perſons of a dry conſtitution, as it exſiccates too faſt; more eſpecially to perſons hectically inclined, as by means thereof the humours already too prone to colliquation, are ſtill more reſolved.

Cold-bathing was in high eſteem among the ancient phyſicians for the cure of diſeaſes, as appears from Strabo, Pliny, Hippocrates, and Oribaſius. Whence frequent exhortations to waſhing in the ſea, and plunging into cold water.

Hot-*bathing* firſt, and then uſing the cold-*bath* immediately afterwards, is ſaid to be good for the SCURVY, at leaſt for that kind ſo common in cold countries. This is confirmed by the practice of the Ruſſians and other northern nations. In violent pains, hot and cold *bathing* produce the ſame effects, and in the ſame way, in one reſpect, viz. aſſuaging the pain, by taking off the attention from it. When one is much pained, withdrawing the action of the nerves correſponding to the affected part, employing many nerves, and ſome of them violently, another way, will ſeldom fail of giving eaſe. One pain is often a cure for another. Applying garlic to a diſtant part, burning and bliſtering, cure altogether in this way. The efficacy of hot and cold *bathing* is acknowledged in many caſes. How they act, ſeems a queſtion not yet fully decided in the writings of phyſicians.

BATTALION, a ſmall body of infantry ranged in form of battle, and ready to engage. A battalion uſually contains from 500 to 800 men; but the number it conſiſts of is not determined. They are armed with firelocks, ſwords, and bayonets; and divided into 13 companies, one of which is grenadiers. They are uſually drawn up three men deep. Some regiments conſiſt of but one battalion, others are divided into four or five. See Treatiſe on MILITARY AFFAIRS. Sect. 3.

BATTERY, in law, is the unlawful beating of another. The leaſt touch of another's perſon wilfully, or in anger, is a battery; for the law cannot draw the line between different degrees of violence, and therefore totally prohibits the firſt and loweſt ſtage of it; every man's perſon being ſacred, and no other having a right to meddle with it, in any the ſlighteſt manner. But battery is in ſome caſes juſtifiable or lawful; as where one who hath authority, a parent or maſter, gives moderate correction to his child, his ſcholar or his apprentice. So alſo on the principle of ſelf-defence; for if one

ſtrikes

ſtrikes me firſt, or even only aſſaults me, I may ſtrike in my own defence; and if ſued for it, may plead *ſon aſſault demeſne*, or that it was the plaintiff's own original aſſault that occaſioned it. So it likewiſe in defence of my goods or poſſeſſion; if a man endeavours to deprive me of them, I may juſtify laying hands upon him to prevent him: and in caſe he perſiſts with violence, I may proceed to beat him away. Thus too in the exerciſe of an office, as that of churchwarden or beadle, a man may lay hands upon another to turn him out of church, and prevent his diſturbing the congregation. And if ſued for this or the like battery, he may ſet forth the whole caſe, and plead that he laid hands upon him gently, *molliter manus impoſuit*, for this purpoſe. On account of theſe cauſes of juſtification, battery is defined to be the unlawful beating of another, for which the remedy is, as for aſſault, by action of *treſpaſs vi et armis*: wherein the jury will give adequate damages.

BATTERY, in electricity, is a combination of coated ſurfaces of glaſs, ſo connected together, that they may be charged at once, and diſcharged by a common conductor. For a number of experiments with the Electric Battery, and deſcription of the apparatus, &c. ſee the Syſtem, Sect. II. Art. 4, throughout. For repreſentation, ſee Plate II. Fig. 14 and 34.

BATTLE, an action which paſſes between two armies ranged in order of *battle*. An ingenious modern author remarks, that it is not, uſually, the real loſs ſuſtained in a *battle* (that is, of ſome thouſands of men) that proves ſo fatal to a ſtate; but it is the imaginary loſs, and diſcouragement, which deprives it of the uſe of thoſe very powers which fortune had left it. Conſid. ſur les Cauſ. de la Grand. des Rom. c. iv. p. 39.

The chief view of the great commanders of late days is rather to haraſs or ſtarve the enemy by frequent alarms, cutting off his proviſions, carrying off his baggage, ſeizing his poſts, &c. than to join iſſue with him, and put the whole on the event of a day; a *battle* generally deciding the fate of a campaign, ſometimes of a whole war. Hence it is a rule, never to venture a general *battle* unleſs either you fight to advantage, or be forced to it. In a word, all the meaſures, movements, encampments a general makes, are to lead to the execution of his great deſign, which is to fight to advantage, till by ſome miſtake of the enemy, he at length find the favourable opportunity. It is in this, that a ſuperior genius will at length prevail over an inferior; in the courſe of a campaign he will take a number of advantages over him, which together are equivalent to a battle, the event of which is ever doubtful. For the neceſſary qualifications eſſential to form a complete General, ſee the article WAR.

BATTLE, in a *naval ſenſe*, denotes an engagement between two fleets, ſquadrons, or even ſingle ſhips. This is more frequently diſtinguiſhed by the name of ſea-fight. Of late times, fleets are ranged in line of *battle*, like land armies, and fight much after the ſame order; to the expediency of which, ſome objections may be made.

The ancients had divers forms of ſea-*battles*: as the half-moon, circle, and forceps. In all theſe, not only the ſhips engaged each other, and by their beaks and prows, and ſometimes the ſterns, endeavoured to daſh in pieces, or overſet and ſink each other, but the ſoldiers alſo annoyed the enemy with darts and ſlings, and on their nearer approach, with ſwords and ſpears, boarding each other by laying bridges between the ſhips. By way of preparation, they took down their ſails, and lowered their maſts, and ſecured whatever might expoſe them to the wind, chooſing rather to be governed by their oars. It is obſervable, that the ancient and uſual way of fighting in our fleets was board and board, yard-arm and yard-arm, through and through; and not at a diſtance in a line or half-moon, as is now done. For a copious deſcription of Naval Tactics, and the manner of a naval Engagement, ſee the Treatiſe on NAVAL AFFAIRS, Sect. II. and III.

BAWD, a perſon who keeps a place of proſtitution, or makes a trade of debauching women, and procuring or conducting criminal intrigues. Some think the word is derived from the old French *baude*, *bold* or *impudent*; though Verſtegan has a conjecture which would carry it higher, viz. from *bathe*, anciently written *bade*. In which ſenſe, *bawd* originally imported no more than bath-holder, as if bagnios had anciently been the chief ſcenes of ſuch proſtitution.

BAWDY-HOUSE, a houſe of ill fame, to which lewed perſons of both ſexes reſort, and there have criminal converſation. The keeping of a bawdy-houſe is a common nuiſance, not only on account that it endangers the public peace, by drawing together debauched and idle perſons, and promoting quarrels, but likewiſe for its tendency to corrupt the manners of the people. And therefore perſons convicted of keeping bawdy-houſes, are puniſhable by fine and impriſonment; alſo liable to ſtand in the pillory, and to ſuch other puniſhment as the court at their diſcretion ſhall inflict. Perſons reſorting to a bawdy-houſe are likewiſe puniſhable, and they may be bound to their good behaviour.—It was always held infamous to keep a bawdy-houſe: yet ſome of our hiſtorians mention bawdy-houſes publicly allowed here in former times, till the reign of Henry VIII. and aſſign the number to be 18 thus allowed on the Bank-ſide in Southwark. Bawdy-houſes are licenſed in Holland, and pay a conſiderable tax to the ſtate.

BAY, in geography, an arm of the ſea ſhooting up into the land, and terminating in a neck. It is a kind of leſſer gulf, bigger than a creek, and larger in its middle than at its entrance. The largeſt and moſt noted bays in the world, are thoſe of Biſcay, Bengal, Hudſon's, Panama, &c.

BAYS, in commerce, a ſort of open woollen ſtuff, having a long nap, ſometimes friſed, and ſometimes not. This ſtuff is without wale; and is wrought in a loom with two treddles, like flannel. It is chiefly manufactured at Colcheſter and Bockin in Eſſex, where there is a hall called the *Dutch-bay hall*, or *raw-hall*. This manufacture was firſt introduced into England, with that of ſays, ſerges, &c. by the Flemings; who being perſecuted by the Duke of Alvy for their religion, fled thither about the fifth of Queen Elizabeth's reign; and had afterwards peculiar privileges granted them by act of parliament, 12 Charles II. 1660, which the bays-makers in the above places ſtill enjoy. The exportation of bays was formerly much more conſiderable than at preſent, when the French have learned to imitate them. However, the Engliſh bays are ſtill ſent in great quantities to Spain and Portugal, and even to Italy. Their chief uſe is for dreſſing the monks and nuns, and for linings, eſpecially in the army. The looking-glaſs makers alſo uſe them behind their glaſſes, to preſerve the tin or quickſilver; and the caſemakers, to line their caſes. The breadth of the bays is commonly a yard and a half, a yard and three quarters, or two yards, by 42 to 48 in length. Thoſe of a yard and three quarters are moſt proper for the Spaniſh trade.

BEAD, a ſmall globule or ball uſed in necklaces; and made of different materials, as pearl, ſteel, garnet, coral, diamond, amber, cryſtal, paſtes, glaſs, &c. The Romaniſts make uſe of beads in rehearſing their *Ave marias*, and *Paternoſters*; and the like uſage is found among the derviſes and other religions throughout the Eaſt, as well Mahometan as Heathen. The ancient Druids appear alſo to have had their beads, many of which are ſtill found; at leaſt, if the conjecture of an ingenious author may be admitted, who takes thoſe antique glaſs globules, having a ſnake painted round them, and called *adder beads*, or *ſnake-buttons*, to have been the beads of our ancient Druids.

BEAD-*Roll*, among Papiſts, a liſt of thoſe perſons, for the reſt of whoſe ſouls they are obliged to repeat a certain number of prayers, which they count by means of their beads.

BEAD, in aſſaying, the ſmall lump or maſs of pure metal ſeparated from the *ſcoriæ*, and ſeen diſtinct and pure in the middle of the cuppel while in the fire. Thus, in ſeparating ſilver from its ore, by means of lead, the ſilver remains in form of a *bead*, when the lead, that had before aſſiſted in the operation, is reduced to *ſcoriæ*. In this proceſs, the *bead* of ſilver muſt be taken out of the cuppel as ſoon as it is ſeen pure and fine, leſt, growing cold, it ſhould be conglutinated to the cuppel or litharge. This *bead*, when rightly made, is always porous underneath. Cramer.

BEAD-*proof*, or *Double-proof*, terms uſed by our diſtillers, to expreſs that ſort of proof of the ſtandard ſtrength of ſpirituous liquors, which conſiſts in their having, when ſhaken in a phial, or poured from on high into a glaſs, a crown of bubbles, which ſtand on the ſurface ſome time after. This is eſteemed a proof that the ſpirit conſiſts of equal parts of rectified ſpirits and phlegm. This is a fallacious rule as to the degree of ſtrength in the liquor: becauſe any thing that will increaſe the tenacity of the ſpirit, will give it this proof, though it be under the due ſtrength. Our malt diſtillers ſpoil the greater part of their goods, by leaving too much of the ſtinking oil of the malt in their ſpirit, in order to give it this proof, when ſomewhat under the ſtandard ſtrength. But this is a great deceit on the purchaſers of malt-ſpirits, as they have them by this means not only weaker than they ought to be, but ſtinking with an oil, which they are not eaſily cleared of afterwards. On the other hand, the dealers in brandy, who uſually have the art of ſophiſticating it to a great nicety (ſee the Treatiſe on Diſtillation) are in the right when they buy it by the ſtrongeſt *bead-proof*, as the grand mark of the beſt: for it being a proof of the brandy containing a large quantity of its oil, it is, at the ſame time, a token of its high flavour, and of its being capable of bearing a very large addition of the common ſpirits of our own produce, without betraying their flavour, or loſing its own. We value the French brandy for the quantity of this eſſential oil of the grape which it contains, and that with good reaſon: as it is with us principally uſed for drinking as an agreeably flavoured cordial: but the French themſelves, when they want it for any curious purpoſes, are as careful in the rectification of it, and take as much pains to clear it from this oil, as we do to free our malt-ſpirit from that nauſeous and fœtid oil, which it originally contains.

No judgement can be formed by brandies by the *bead-proof* as to their mixed or adulterated, or their pure ſtate, further than that they are likely to be moſt pure when they have the greateſt proportion of this oil, in regard to mixtures of other ſpirits. There are many occaſions where we want ſpirit, merely as ſpirit, and where any oil, whether ſweet or ſtinking, muſt be equally improper. Shaw's Eſſ. on Diſtillery.

BEAGLES, a ſmall ſort of hounds or hunting dogs. *Beagles* are of divers kinds; as the *ſouthern beagle*, ſomething leſs and ſhorter, but thicker, than the deep-mouthed hound; the *fleet northern*, or *cat-beagle*, ſmall, and of a finer ſhape than the ſouthern, and a harder runner. From the two, by croſſing the ſtrains, is bred

a third

a third ſort, held preferable to either. To theſe may be added a ſtill ſmaller ſort of *beagles*, ſcarcely bigger than lapdogs, which make pretty diverſion in hunting the coney, or even ſmall hares in dry weather: but otherwiſe unſerviceable, by reaſon of their ſize.

BEAK, or BILL, in ornithology, is a cartilaginous ſubſtance, which forms the *roſtrum* of the beak of a bird, from the peculiar ſhape and ſtructure of which, Linnæus divides this claſs, which is the ſecond in the animal kingdom, into ſix orders, as appears from the arrangement. See the Syſtem of ORNITHOLOGY, Sect. 1. and 4. The bill does the office of teeth in ſome birds; alſo of weapons of offence. In the parrot kind it is hooked, and ſerves to climb and catch hold of boughs. The upper *bill* of this bird is filled with rows of croſs bars, and the under *bill*, which is much ſhorter, ſhuts within the upper, and draws againſt the roof of the mouth; by which means a kind of maſtication is effected, before the meat paſſes into the craw. The *phœnicopterus's bill* is a true *hyperbola*, pointed at the end like a ſword; and what is remarkable, the upper *bill* of this bird moves in eating, the lower being fixed, which is the contrary to that which is found in all other kinds. The woodpecker's *bill* is ſtrong, and ſharp enough to dig holes, and build in the heart of the hardeſt timber. See the articles PHŒNICOPTERUS and PICUS, and the Syſtem of COMPARATIVE ANATOMY, Chap II. Sect. I.

In the iſland of Ferro, a fixed reward is given for the *bills* of ravenous birds: all watermen are obliged to bring a certain number yearly to the county courts, at the feaſt of St. Olaus; when they are thrown into a heap, and burnt in triumph. Plott gives divers inſtances of monſtrous irregularities in the *bills* of birds: particularly of a raven, whoſe mandibles croſſed each other, the lower chap turning upwards, and the upper downwards. Plott's Nat. Hiſt. Stafford. ch. vii. Sect. 4.

BEAN. We have four ſorts of *beans* commonly ſowed in our gardens. 1. The ſmall Liſbon or Maragan. 2. The Spaniſh. 3. The Sandwich. And, 4. The Windſor *bean*. For the moſt approved methods of cultivating beans, ſee the Syſtem of AGRICULTURE, Sect. VI. and the Treatiſe on GARDENING, Art. KITCHEN-GARDEN, months Jan. Feb. and July.

The medicinal and dietetic qualities of *beans* are ſaid to be nutritive, but flatulent: the pods yield a water held to be good againſt the gripes in children. Some have uſed the horſe-bean as a ſuccedaneum to coffee; which in principles it much reſembles; only that it contains but half the quantity of oil. Mr. Boyle has ſeveral experiments of beans, treated pneumatically to ſhew the great plenty of air they afford, on which their flatuleney depends. The expanſion of beans in growing, the ſame author found ſo conſiderable that it would raiſe a plug clogged with above a hundred pounds weight. Boyle's Works abr. tom. I. p. 285. tom. II. p. 615, &c.

Horſe-BEAN. The *horſe-bean* is the only kind propagated by the plough; it delights chiefly in a ſtiff and moiſt clay; three buſhels will ſow an acre, and this is to be done in February. The common produce is about twenty buſhels from an acre. They muſt lie ſome time upon the ground after they are cut, before they are carried in. Some farmers ſow tares and *horſe-beans* together, which is a very good way, for the ſeeds are eaſily ſeparated by a riddle. By the new huſbandry, leſs than one buſhel of ſeed will plant an acre of land; and the produce has exceeded that of the old, by more than ten buſhels an acre. For a copious account of this particular, ſee the Syſtem of AGRICULTURE, Sect. VI.

Kidney-BEAN. For characteriſtic deſcription, ſee PHASEOLUS. It would be of little purpoſe to enumerate all the varieties of this plant which have come to our knowledge: ſince America does annually furniſh us with ſo many new ſorts, that there is no knowing what varieties may be produced in England: beſide, as they are not likely to be much cultivated here, ſince ſome of the old ſorts are preferable to any of the new ones, for the uſe of the kitchen garden, we need therefore only mention thoſe which are moſt eſteemed for the table.

There are at preſent three ſorts of *kidney-beans* chiefly propagated for the table in England. Theſe are, 1. The common white or *Dutch kidney-bean*. 2. The ſmaller kidney-bean, commonly called the *Batterſea kidney-bean*. And, 3. The upright ſort, called the *tree kidney-bean*.

The firſt was ſome time ago greatly propagated in England, and is ſtill in Holland: it grows very tall, and requires long ſtakes and poles to climb on, and its beans are conſiderably broad; and this makes them leſs ſaleable in the markets, people ſuppoſing them to be old becauſe they are broad; and they are hence grown into diſuſe, though a much more valuable kind for eating than any other. The ſecond ſort, or *Batterſea bean*, is what is more univerſally cultivated; it never grows very tall, nor rambles far, and the air can eaſily paſs between the rows, becauſe of its moderate growth; and this makes it bear plentifully and ripen well for the table. It is the beſt taſted bean, except the laſt. The third, or *tree kidney-bean*, is alſo a plentiful bearer, and never rambles, but grows up in form of a ſhrub: but its beans are broader than the Batterſea kind and are not ſo well taſted.

Many Botaniſts recommend the ſcarlet bloſſom bean which has been uſually cultivated for the beauty of its flowers, as the beſt ſort for the table. For the moſt approved method of cultivating *kidney-beans*, ſee the Treatiſe on GARDENING, article KITCHEN-GARDEN; months, April, May, and June.

BEAR, the Engliſh name of the genus *Urſus* in the ſyſtem of mammalia. For deſcription of the genus and ſeveral ſpecies, ſee the article URSUS. For Repreſentation ſee Plate V. Genus 16.

The *bear* was formerly an inhabitant of the Britiſh iſland; and was tranſported from Britain to Rome. *Bear*-baiting was a favourite paſtime with our anceſtors; an inſtance of which occurs ſo lately as the time of queen Elizabeth. The bear is obſerved to bear ſome analogy to man: as having hair on both eyelids, which no other brute has. His ſtructure and anotomy are deſcribed by the French academiſts. Du Hamel Hiſt. Reg. Acad. Sc. liv. I. Sect. 11. Some diſtinguiſh two kinds of *bears*, *terreſtrial* and *marine*; the former of which keep to the mountains, whereas the latter come out on the ice as far as the middle of the North Sea. Some of this kind are found in Nova Zembla, of an incredible ſize. Each male among the *ſea bears* has a ſeraglio to himſelf, containing from fifteen to fifty females, which he poſſeſſes as his own property.

BEAR's *fleſh* was much eſteemed by the ancients: even at this day, the paw of a bear ſalted and ſmoked, is ſerved up at the tables of princes. *Bear's-fleſh* is reckoned one of the greateſt rarities among the Chineſe; inſomuch that, as Du Halde informs us, the emperor will ſend fifty or a hundred leagues into Tartary, to procure them for a great entertainment.

BEAR's-*ſkin*, makes a fur in great eſteem, and on which depends a conſiderable article of commerce, being uſed in houſings, on coach-boxes, &c. In ſome countries clothes are made of it, more eſpecially bags, wherein to keep the feet warm in ſevere colds. Of the ſkins of bears' cubs are made gloves, muffs, and the like.

BEAR, in aſtronomy, a name given to two conſtellations, called the *Greater* and the *Leſſer Bear*; or URSA *major* and *minor*. The pole-ſtar is ſaid to be the tail of the *Leſſer Bear*; this ſtar is never above two degrees diſtant from the north pole of the world. See the Syſtem, Sect. VIII. and Plate VI. Fig. 2.

BEARD, the hair growing on the chin and adjacent parts of the face, chiefly of adults and males. Various have been the ceremonies and cuſtoms of moſt nations in regard to the beard. The Tartars, out of religious principle, waged a long and bloody war with the Perſians, declaring them infidels, merely becauſe they would not cut their whiſkers after the rite of Tartary: and we find, that a conſiderable branch of the religion of the ancients conſiſted in the management of their beard. The Greeks wore their beards till the time of Alexander the Great; that prince having ordered the Macedonians to be ſhaved, for fear it ſhould give a handle to their enemies. According to Pliny, the Romans did not begin to ſhave till the year of Rome, 454, when P. Ticinius brought over a flock of barbers from Sicily.

As to eccleſiaſtics, the diſcipline has been very different on the article of beards: ſometimes they have been enjoined to wear them, from a notion of too much effeminacy in ſhaving, and that a long beard was more ſuitable to the eccleſiaſtical gravity; and ſometimes again they were forbid it, as imagining pride to lurk beneath a venerable beard. The Greek and Roman churches have been long in contention together about their beards: ſince the time of their ſeparation, the Romaniſts ſeem to have given more into the practice of ſhaving, by way of oppoſition to the Greeks; and have even made ſome expreſs conſtitutions *de radendis barbis*. The Greeks, on the contrary, eſpouſe very zealouſly the cauſe of long beards, and are extremely ſcandalized at the beardleſs images of ſaints in the Roman churches. By the ſtatutes of ſome monaſteries it appears, that the lay monks were to let their beards grow, and the prieſt among them to ſhave; and that the beards of all that were received into the monaſteries, were bleſſed with a great deal of ceremony. There are ſtill extant the prayers uſed in the ſolemnity of conſecrating the beard to God, when an eccleſiaſtic was ſhaven.

Le Comte obſerves, that the Chineſe affect long beards extravagantly; but nature has balked them, and only given them very little ones, which, however, they cultivate with infinite care: the Europeans are ſtrangely envied by them on this account, and eſteemed the greateſt men in the world. Chryſoſtom obſerves, that the kings of Perſia had their beards wove or matted together with gold-thread; and ſome of the firſt kings of France had their beards knotted and buttoned with gold.

Among the Turks, it is more infamous for any one to have his beard cut off, than among us to be publicly whipped or branded with a hot iron. There are abundance in that country, who would prefer death to this kind of puniſhment. The Arabs make the preſervation of their beards a capital point of religion, becauſe Mahomet never cut his. Hence the razor is never drawn over the Grand Signior's face.

In Louis XIII's reign, whiſkers attained the higheſt degree of favour, at the expence of the expiring beards. In thoſe days of gallantry, not yet empoiſoned by wit, they became the favourite occupation of lovers. A fine black whiſker, elegantly turned up, was a very powerful mark of dignity with the fair ſex. Whiſkers were ſtill in faſhion in the beginning of Louis XIV's reign. This king and all the great men of his reign, took a pride in wearing them. In thoſe days it was the general cuſtom for

for a favourite lover to have his whiſkers turned up, combed, and pomatumed, by his miſtreſs; and, for this purpoſe, a man of faſhion took care to be provided with every little neceſſary article, eſpecially whiſker-wax. It was highly flattering to a lady to have it in her power to praiſe the beauty of her lover's whiſkers; which, far from being diſguſting, gave his perſon an air of vivacity: ſeveral even thought them an incitement to love. It ſeems the levity of the French made them undergo ſeveral changes both in form and name: there were *Spaniſh*, *Turkiſh*, *guard-dagger*, &c. whiſkers; in ſhort, *royal* ones, which were the laſt worn: their ſmallneſs proclaimed their approaching fall.

The faſhion of the BEARD has varied in different ages and countries: ſome cultivating and entertaining one part of it, ſome another. Thus the Hebrews wear a beard on their chin; but not on the upper lip or cheeks. Moſes forbids them to cut off entirely the angle or extremity of their beard; that is, to manage it after the Egyptian faſhion, who left only a little tuft of beard at the extremity of their chin; whereas the Jews to this day ſuffer a little fillet of hair to grow from the lower end of their ears to their chins, where, as well as on their lower lips, their beards are in a pretty long bunch. The Jews in time of mourning, neglected to trim their beards, that is, to cut off what grew ſuperfluous on the upper-lips and cheeks.

Anointing the BEARD with unguents is an ancient practice both among the Jews and Romans, and ſtill continues in uſe among the Turks; where one of the principal ceremonies obſerved in ſerious viſits is to throw ſweet-ſcented water on the beard of the viſitant, and to perfume it afterwards with aloes-wood, which ſticks to this moiſture, and gives it an agreeable ſmell, &c. In the middle-age writers we meet with *adentare barbam*, uſed for ſtroking and combing it, to render it ſoft and flexible. The Turks, when they comb their beards, hold a handkerchief on their knees, and gather carefully the hairs that fall; and when they have got together a certain quantity, they fold them up in paper, and carry them to the place where they bury the dead.

BEARDED, denotes a perſon or thing with a beard, or ſome reſemblance thereof. The faces on ancient Greek and Roman medals are generally bearded, ſome are denominated *pogonati*, as having long beards, *e. g.* the Parthian kings. Others have only a lanugo about the chin, as the Seleucid family. Adrian was the firſt of the Roman emperors who nouriſhed his beard: hence all imperial medals before him are *beardleſs*; after him *bare-headed*.

BEARDED *Women* have all been obſerved to want the menſtrual diſcharge; ſeveral inſtances are given by Hippocrates, and other phyſicians, of grown women, eſpecially widows, in whom the menſes coming to ſtop, beards have appeared. Euſebius Nierembergius, mentions a woman who had a beard reaching to her navel.

Of women remarkably bearded we have ſeveral inſtances. In the cabinet of curioſities at Stutgard in Germany, there is the portrait of a woman called *Bartel Graetje*, whoſe chin is covered with a very large buſhy beard. She was drawn in 1587, at which time ſhe was 25 years of age. There is likewiſe in the ſame cabinet another portrait of her when ſhe was more advanced in life, but likewiſe with a beard.—It is ſaid, that the duke of Saxony had the portrait of a poor Swiſs woman taken, remarkable for her long buſhy beard; and thoſe who were at the carnival at Venice in 1726, ſaw a female dancer aſtoniſh the ſpectators not more by her talents than by her chin covered with a black buſhy beard.—Charles XII. had in his army a female grenadier: it was neither courage nor a beard that ſhe wanted to be a man. She was taken at the battle of Pultowa, and carried to Peterſburg, where ſhe was preſented to the Czar in 1724: her beard meaſured a yard and a half.—We read in the Trévoux Dictionary, that there was a woman ſeen at Paris, who had not only a buſhy beard on her face, but her body likewiſe covered all over with hair. Among a number of other examples of this nature, that of Margaret, the governeſs of the Netherlands, is very remarkable. She had a very long ſtiff beard, which ſhe prided herſelf on; and being perſuaded that it contributed to give her an air of majeſty, ſhe took care not to loſe a hair of it. This Margaret was a very great woman. It is ſaid that the Lombard women, when they were at war, made themſelves beards with the hair of their heads, which they ingeniouſly arranged on their cheeks, in order that the enemy, deceived by the likeneſs, might take them for men. It is aſſerted, after Suida, that in a ſimilar caſe, the Athenian women did as much. Theſe women were more men than our Jemmy-Jeſſamy countrymen. About a century ago, the French ladies adopted the mode of dreſſing their hair in ſuch a manner that the curls hung down their cheeks as far as their boſom. Theſe curls went by the name of *whiſkers*. This cuſtom undoubtedly was not invented, after the example of the Lombard women, to fright the men. Neither is it with intention to carry on a very bloody war, that in our time they have affected to bring forward the hair on the cheeks. The diſcovery ſeems to have been a fortunate one: it gives them a tempting, roguiſh look.

BEARING, in navigation, the ſituation of one place from another, with regard to the points of the compaſs; or the angle which a line drawn through the two places makes the meridians of each. For the utility of aſcertaining the various bearings of objects, ſee the Syſtem, Part V.

The *bearings* of places on the ground are uſually determined from the magnetic needle: in the managing of theſe lies the principal part of ſurveying; ſince the *bearing* and diſtance of a ſecond point from the firſt being found, the place of that ſecond is determined; or the *bearings* of a third point from two others, whoſe diſtance from each other is known, being found, the place of the third is determined: inſtrumentally we mean; for, to calculate trigonometrically, there muſt be more *data*. Mr. Collins gives the ſolution of a problem in the Philoſophical Tranſactions, where the diſtances of three objects on the ſame plane being given, and the *bearings* from a fourth place in the ſame plane, obſerved, the diſtances from the place of obſervation to the reſpective objects are required.

BEARINGS, in heraldry, a term uſed to expreſs a coat of arms, or the figures of armories, by which the nobility and gentry are diſtinguiſhed from the vulgar, and from one another. Theſe ſigns of nobility are with us evidently a copy of the ſtatues and images among the ancient Romans, which they uſed to expoſe before their houſes on public days, and carried before the body at a funeral of a great perſon. Theſe ſtatues among them were the reſemblance of their noble anceſtors. And as our coats of arms evidently were brought up in the place of them, it ſeems very natural to date the riſe and origin of heraldry in England, as now practiſed, from the time of the ſubverſion of the Roman empire by the Goths and Vandals; who as they deſtroyed many liberal arts, ſo they ſeem in return to have given birth to this of heraldry. For a full diſquiſition of which, ſee the Syſtem throughout. For the ſeveral armorial bearings, ſee Plates II. III. and IV.

BEARING *down of the matrix*, a diſorder in pregnant women, being a ſenſation of a weight at the bottom of the abdomen, or preſſure on the neck of the womb, ſo as to hinder the perſon from walking without pain; and ſometimes alſo occaſioning difficulty of urine, numbneſs of the hips, uneaſineſs in going to ſtool, and in the end abortion. See the Syſtem of MIDWIFERY, Part II. Sect. 9.

BEATIFICATION, an act by which the pope declares a perſon beatified or bleſſed after his death. It is the firſt ſtep towards canonization, or raiſing any one to the honour and dignity of a ſaint. No perſon can be beatified till 50 years after his or her death. All certificates or atteſtations of virtues and miracles, the neceſſary qualifications for ſainthip, are examined by the congregation of rites. This examination often continues for ſeveral years; after which his holineſs decrees the beatification. The corpſe and relics of the future ſaint are from thenceforth expoſed to the veneration of all good Chriſtians: his images are crowned with rays, and a particular office is ſet apart for him; but his body and relics are not carried in proceſſion: indulgences likewiſe, and remiſſion of ſins, are granted on the day of his beatification; which, though not ſo pompous as that of canonization, is however very ſplendid.

BEATIFICATION was introduced, when it was thought proper to delay the canonization of ſaints, for the greater aſſurance of the truth and manifeſtation of the rigorous ſteps taken in the proceedure. It is remarkable, that particular orders of monks aſſume to themſelves the power of *beatification*. Thus Octavia Melchiorica was *beatified* with extraordinary ceremonies by the Dominicans, for a legacy of 7000 dollars to the order.

BEATING, PULSATION, is applied to the reciprocal agitation or palpitation of the heart and pulſe. Some phyſicians diſtinguiſh eighty-one different kinds of ſimple beatings, and fifteen compound ones. They compute ſixty beats in the ſpace of a minute, in a temperate man. But, in fact, we generally find a greater number. For the action of the heart, &c. ſee the Syſtem of ANATOMY, Part V. Sect. 3.

BEAVER, the Engliſh name of the Genus *Caſtor*, in the Syſtem of mammalia. For deſcription of the genus and ſpecies appertaining to it, ſee the article CASTOR.

BEAVER-*Skins*, in commerce. Of theſe merchants diſtinguiſh three ſorts; the new, the dry, and the fat. The new beaver, which is alſo called the *white beaver* or *Muſcovy beaver*, becauſe it is commonly kept to be ſent into Muſcovy, is that which the ſavages catch in their winter hunting. It is the beſt, and the moſt proper for making fine furs, becauſe it has loſt none of its hair by ſhedding. The dry beaver, which is ſometimes called *lean beaver*, comes from the ſummer hunting, which is the time when theſe animals loſe part of their hair. Though this ſort of beaver be much inferior to the former, yet it may alſo be employed in furs; but it is chiefly uſed in the manufacture of hats. The French call it *ſummer caſtor* or *beaver*. The fat beaver is that which has contracted a certain groſs and oily humour, from the ſweat which exhales from the bodies of the ſavages, who wear it for ſome time. Though this ſort be better than the dry beaver, yet it is uſed only in the making of hats.

Beſides hats and furs, in which the beaver's hair is commonly uſed, they attempted in France, in the year 1699, to make other manufactures of it: and accordingly, they made cloths, flannels, ſtockings, &c. partly of beaver's hair and partly of Segovia wool. This manufactory, which was ſet up at Paris, in St. Anthony's ſuburbs, ſucceeded at firſt pretty well; and, according to the genius of the

The BINDER is deſired to obſerve, that this Sheet (5 I—1) is to be placed before Sheet (5 I—2) it being an additional Sheet introduced in the new Edition of this Work, to enlarge on the Articles BATHS, BATHING, BEAUTY, and BIBLE.

French, the novelty of the thing brought into ſome repute the ſtuffs ſtockings, gloves, and cloth, made of beaver's hair. But they went out of fashion on a ſudden, becauſe it was found, by experience, that they were of a very bad wear, and beſides that the colours faded very much; when they had been wet, they became dry and hard, like felt, which occaſioned the miſcarriage of the manufactory for that time. When the hair has been cut off from the beavers' ſkins, to be uſed in the manufactoring of hats, thoſe ſkins are ſtill employed by ſeveral workmen; namely, by the trunk-makers, to cover trunks and boxes; by the ſhoemakers, to put into ſlippers; and by turners, to make ſleeves for ſtiffing grain and ſeeds.

BEAUTY is a term whereby we expreſs a certain relation of ſome object, either to an agreeable ſenſation, or to an idea of approbation. When, therefore, I ſay, a thing is *beautiful*, I either mean that I perceive ſomething that I approve, or that ſomething gives me pleaſure: hence it appears, that the idea annexed to the word *beauty* is double; which renders the word equivocal, and this is the ſource of moſt of the diſputes on the ſubject of *beauty*. We muſt therefore diſtinguiſh between *ideas* and *ſenſations*. Ideas occupy the mind, ſenſations intereſt the heart. Though we ſee nothing in an object to intereſt us, we yet diſcover ſomething in its idea to merit our approbation. Such an object therefore pleaſes, and does not pleaſe, i. e. it pleaſes the underſtanding and not the ſenſe. On the contrary, there are ſome objects, whoſe ideas do not offer any thing laudable, which yet excite agreeable ſenſations. There is therefore *beauty* of two ſorts. It is exceedingly hard to fix any general characteriſtic of *beauty*: for, as the ideas and ſenſations of different perſons differ according to the habitudes of the body and the turn of the mind; ſo do the relations of objects to thoſe ideas and ſenſations vary; whence what we call *beauty* reſults. Hence ariſe thoſe different opinions of a *beautiful* thought, a *beautiful* woman, a *beautiful* painting, &c. The principles of *beauty*, according to Mr. Hogarth, are fitneſs, variety, uniformity, ſimplicity, intricacy, and quantity. Analyſis of Beauty.

Dr. Hutcheſon makes uniformity amidſt variety the ſource of *beauty*; and he refers our ideas of it merely to an implanted ſenſe. Inquiry into the Original of our Ideas of Beauty and Virtue.

M. Perrault diſtinguiſhes two kinds of *beauty* in architecture, which correſpond with the two ſpecies of *beauty* above; the one, he calls *poſitive* and *convincing*, ſuch as the richneſs of the materials, grandeur of the ſtructure, neatneſs of the workmanſhip, ſymmetry, &c. The other he calls *arbitary*, which depends on the will, and which would admit of having its proportion changed without deformity. Theſe only pleaſe by the connection, or aſſociation of their ideas with others of a different, which pleaſe themſelves; they owe their *beauty* to that prepoſſeſſion of the mind, whereby a thing, whoſe value we do know, inſinuates an eſteem for others which we do not.

Beauty, in its native ſignification, is appropriated to objects of ſight. Objects of the other ſenſes may be agreeable, ſuch as the ſound of muſical inſtruments; but the agreeableneſs called *beauty*, belongs to objects of ſight.

The human body is a compoſition of numberleſs beauties ariſing from the parts and qualities of the object, various colours, various motions, figures, ſize, &c. all united in one complex object, and ſtriking the eye with combined force. Hence it is, that beauty, a quality ſo remarkable in viſible objects, lends its name to every thing that is eminently agreeable. Thus by a figure of ſpeech, we ſay, a *beautiful thought*, a *beautiful diſcovery*, &c.

Conſidering attentively the beauty of viſible objects, two kinds are diſcovered. The firſt may be termed *intrinſic* beauty, becauſe it is diſcovered in a ſingle object, with relation to any other: the other may be termed *relative*, being founded on the relation of objects. Intrinſic beauty is a perception of ſenſe merely; to perceive the beauty of a ſpreading oak, or of a flowing river, no more is required than ſingly an act of viſion. Relative beauty is accompanied with an act of underſtanding and reflection; for we perceive not the relative beauty of a fine inſtrument or engine until we learn its uſe and deſtination. In a word, intrinſic beauty is ultimate; and relative beauty is that of means relating to ſome good end or purpoſe.

We ſhall here make a few obſervations on ſimplicity, which may be of uſe in examining the beauty of ſingle objects. A multitude of objects crowding into the mind at once, diſturb the attention, and paſs without making any laſting impreſſion. This juſtifies ſimplicity in works of art, as oppoſed to complicated circumſtances and crowded ornaments.

Uniformity is ſingular in one circumſtance, that it is apt to diſguſt by exceſs. A number of things deſtined for the ſame uſe, as windows, chairs, &c. cannot be too uniform. But a ſcrupulous uniformity of parts in a large garden or field is far from being agreeable. In all the works of nature ſimplicity makes a capital figure. It alſo makes a figure in works of art: Profuſe ornament in painting, gardening, or architecture, as well as in dreſs or in language, ſhows a mean or corrupted taſte. Simplicity in behaviour and manners has an enchanting effect, and never fails to gain our affection.

Love, ariſing from a ſenſe of beauty, loſes when exceſſive, its ſocial character: the appetite for gratification, prevailing over affection for the beloved object, is ungovernable, and tends rapidly to its end, regardleſs of the miſery that muſt follow. Love in this ſtate, is no longer a ſweet agreeable paſſion: it becomes painful, like hunger or thirſt; and produceth no happineſs but in the inſtant of fruition. This ſuggeſts an important leſſon, that moderation in our deſires and appetites, which fits us for doing our duty, contributes at the ſame time the moſt to happineſs: even ſocial paſſions, when moderate, are more pleaſant than when they ſwell beyond proper bounds.

Human or perſonal BEAUTY, may be conſidered under theſe four heads; Colour, Form, Expreſſion, and Grace: the two former being, as it were, the Body; the two latter the ſoul of beauty.

1. *Colour.* Although this be the loweſt of all the conſtituent parts of beauty, yet it is commonly the moſt ſtriking, and the moſt obſerved. For which there is a very obvious reaſon to be given; that "every body can ſee, and very few can judge;" the beauties of colour requiring much leſs of judgment than either of the other three.

As to the colour of the body in general, the moſt beautiful perhaps that was ever imagined, was that which Apelles expreſſed in his famous Venus; and which, though the picture itſelf be loſt, Cicero has in ſome degree preſerved to us, in his excellent deſcription of it. It was (as we learn from him) a fine red, beautifully intermixed and incorporated with white; and diffuſed, in its due proportions, through each part of the body. Such are the deſcriptions of a moſt beautiful ſkin in ſeveral of the Roman poets; and ſuch often is the colouring of Titian, and particularly in his ſleeping Venus, or whatever other beauty that charming piece was meant to repreſent.

It is an obſervation apparently whimſical, but perhaps not unjuſt, that the ſame thing which makes a fine evening, makes a fine face, that is, as to the particular part of beauty now under conſideration. The beauty of an evening ſky, about the ſetting of the ſun, is owing to the variety of colours that are ſcattered along the face of the heavens. It is the fine red clouds, intermixed with white, and ſometimes darker ones, with the azure bottom appearing here and there between them, which makes all that beautiful compoſition that delights the eye ſo much, and gives ſuch a ſerene pleaſure to the heart. In the ſame manner if you conſider ſome beautiful faces, you may obſerve, that it is much the ſame variety of colours which gives them that pleaſing look, which is ſo apt to attract the eye, and but too often to engage the heart. For all this ſort of beauty is reſolvable into a proper variation of fleſh-colour and red, with the clear blueneſs of the veins pleaſingly intermixed about the temples and the going off of the cheeks, and ſet off by the ſhades of full eyebrows, and of the hair, when it falls in a proper manner round the face.

It is for much the ſame reaſon that the beſt landſcape painters have been generally obſerved to chooſe the autumnal part of the year for their pieces, rather than the ſpring. They prefer the variety of ſhades and colours though in their decline, to all their freſhneſs and verdure in their infancy; and think all the charms and livelineſs even of the ſpring, more than compenſated by the choice, oppoſition, and richneſs of colours, that appear almoſt on every tree in the autumn.

Though one's judgment is apt to be guided by particular attachments (and more perhaps in this part of beauty than any other), yet the general perſuaſion ſeems well founded, that a complete brown beauty is nearly equal to a fair one. Raphael's moſt charming Madona is a brunette beauty; and his earlier Madonas (or thoſe of his middle ſtyle) are generally of a lighter and leſs pleaſing complexion. All the beſt artiſts in the nobleſt age of painting, about Leo the tenth's time, uſed this deeper and richer kind of colouring; and perhaps one might add, that the glaring lights introduced by Guido, went a great way towards the declenſion of that art; as the enfeebling of the colours by Carlo Marat (or his followers) hath ſince almoſt completed the fall of it in Italy.

2. *Form.* This takes in the turn of each part, as well as the ſymmetry of the whole body: By which is not only meant the poſture of the perſon, but the poſition of each part; as the turning of the neck, the extending of the hand, the placing of a foot; and ſo on to the moſt minute particulars. The general cauſe of beauty in the form or ſhape in both ſexes is a proportion, or an union and harmony, in all parts of the body. The diſtinguiſhing character of beauty in the female form, is delicacy and ſoftneſs; and in the male, either apparent ſtrength or agility. The fineſt exemplars that can be ſeen for the former, is the Venus of Medici; and for the two latter, the Hercules Farneſe, and the Apollo Belvedere.

There is one thing indeed in the laſt of the figures which exceeds the bounds of our preſent enquiry; what an Italian artiſt called *Il ſovra umano*; and what we may call the tranſcendant, or celeſtial. It is ſomething diſtinct from all human beauty and of a nature greatly ſuperior to it: ſomething that ſeems like an air of divinity, which is expreſſed, or at leaſt is to be traced out, but in very few works of the artiſts; and of which ſcarce any of the poets have caught any ray in their deſcriptions (or perhaps even in their imaginations), except Homer and Virgil, among the ancients; and our Shakſpeare and Milton among the moderns.

The beauty of the mere human form is much ſuperior to that of colour; and it may be partly for this reaſon, that when one is obſerving the fineſt works of the artiſts at Rome (where there is ſtill the nobleſt collection of any in the world), one feels the mind more

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ſtruck and more charmed with the capital ſtatues, than with the pictures of the greateſt maſters. One of the old Roman poets, in ſpeaking of a very handſome man, who was candidate for the prize in ſome of the public games, ſays, that he was much expected and much admired by all the ſpectators at his firſt appearance; but that when he flung off his robes, and diſcovered the whole beauty of his ſhape altogether, it was ſo ſuperior, that it quite extinguiſhed the beauties they had before ſo much admired in his face. Much the ſame effect may be felt in viewing the Venus of Medici. If you obſerve the face only, it appears extremely beautiful; but if you conſider all the elegancies of her make, the beauty of her face becomes leſs ſtriking, and is almoſt loſt in ſuch a multiplicity of charms. Whoever would learn what makes the beauty of each part of the human body, may find it laid down pretty much at large by Felibien: or may ſtudy it with more pleaſure to himſelf, in the fineſt pictures and ſtatues; for in life we commonly ſee but a ſmall part of the human body, moſt of it being either diſguiſed or altered by what we call dreſs.

In fact we do not only thus, in a great meaſure, hide beauty; but even injure, and kill it, by ſome parts of dreſs. A child is no ſooner born into the world, than it is bound up, almoſt as firmly as an old Egyptian mummy, in ſeveral folds of linen. It is in vain for him to give all the ſigns of diſtreſs that nature has put in his power, to ſhow how much he ſuffers whilſt they are thus impriſoning his limbs; or all the ſigns of joy, every time they are ſet at liberty. In a few minutes, the old witch who preſides over his infineſt days, falls to tormenting him afreſh, and winds him up again in his deſtined confinement. When he comes to be dreſt like a man he has ligatures applied to his arms, legs, and middle; in ſhort, all over him; to prevent the natural circulation of his blood, and make him leſs active and healthy; and if it be a child of the tenderer ſex, ſhe muſt be bounded more ſtraitly about the waiſt and ſtomach, to acquire a diſproportion that nature never meant in her ſhape.

The two other conſtitutent parts of beauty are expreſſion and grace; the former of which is common to all perſons and faces; and the latter is to be met with in very few.

3. *Expreſſion.* By this is meant the expreſſion of the paſſions; the turns and changes of the mind, ſo far as they are made viſible to the eye by our looks and geſtures.

Philoſophers may diſpute as much as they pleaſe about the ſeat of the ſoul: but, where-ever it reſides, we are ſure that it ſpeaks in the eyes. Perhaps it is injuring the eyebrows to make them only dependants on the eye; for they, eſpecially in lively faces, have, as it were, a language of their own: and are extremely varied, according to the different ſentiments and paſſions of the mind.

Homer makes the eyebrows the ſeat of majeſty; Virgil, of dejection; Horace, of modeſty; and Juvenal of pride: and it is not certain whether every one of the paſſions be not aſſigned by one or other of the poets to the ſame part.

Having hitherto ſpoken only of the paſſions in general, we will now conſider a little which of them add to beauty, and which of them take from it. We may ſay, in general, that all the tender and kind paſſions add to beauty; and all the cruel and unkind ones add to deformity: And it is on this account that good-nature may very juſtly be ſaid to be "the beſt feature even in the fineſt face." Mr. Pope has included the principal paſſion of each ſort in two very pretty lines:

> Love, hope, and joy, fair Pleaſure's ſmiling train;
> Hate, fear, and grief, the family of Pain.

The former of which naturally give an additional luſtre and enlivening to beauty; as the latter are too apt to ſpread a gloom and cloud over it.

Yet in theſe, and all the other paſſions, moderation ought perhaps to be conſidered in a great meaſure the rule of their beauty, almoſt as far as moderation in actions is the rule of virtue. Thus an exceſſive joy may be too boiſterous in the face to be pleaſing; and a degree of grief, in ſome faces, and on ſome occaſions, may be extremely beautiful. Some degrees of anger, ſhame, and ſurpriſe, fear, and concern, are beautiful; but all exceſs is hurtful, and all exceſs ugly. Dulneſs, auſterity, impudence, pride, affectation, malice, and envy, are always ugly. The fineſt union of paſſions that can perhaps be obſerved on any face, conſiſts of a juſt mixture of modeſty, ſenſibility, and ſweetneſs; each of which when taken ſingly is very pleaſing: but when they are all blended together, in ſuch a manner as either to enliven or correct each other, they give almoſt as much attraction as the paſſions are capable of adding to a very pretty face.

The ſuperiority which the beauty of the paſſions has over the two parts of beauty firſt mentioned, will probably be now pretty evident: or if this ſhould ſtill appear problematical to any one, let him conſider a little the following particulars, of which every body muſt have met with ſeveral inſtances in their lifetime. That there is a great deal of difference in the ſame face, according as the perſon is in a better or worſe humour, or in a greater or leſs degree of livelineſs; that the beſt complexion, the fineſt features, and the exacteſt ſhape, without any thing of the mind expreſſed on the face, are as inſipid and unmoving as the waxen figure of the fine Ducheſs of Richmond in Weſtminſter-Abbey: that the fineſt eyes in the world, with an exceſs of malice or rage in them, will grow as ſhocking as they are in that fine face of Meduſa on the famous ſeal in the Strozzi family at Rome: that a face without any good features in it, and with a very indifferent complexion, ſhall have a very taking air, from the ſenſibility of the eyes, the general good-humoured turn of the look, and perhaps a little agreeable ſmile about the mouth. And theſe three things perhaps would go a great way toward accounting for the *Je ne ſçai quoi*, or that inexplicable pleaſingneſs of the face (as they chooſe to call it) which is ſo often talked of and ſo little underſtood; as the greater part, and perhaps all the reſt of it, would fall under the laſt article, that of grace. Thus it appears that the paſſions can give the beauty without the aſſiſtance of colour or form; and take it away where they have united the moſt ſtrongly to give it. And hence the ſuperiority of this part of beauty to the other two.

This, by the way, may help us to account for the juſtneſs of what Pliny aſſerts in ſpeaking of the famous ſtatue of Laocoon and his two ſons: he ſays, it was the fineſt piece of art in Rome; and to be preferred to all the other ſtatues and pictures, of which they had ſo noble a collection in his time. It had no beauties of colour to vie with the paintings and other ſtatues there: as the Apollo Belvedere and the Venus of Medici, in particular, were as finely proportioned as the Laocoon: but this had much greater variety of expreſſion even than thoſe fine ones; and it muſt be on that account alone that it could have been preferable to them and all the reſt.

Before quitting this head, two things before mentioned deſerve to be repeated: that the chief rule of the beauty of the paſſions is moderation; and that the part in which they appear moſt ſtrongly are the eyes. It is there that love holds all his intereſted language: It is there that virtue commands, modeſty charms, joy enlivens, ſorrow engages, and inclination fires the hearts of the beholders: it is there that even fear, and anger, and confuſion, can be charming. But all theſe, to be charming, muſt be kept within their due bounds and limits; for too ſullen an appearance of virtue, a violent and proſtitute ſwell of paſſion, a ruſtic and overwhelming modeſty, a deep ſadneſs, or too wild and impetuous joy, become all either oppreſſive or diſagreeable.

4 The laſt finiſhing and nobleſt part of beauty is *Grace*; which every body is accuſtomed to ſpeak of as a thing inexplicable; and in a great meaſure perhaps it is ſo. We know that the ſoul is, but we ſcarce know what it is: every judge of beauty can point out grace; but no one ſeems even yet to have fixed upon a definition for it.

But though one cannot punctually ſay what grace is, we may point out the parts and things in which it is moſt apt to appear.

In a very graceful face, by which we do not ſo much mean a majeſtic as a ſoft and pleaſing one, there is, now and then, a certain deliciouſneſs that almoſt always lives about the mouth, in ſomething not quite enough to be called a ſmile, but rather an approach towards one, which varies gently about the different lines there like a little fluttering Cupid, and perhaps ſometimes diſcovers a little dimple, that after juſt lightening upon you diſappears and appears again by fits.

The grace of attitudes may belong to the poſition of each part as well as to the carriage and diſpoſition of the whole body: but how much more it belongs to the head than to any other part, may be ſeen in the pieces of the moſt celebrated painters; and particularly in thoſe of Guido, who has been rather too laviſh in beſtowing this beauty on almoſt all his fine women; whereas nature has given it in ſo high a degree but to very few.

But it is not only in genteel motions that a very pretty woman will be graceful: and Ovid (who was ſo great a maſter in all the parts of beauty) had very good reaſon for ſaying, That when Venus, to pleaſe her gallant, imitated the hobbling gait of her huſband, her very lameneſs had a great deal of prettineſs and grace in it.

There are two very diſtinct (and, as it were, oppoſite) ſorts of grace; the majeſtic and the familiar. The former belongs chiefly to the very *fine* women, and the latter to the very *pretty* ones: *That* is more commanding, and *this* the more delightful and engaging. The Grecian painters and ſculptors uſed to expreſs the former moſt ſtrongly in the looks and attitudes of their Minervas, and the latter in thoſe of Venus. Xenophon, in his choice of Hercules (or at leaſt the excellent tranſlator of that piece) has made juſt the ſame diſtinction in the perſonages of wiſdom and pleaſure; the former of which he deſcribes as moving on to that young hero with the majeſtic ſort of grace; and the latter with the familiar.

> Graceful, yet each with different grace they move:
> This ſtriking ſacred awe, that ſofter winning love.

No poet ſeems to have underſtood this part of beauty ſo well as our own Milton. He ſpeaks of theſe two ſorts of grace very diſtinctly; and gives the majeſtic to his Adam, and both the familiar and majeſtic to Eve; but the latter in a leſs degree than the former:

> Two of far nobler ſhape, erect and tall,
> Godlike erect, with native honour clad,
> In naked majeſty, ſeem'd lords of all;
> And worthy ſeem'd. For in their looks divine
> The image of their glorious Maker ſhone:
> Truth, wiſdom, ſanctitude ſevere and pure:
> Severe, but in true filial freedom plac'd;
> Whence true authority in men: Though both
> Not equal, as their ſex not equal ſeem'd.

For contemplation he; and valour form'd;
For softness she, and sweet attractive grace.
Milton's Par. Lost. B. iv. 298.

Grace was in all her steps: Heav'n in her eye;
In ev'ry gesture, dignity and love. B. viii. 489.

Speaking, or mute, all comeliness and grace
Attends thee; and each word, each motion, forms. *Ib.* 223.

All the best statues are represented as in some action or motion; and the most graceful statue in the world (the Apollo Belvedere) is so much so, that when one faces it at a little distance, one is almost apt to imagine that he is actually going to move on toward you.

Whatever are the causes of it, this is certain, that grace is the chief of all the constituent parts of beauty: All the rest are only relative. One likes a brunette beauty better than a fair one: I may love a little woman, and you a large one best: a person of a mild temper will be fond of the gentler passions in the face, and one of a bolder cast may choose to have more vivacity and more vigorous passions expressed there: But grace is found in few, and is pleasing to all. Grace, like poetry, must be born with a person, and is never wholly to be acquired by art. The most celebrated of all the ancient painters was Apelles; and the most celebrated of all the modern, Raphael: And it is remarkable, that the distinguishing character of each of them was grace. Indeed, that alone could have given them so high a pre-eminence over all their other competitors.

The Greeks as well as the Romans must have been of this opinion; when in settling their mythology, they made the graces the constant attendants of Venus, or the cause of love. In fact, there is nothing causes love so generally and so irresistibly as grace. It is like the Cestus of the same goddess, which was supposed to comprehend every thing that was winning and engaging in it; and beside all, to oblige the heart to love by a secret and inexplicable force, like that of some magic charm.

She said; with awe divine, the queen of love
Obey'd the sister and the wife of Jove:
And from her fragrant breast the zone unbrac'd,
With various skill and high embroidery grac'd.
In this was every art, and every charm,
To win the wisest, and the coldest warm:
Fond love, the gentle vow, the pay delay,
The kind reveal, the still reviving fire,
Persuasive speech, and more persuasive sighs,
Silence that spoke, and eloquence of eyes.
This on her hand the Cyprian goddess laid;
Take this, and with it all thy wish, she said:
With smiles she took the charm: and smiling press'd
The pow'rful Cestus to her snowy breast.
Pope, Il. xiv. 256.

But the greatest and most general misleader of our judgments in relation to beauty, is custom, or the different national tastes for beauty, which turn chiefly on the two lower parts of it, colour and form. It was from the most common shape of his country-women that Rubens, in his pictures, delights so much in plumpness; not to give it a worse name. Whenever he was to represent the most beautiful women, he was sure to give them a good share of corpulence. It seems as if nobody could be a beauty with him under two hundred weight. His very graces are all fat.

But this may go much farther than mere bulk; it will reach even to very great deformities; which sometimes grow into beauties, where they are habitual and general. One of our own countrymen (who was a particularly handsome man) in his travelling over the Alps, was detained by a fever in one of those villages, where every grown person has those sorts of swellings in the neck which they call *goitres*: and of which some are pretty near as big as their heads. The first Sunday that he was able, he went to their church (for he was a Roman Catholic) to return thanks to Heaven for his recovery. A man of so good a figure, and so well dress, had probably never before been within the walls of that chapel. Every body's eyes were fixed upon him: and as they went out, they cried out loud enough for him to hear them, "O how completely handsome would that man be, if he had but a *goitre!*"

In some of the most military nations of Africa, no man is reckoned handsome that has not five or six scars in his face. This custom might possibly be introduced among them to make them less afraid of wounds in that part in battle; but however that was, it grew at last to have so great a share in their idea of beauty, that they now cut and slash the faces of their poor little infants, in order to give them those graces, when they are grown up, which are so necessary to win the hearts of their mistresses: and which, with the assistance of some jewels or ingots of gold in their noses, ears, and lips, must certainly be irresistible to the ladies of that country.

The covering each cheek all over with a burning sort of red colour, has long been looked upon in a neighbouring country to be as necessary to render a fine lady's face completely beautiful, as these scars are for the beaux in Africa. The natural complexion of the Italian ladies is of a higher glow than our's usually are; and yet Mr. Addison is very just, in making a Numidian call the ladies of the same country *pale unripened beauties*.

The glowing dames of Zama's royal court
Have faces flush'd with more exalted charms:
The sun, that rolls his chariot o'er their heads,
Works up more fire and colour in their cheeks:
Were you with these, my prince, you'd soon forget
The pale unripen'd beauties of the north!
Sypbax to Juba, in *Cato*; Act i. Scene 4.

We cannot avoid observing, however, that heaven is very good and merciful to mankind, even in making us capable of all this variety of mistakes. If every person judged exactly right of beauty, every man that was in love in such a district, would be in love with the same woman. The superior beauty of each hamlet would be the object of the hate and malice of all the rest of her own sex in it, and the cause of dissention and murders among all of the other. If this would hold in one town, it would hold, for the same reasons, in every other town or district; and of course there would be nothing more wanting than this universal right judgment of beauty to render the whole world one continued scene of blood and misery.

BEAUTY, in architecture, painting, and other arts, is the harmony and justness of the whole composition taken together.

BED. It was universally the practice, in the first ages, for mankind to sleep upon the skins of beasts. It was originally the custom of the Greeks and Romans. It was particularly the custom of the ancient Britons before the Roman invasion; and these skins were spread on the floor of their apartments. Afterwards they were changed for loose rushes and leather. The common Welch had their beds thinly stuffed with rushes as late as the conclusion of the 12th century; and with the gentlemen it continued many ages afterwards. Straw was used even in the royal chambers of England as late as the close of the 15th. Most of the peasants about Manchester lie on chaff at present, as do likewise the common people all over Scotland: In the Highlands heath also is very generally used as bedding even by the gentry; and the repose on a heath bed has been celebrated by travellers as a peculiar luxury, superior to that yielded by down. In France and Italy, straw beds remain general to this day.

BEE, a winged vaivicous insect, bred from maggots or worms, that are *apoda*, or without feet; remarkable for its skill and industry, in collecting honey and wax from flowers, &c. and on that account frequently preserved in gardens. In the Linnæan system of entomology it is a genus of insects belonging to the class *Hymenoptera*, and comprehending fifty-five different species. Beside the common *honey-bee*, Mr. Ray reckons nine other species. To this species of *hive-bees* belong the common *working-bee*, the *drones*, and the *queen-bee*. For a description at large, see the article APIS.

BEECH-*tree*, *Fagus*, in botany. For the characters, culture, properties and uses of this tree, see the article FAGUS.

BEECH-*mast*, the fruit of the beech-tree. It fattens hogs and deer, and has sometimes supplied men instead of bread. Chios is said to have endured a memorable siege by means of it.

BEECH-*oil*, an oil drawn from the fruit, or mast, of the beech-tree. The *beech-mast* is a kind of a triangular seed, in form of a nut, or rather acorn, containing a whitish oleaginous pith, of a very agreeable taste; whereof is made an oil much valued for sallads, &c. It is very common in Picardy, and other places where the mast abounds. They draw it cold by expression, after the mast has been shelled and pounded. An attempt was made, a few years ago, to introduce the manufacture of beech-oil in England, and a patent was granted to the proprietor, but without success: the country people, it seems, turning this mast to better account in feeding the hogs with it, than in selling to the patentee, and his co-proprietors, for oil.

BEER, is a spiritous liquor made from any farinaceous grain, but generally from barley. It is, properly speaking, the wine of barley. The meals of any of these grains being extracted by a sufficient quantity of water, and remaining at rest, in a degree of heat requisite for the spirituous fermentation, naturally undergo this fermentation, and are changed into a vinous liquor. But as all these matters render the water mucilaginous, fermentation proceeds slowly and imperfectly in such liquors. On the other side, if the quantity of farinaceous matter be so diminished that its extract or decoction may have a convenient degree of fluidity, this liquor will be impregnated with so small a quantity of fermentable matter, that the beer or wine of the grain will be too weak, and have too little taste.

These inconveniencies are remedied by preliminary operations which the grain is made to undergo.---These preparations consist in steeping it in cold water, that it may soak and swell to a certain degree, and in laying it in a heap with a suitable degree of heat, by means of which, and of the imbibed moisture, a germination begins, which is to be stopped by a quick drying, as soon as the bud shows itself. To accelerate this drying, and render it more complete, the grain is slightly roasted, by making it pass down an inclined canal sufficiently heated. This germination, and this slight roasting, change considerably the nature of the mucilaginous fermentable matter of the grain. The germination attenuates much, and in some measure totally destroys, the viscosity of the mucilage; and it does this, when not carried too far, without depriving the grain of any of its disposition to ferment. On the contrary,

trary, it changes the grain into a ſaccharine ſubſtance, as may be perceived by maſhing grains beginning to germinate. The ſlight roaſting contributes alſo to attenuate the mucilaginous fermentable matter of the grain. When the grain is thus prepared, it is fit to be ground, and to impregnate water with much of its ſubſtance, without forming a glue or viſcous maſs. The grain thus prepared is called *malt*. This malt is then to be ground; and all its ſubſtance, which is fermentable and ſoluble in water, is to be extricated by means of hot water. This extract or infuſion is ſufficiently evaporated by boiling in caldrons; and ſome plant of an agreeable bitterneſs, ſuch as hops, is at that time added, to heighten the taſte of the beer, and to render it capable of being longer preſerved. Laſtly, this liquor is put into caſks, and allowed to ferment; nature performs the reſt of the work, and is only to be aſſiſted by the other moſt favourable circumſtances for the ſpirituous fermentation. See FERMENTATION, and for a copious account of the method of making Beer, ſee the Treatiſe on the Art of BREWING.

Foreigners have framed divers conjectures to account for the excellency of the Britiſh beer, and its ſuperiority to that of other countries, even of Bremen, Mons, and Roſtoch. The excellency of our beer is in general attributed to the quality of our malt and water, and the ſkill of our brewers in preparing of it.

Sour-beer may be reſtored divers ways; as by ſalt made of the aſhes of barley-ſtraw, put into the veſſel, and ſtirred; by three or four handfuls of beech aſhes thrown into the veſſel, and ſtirred; or, where the liquor is not very ſour, by a little put into a bag, without ſtirring: chalk calcined, oyſter-ſhells, egg-ſhells burnt, ſea-ſhells, crabs' eyes, alkalized coral, &c. do the ſame, as they imbibe the acidity, and unite with it into a ſweetneſs. Beer, it is ſaid, may be kept from turning ſour in ſummer, by hanging into the veſſel a bag containing a new laid egg, pricked full of little pin-holes, ſome laurel-berries, and a few barley-grains; or by a new laid egg and walnut-tree leaves. Glauber commends his ſalmirabile and fixed nitre, put in a linen bag and hung on the top of the caſk ſo as to reach the liquor, not only for recovering ſour beer, but preſerving and ſtrengthening it. Laurel-berries, their ſkin being peeled off, will keep beer from *deadneſs*; and beer already dead may be reſtored by impregnating it with fixed air. *Beer taſting of the caſk* may be freed from it by putting a handful of wheat in a bag, and hanging it in the veſſel.

BEESTINGS, or BREASTINGS, a term uſed by country-people for the firſt milk taken from a cow after calving. The beeſtings are of a thick conſiſtence, and yellow colour, ſeeming impregnated with ſulphur. Dr. Morgan imagines them to be peculiarly fitted and intended by nature to cleanſe the young animal from the recrements gathered in its ſtomach and inteſtines during its long habitation *in utero*. The like quality and virtue he ſuppoſes in women's firſt milk after delivery; and hence infers the neceſſity of the mother's ſuckling her own child, rather than committing it to a nurſe whoſe firſt milk is gone. See the Syſtem of MIDWIFERY, Part X. Sect. 6.

BEETLE, the Engliſh name of the genus *Scarabæus*, in the Syſtem of *Entomology*. For deſcription of the genus, ſee SCARABÆUS. For claſſification, ſee the Syſtem.

BEGGAR. *Beggars* pretending to be blind, lame, &c. found begging in the ſtreets, are to be removed by the conſtables; and refuſing to be removed ſhall be whipped, &c. ſtat. 12 Anne; and our ſtatutes have been formerly ſo ſtrict for puniſhing of *beggars*, that in the reign of king Henry VIII. a law was enacted, that *ſturdy-beggars* convicted of a ſecond offence ſhould be executed as felons. But this ſtatute was afterwards repealed. See VAGABOND.

BEHEADING, a capital puniſhment, wherein the head is ſevered from the body by the ſtroke of an axe, ſword, or other cutting inſtrument. In England, and in France alſo (prior to the revolution) *beheading* is the puniſhment of nobles; being reputed not to derogate from nobility, as hanging does. In Scotland they do not behead with an axe, as in England; nor with a ſword, as in Holland; but with an edged inſtrument called the MAIDEN. In France they have invented an inſtrument for the purpoſe of beheading, called LE GUILLOTINE, models of which were expoſed to public view in many parts of this metropolis.

BEHEMOTH, a huge animal mentioned in ſcripture, concerning which interpreters are much divided. Many ſuppoſe it to be the *Hippopotamus*, or *River-Horſe*, which is deſcribed in the order of the alphabet, under the article HIPPOPOTAMUS.

BEL *and the Dragon* (The Hiſtory of); an apocryphal, and uncanonical book of ſcripture. It was always rejected by the Jewiſh church, and is extant neither in the Hebrew nor the Chaldee language, nor is there any proof that it ever was ſo. St. Jerom gives it no better title than *the Fable of Bel and the Dragon*. It is however permitted to be read, as well as the other apocryphal writings, for the inſtruction and improvement of manners.

BELIEF, in its general and natural ſenſe, denotes a perſuaſion, or a ſtrong aſſent of the mind to the truth of any propoſition. In which ſenſe, *belief* has no relation to any particular kind of means or arguments, but may be produced by any means whatever. Thus we are ſaid to believe our ſenſes, to believe our reaſon, to believe a witneſs, &c. and hence in rhetoric, all ſorts of proofs, from whatever topics deduced, are called πίστεις, becauſe apt to get belief, or perſuaſion, touching the matter in hand.

BELIEF, in its more reſtrained and technical ſenſe, invented by the ſchoolmen, denotes that kind of aſſent which is grounded only on the authority, or teſtimony, of ſome perſon or perſons, aſſerting or atteſting the truth of any matter propoſed. In this ſenſe *belief* ſtands oppoſed to knowledge and ſcience. We do not ſay we believe that ſnow is white, or that the whole is equal to its parts; but we ſee and know them to be ſo: that the three angles of a triangle are equal to two right angles, or that all motion is naturally rectilinear, are not ſaid to be things credible, but ſcientifical; and the comprehenſion of ſuch truths is not belief but ſcience.

But when a thing propounded to us is neither apparent to our ſenſe, nor evident to our underſtanding; neither certainly to be collected from any clear and neceſſary connection with the cauſe from whence it proceeds, nor with the effects it naturally produces; nor is taken up upon any real arguments, or any relation thereof to other acknowledged truths: and yet, notwithſtanding, appears as true, not by a manifeſtation, but by an atteſtation of the truth, and moves us to aſſent, not of itſelf, but in virtue of a teſtimony given to it—this is ſaid to be properly *credible*; and an aſſent to this is the proper notion of *belief* or FAITH.

BELL, a well known machine, ranked by muſicians among the muſical inſtruments of percuſſion.

The conſtituent parts of a bell are the body or *barrel*, the *clapper* on the inſide, and the ear or *cannon* by which it hangs to a large beam of wood. The matter of which it is uſually made is a compoſition called *bell-metal*. The thickneſs of a bell's edge is uſually one-fifteenth of the diameter, and its height 12 times its thickneſs. The bell-founders have a diapaſon, or bell-ſcale, wherewith they meaſure the ſize, thickneſs, weight and tone of their bells. The ſound of a bell is conjectured to conſiſt in a vibratory motion of its parts, much like that of a muſical chord. The ſtroke of the clapper muſt neceſſarily change the figure of the bell, and of a round make it oval; but the metal having a great degree of elaſticity, that part will return back again, which the ſtroke drove fartheſt off from the centre, and that even ſome ſmall matter nearer the centre than before; ſo that the two parts which before were extremes of the longeſt diameter, do then become thoſe of the ſhorteſt: and thus the external ſurface of the bell undergoes alternate changes of figure, and by that means give that tremulous motion to the air in which the ſound conſiſts. M. Perrault maintains, that the ſound of the ſame bell or chord, is a compound of the ſounds of the ſeveral parts thereof, ſo that where the parts are homogeneous and the dimenſions of the figure uniform, there is ſuch a perfect mixture of all theſe ſounds as conſtitutes one uniform, ſmooth, even ſound: and the contrary circumſtances produce harſhneſs. This he proves from the bell's differing in tone according to the part you ſtrike: and yet ſtrike it any where, there is a motion of all the parts. He therefore conſiders bells as a compound of an infinite number of rings, which according to their different dimenſions have different tones, as chords of different length have; and when ſtruck, the vibrations of the parts immediately ſtruck determine the tone, being ſupported by a ſufficient number of conſonant tones in the other parts.

Bells are obſerved to be heard farther placed on plains than on hills; and ſtill farther in valleys than on plains: the reaſon of which will not be difficult to aſſign, if it be conſidered that the higher the ſonorous body is, the rarer is its medium; conſequently, the leſs impulſe it receives, and the leſs proper vehicle it is to convey it to a diſtance.

Matthew Paris obſerves, that anciently the uſe of bells was prohibited in time of mourning; though at preſent they make one of the principal ceremonies of mourning. Mabillon adds, that it was an ancient cuſtom to ring the bells for perſons about to expire, to adverti'e the people to pray for them; whence our paſſing bells. The paſſing bell, indeed, was anciently rung for two purpoſes; one to beſpeak the prayers of all good chriſtians, for a ſoul juſt departing; the other to drive away the evil ſpirits who ſtood at the bed's foot, and about the houſe, ready to ſeize their prey, or at leaſt to moleſt and terrify the ſoul in its paſſage: but by the ringing of that bell (for Durandus informs us, evil ſpirits are much afraid of bells) they were kept aloof; and the ſoul, like a hunted hare, gained the ſtart, or had what is by ſportſmen called *law*. Hence, perhaps, excluſive of the additional labour, was occaſioned the high price demanded for tolling the greateſt bell of the church; for, that being louder, the evil ſpirits muſt go farther off to be clear of its ſound, by which the poor ſoul got ſo much more the ſtart of them: beſides, being heard farther off, it would likewiſe procure the dying man a greater number of prayers. This diſlike of ſpirits to bells, is mentioned in the Golden Legend, by W. de Worde. "It is ſaid, the evill ſpirytes, that ben in the regyon of thayre, doubte moche when they here the belles rongen: and this is the cauſe why the belles ben rongen whan it thondreth, and whan grete tempeſte and outrages of wether happen, to the ende that the feinds and wycked ſpirites ſhold be abaſhed and flee, and ceaſe of

This being an additional Sheet (5 I---2) to the new Edition of this work, the BINDER is deſired to be careful in placing it after (5I---2); ſhould it be Miſplaced, or thrown out in the Binding, under the idea of its being a duplicate Sheet, the Work will be rendered imperfect.

the movynge of tempeſte." Lobineau obſerves, that the cuſtom of ringing bells, at the approach of thunder, is of ſome antiquity; but that the deſign was not ſo much to ſhake the air, and ſo diſſipate the thunder, as to call the people to church, to pray that the pariſh might be preſerved from that terrible meteor.

In the times of popery, bells were baptiſed and anointed *oleo chriſmatis:* they were exorciſed and bleſſed by the biſhop: from a belief, that, when theſe ceremonies were performed, they had power to drive the devil out of the air, to calm tempeſts, to extinguiſh fire, and to recreate even the dead. The ritual for theſe ceremonies is contained in the Roman pontifical; and it was uſual in their baptiſm to give to bells the name of ſome ſaint. In Chauncy's hiſtory of Hertfordſhire, page 383, is a relation of the baptiſm of a ſet of bells in Italy with great ceremony, a ſhort time before the writing that book. The bells of the pariſh-church of Winnington in Bedfordſhire had their names caſt about the verge of every one in particular, with theſe rhiming hexameters:

Nomina Campavis hæc indita ſunt quoque noſtris.
1. *Hoc ſignum Petri pulſatur nomine Chriſti.*
2. *Nomen Magdalene compana ſonat melode.*
3. *Sit nomen Domini benedictum ſemper in eum.*
4. *Muſa Raphaëlis ſonat auribus Immanëulis.*
5. *Sum Roſa pulſata mundique Maria vocata.*

Weev. Fun. 122.

By an old chartulary, once in the poſſeſſion of Weever the antiquary, it appears that the bells of the priory of Little Dunmow in Eſſex, were, anno 1501, new caſt, and baptized by the following names:

Prima in honore Sancti Michaëlis Archangeli.
Secunda in honore S. Johannis Evangeliſti.
Tertia in honore S. Johannis Baptiſti.
Quarta in honore Aſſumptionis beatæ Mariæ,
Quinta in honore ſanctæ Trinitatis, et omnium ſanctorum.

Ib. 633.

The bells of Oſney abbey near Oxford, were very famous; their ſeveral names were Douce, Clement, Auſtin, Hautecler. [potius Hauteleri], Gabriel, and John. The cuſtom of chriſtening, or bleſſing bells, is very ancient. Some ſay it was introduced by pope John XIII. in 972; but it is evidently of an older ſtanding, there being an expreſs prohibitation of the practice in a capitular of Charlemagne in 789. See Hoſpinian de Origine Templorum, p. 113, where there is a particular account of all the ridiculous ceremonies practiſed about bells. See Dr. Franklin's Obſervations on conſecrated bells, and the form in conſecrating them. Experiments, Obſervations, &c. p. 448. ed. 1769.

The practice of ringing bells in change or regular peals, is ſaid to be peculiar to England; whence Britain has been termed the *ringing iſland.* The cuſtom ſeems to have commenced in the time of the Saxons, and was common before the conqueſt. The ringing of bells, though a recreation chiefly of the lower ſort, is in itſelf not incurious.

The muſic of bells is altogether melody; but the pleaſure ariſing from it conſiſts in the variety of interchanges, and the various ſucceſſion and general predominance of the conſonances in the ſounds produced. Muſical authors ſeem to have written but little upon this ſubject.

Diving-BELLS. For a copious deſcription of this machine, ſee the Syſtem of HYDROSTATICS, Part II. Art. 9. For repreſentation, ſee Plate II. Fig. 27

Electrical-BELLS are uſed in a variety of entertaining experiments by electricians. For deſcription of the apparatus and the methods of application, ſee the Syſtem of ELECTRICITY, Part II. Art. 1. Experiment 6. and Plate II. Fig. 21.

BELL-*metal* is a compoſition of tin and copper melted together in due proportion: which has this property, that it is more ſonorous than any of the ingredients taken apart. The ordinary proportion is about twenty-two or twenty-three pounds of tin to one hundred weight of copper; though the proportion varies according to the ſize of the bells; a greater quantity of copper being uſed in the greater bells than in the ſmaller ones. Some add lead and braſs, others zinc or ſpelter, to the compoſition. It has long been obſerved, that though tin is ſpecifically lighter than copper, yet the gravity of the compound *bell-metal* is greater than that of copper itſelf. Notice has been frequently taken of this not uncommon phenomenon in chymiſtry, from which it appears that Archimedes's propoſition and tables, calculated upon that principle, for determining the propotion of two metals in any given compound, by hydroſtatical experiments, are leſs to be depended upon than has hitherto been ſuppoſed. Some alſo ſpeak of a native mineral under the denomination *bell-metal*, or *helmettel*, from which Becher affirms he procured zaffer and ſmalt. For a further account of this compoſition, ſee the Syſtem of CHYMISTRY, Part III. Chap. 2. Sect. 4.

BELL-*animal*, a name given by the writer on microſcopical diſcoveries to a very ſmall animal found at the roots of the common duckweed. The bodies of theſe animals are ſhaped like *bells*, and they have very long ſlender tails, by which they faſten themſelves to the roots of theſe little plants. They are uſually found in great numbers together, in a ſort of cluſter or bunches; and all of the ſame bunch have always the ſame motion, very frequently contracting themſelves, and afterwards expanding all together to the full length of their tails. They uſually contract inſtantaneouſly; but are more ſlow in the expanding themſelves again.—See MICROSCOPIC OBJECTS, and Plate I. Fig. 9.

BELLOWS, a machine ſo contrived as to expire and inſpire the air by turns, by enlarging and contracting its capacity.

Anacharſis, the Scythian, is recorded as the inventor of bellows. The action of bellows bears a near affinity to that of the lungs; and what we call blowing in the latter affords a good illuſtration of what we call *reſpiring* in the former. Animal life itſelf may on ſome occaſions be ſubſiſted, by blowing into the lungs by a pair of bellows. Dr. Hook's experiment to this effect is famous: having laid the thorax of a dog bare, by cutting away the ribs and diaphragm, pericardium, &c. and having cut off the aſpera arteria below the epiglottis, and bound it on the noſe of the bellows, he found, that as he blowed, the dog recovered, and as he ceaſed, fell convulſive; and thus was the animal kept alternately alive and dead above the ſpace of an hour. There are bellows made wholly of wood, without any leather about them; one of which is preſerved in the repoſitory of the Royal Society; and Dr. Plot deſcribes another in the copper works at Elliaſton in Staffordſhire. Ant. della Fruta contrived a ſubſtitute for bellows, to ſpare the expence thereof in the fuſion of metals. This is called by Kircher *camera æolia*, and in England commonly the *water-bellows;* where water falling through a funnel into a cloſe veſſel, ſends from it ſo much air continually as blows the fire.

HYDROSTATIC-*bellows*. For a copious account of the *water* or *hydroſtatic-bellows*, and the principles on which it acts, ſee the Syſtem of HYDROSTATICS, Part I. Sect. 2. For repreſentation ſee Plate I. Fig. 9.

BELLY, in a general ſenſe, denotes the whole ABDOMEN, or that region of the body contained between the *ſeptum tranſverſum*, the *hypochondria*, and *pubes*.

BELLY is alſo uſed, in a more confined ſenſe, for the inteſtines alone, as containing the *fæces*. In this ſenſe we ſpeak of the looſeneſs or coſtiveneſs of the belly, &c. For a copious deſcription of the *Abdomen* and its ſeveral parts, ſee the Syſtem of ANATOMY, Part III. throughout. For repreſentation ſee Plate IV. Fig. 3, and ſeveral Figures in Plate V.

BELLY, is alſo uſed in ſpeaking of the bodies of beaſts. Thus, we ſay a light-*belly*, meaning a ſlender or lank one: a cow-*belly*, that where the ribs being unable to hold the *viſcera*, they preſs downwards, and bulge diſagreeably. Feeding horſes with graſs, or much hay, and few oats, makes them grow cow-bellied. It is a maxim that horſes which are light-bellied, and fiery, ſoon deſtroy themſelves. The belly of an horſe ſhould be of an ordinary bigneſs, except in draught horſes, where the larger the better, provided it be round, and well incloſed within the ribs; rather extending upon the ſides than downwards. Thoſe horſes are apt to be cow-bellied, which, having ſtraight ribs, are great feeders.

BENCH in law, *Free*-BENCH ſignifies that eſtate in copyhold-lands, which the wife, being eſpouſed a virgin, has after the deceaſe of her huſband, for her dower, according to the cuſtom of the manor. As to this free-bench, ſeveral manors have ſeveral cuſtoms: and in the manors of Eaſt and Weſt Enbourne in the county of Berks, and other parts of England, there is a cuſtom, that when a copyhold tenant dies, the widow ſhall have her free-bench in all the deceaſed huſband's lands, while ſhe lives ſingle, and chaſte; but if ſhe commits incontinency, ſhe ſhall forfeit her eſtate: nevertheleſs, upon her coming into the court of the manor, riding on a black ram, and having his tail in her hand, and at the ſame time repeating a form of words preſcribed, the ſteward is obliged, by the cuſtom of the manor, to re-admit her to her free-bench.

King's-BENCH, a court in which the king was formerly accuſtomed to ſit in perſon, and on that account was moved with the king's houſhold. This was originally the only court in Weſtminſter-hall, and from this it is thought that the courts of common-pleas and exchequer were derived. As the king in perſon is ſtill preſumed in law to ſit in this court, though only repreſented by his judges, it is ſaid to have ſupreme authority; and the proceedings in it are ſuppoſed to be *coram nobis*, that is, before the king. See the Article COURT.

BEND, in *heraldry*, an ordinary or bearing, formed by two lines drawn diagonally, or athwart, from the dexter chief of the ſhield to the ſiniſter baſe; being ſuppoſed to repreſent a ſhoulder-belt, or ſcarf, worn over the ſhoulder. The *bend* is one of the ten honourable ordinaries, containing a third part of the field when charged, and a fifth when plain. It is ſometimes indented, ingrailed, &c. Heralds ſpeak of a *bend dexter*, and a *bend ſiniſter*. See the Syſtem, Sect. 6. Art. 1, and Plate III.

BENDING. M. Bernouilli, has a diſcourſe on the *bending* of ſprings, or elaſtic bodies. M. Amontons gives ſeveral experiments concerning the bending of ropes. The traction of a rope bent, or wound round an immoveable cylinder, is ſufficient, with a very ſmall power, to ſuſtain very great weights. Mem. Acad. Sc. 1703, 1705, 1699. Divers methods have been contrived for bending timber, in order to ſupply crooked planks, and pieces for building ſhips: M. Daleſme ingeniouſly enough propoſed to have the

the young trees bent, while growing in the foreſt. The method of bending planks by a ſand-heat, now uſed in the king's yards at Deptford, was invented by Captain Cumberland. Phil. Tranſ. No. 371. p. 75.

BENDY, BANDE, in *Blazonry*, denotes an eſcutcheon's being divided bend-wiſe into an even number of partitions, varying of metal and colour. If they be odd, the field muſt firſt be named, and then the number of bends. In England, the number is always made even; in other countries this is not regarded. See the Syſtem of HERALDRY, Sect. 2, and Plate II.

BENEDICTINS, in church hiſtory, an order of monks, who profeſs to follow the rules of St. Benedict. The Benedictins, being thoſe only that are properly called *monks*, wear a looſe black gown, with large wide ſleeves, and a capuche, or cowl, on their heads, ending in a point behind. In the canon law, they are ſtyled *black-friars*, from the colour of their habit. The rules of St. Benedict, as obſerved by the Engliſh monks before the diſſolution of the monaſteries, were as follows: They were obliged to perform their devotions ſeven times in 24 hours, the whole circle of which devotions had a reſpect to the paſſion and death of Chriſt.

The time when this order came firſt into England is well known; for to it the Engliſh owe their converſion from idolatry. In the year 596, pope Gregory ſent hither Auguſtin, prior of the monaſtery of St. Andrew at Rome, with ſeveral other Benedictin monks. St. Auguſtin became archbiſhop of Canterbury; and the Benedictins founded ſeveral monaſteries in England, as alſo the metropolitan church of Canterbury, and all the cathedrals that were afterwards erected.

Pope John XXII. who died 1334, after an exact inquiry, found, that, ſince the firſt riſe of the order, there had been of it 24 popes, near 200 cardinals, 7000 archbiſhops, 15,000 biſhops, 15,000 abbots of renown, about 4000 ſaints, and upwards of 37,000 monaſteries. There have been likewiſe of this order, 20 emperors, and 10 empreſſes, 47 kings, and above 50 queens, 20 ſons of emperors, and 48 ſons of kings; about 100 princeſſes, daughters of kings and emperors: beſides dukes, marquiſſes, earls, counteſſes, &c. innumerable. The order has produced a vaſt number of eminent writers and other learned men. Their Rabanus ſet up the ſchool of Germany. Their Alcuinus founded the univerſity of Paris. Their Dionyſius Exiguus perfected the eccleſiaſtical computation. Their Guido invented the ſcale of muſic; and their Sylveſter, the organ. They boaſt to have produced Anſelmus, Ildephonſus, Venerable Bede, &c.

The Engliſh congregation, which had ſubſiſted from the time of the miſſion of St. Auſtin, was deſtroyed under Henry VIII. and by degrees reduced to one ſingle man, father Buckley, who, in 1607, procured a re-eſtabliſhment of the congregation at Doway, in the Netherlands, where it ſtill ſubſiſts in a kind of dependency on that of St. Valladolid in Spain.

At the general chapters they chuſe provincials, with their aſſiſtants, for each of the provinces of Canterbury and York, who have juriſdiction over the miſſionaries employed therein. They are governed by a preſident-general, and three DEFINITORS, choſen every three years. At their admiſſion they make a fourth vow, viz. that they will go to the miſſion in England, and return when their ſuperiors think fit.

There are nuns likewiſe who follow the rule of St. Benedict: among whom thoſe who call themſelves *mitigated*, eat fleſh three times a week, on Sundays, Tueſdays, and Thurſdays: the others obſerve the rule of St. Benedict in its rigour, and eat no fleſh unleſs they are ſick.

BENEDICTION, in a general ſenſe, the act of bleſſing, or giving praiſe to god, or returning thanks for his favours. It is alſo uſed for an eccleſiaſtical ceremony, whereby a thing is rendered ſacred or venerable. In this ſenſe benediction differs from conſecration, as in the latter unction is applied, which is not in the former: Thus the chalice is conſecrated, and the pix bleſſed; as the former, not the latter, is anointed: though in the common uſage, theſe two words are applied promiſcuouſly. The ſpirit of piety, or rather of ſuperſtition, has introduced into the Romiſh church benedictions for almoſt every thing. We read of forms of benedictions for wax candles, for boughs, for aſhes, for church veſſels, and ornaments; for flags or enſigns, arms, firſt-fruits, houſes, ſhips, paſchal-eggs, cilicium or the hair-cloth of penitents, church-yards, &c. In general, theſe benedictions are performed by aſperſions of holy water, ſigns of the croſs, and prayers ſuitable to the nature of the ceremony. The forms of theſe bendections are found in the Roman pontifical, in the Roman miſſal, in the book of eccleſiaſtical ceremonies, printed in Pope Leo X's. time, and in the rituals and ceremonies of the different churches which are found collected in father Martene's works on the rites and diſcipline of the church.

BENEFICE, in an eccleſiaſtical ſenſe, a church endowed with a revenue for the performance of divine ſervice, or, the revenue itſelf aſſigned to an eccleſiaſtical perſon for life, in return for his performing the ſervice of the church. All church preferments, except biſhoprics, are called benefices; and all benefices are, by the canoniſts, ſometimes called dignities; but we now ordinarily diſtinguiſh between benefice and dignity, by applying the word dignity to biſhoprics, deaneries, archdeaconries, and prebends; and benefice to parſonages, vicarages, and donatives.

There is an obvious reference in the term benefice to the feudal ſyſtem, which was incorporated in all the governments of Europe. As the lands of all private proprietors were holden of the prince, and becauſe they were originally gratuitous donations, denominated *beneficia*, the pope aſſumed the privilege of a feudal lord, and claimed the authority of diſtributing the preferments of the church at pleaſure; and hence the care of the ſouls of a pariſh came to be called a benefice. Blackſtone's Comm. vol. iv. p. 106. ed. 1769. Hence, doubtleſs, came the term benefice to be applied to church livings; for, beſide that the eccleſiaſtics held for life, like the ſoldiers, the riches of the church aroſe from the beneficence of princes.

As to the origin of eccleſiaſtical benefices it is hard to determine when the revenues of the church were firſt divided: it is certain, till the fourth century, all the revenues were in the hands of the biſhops, who diſtributed them by their œconomy; they conſiſted principally in alms, and voluntary contributions. As the church came to have lands, parts thereof were aſſigned for the ſubſiſtence of the clerks, and called benefices; of which we find ſome traces in the fifth and ſixth century; but then there does not appear to have been any certain partition, nor any preciſe quota allotted to each particular; but the allotments were abſolutely diſcretional till about the twelfth century. At firſt, each was contented with a ſingle benefice, but pluralities were, by degrees, introduced, on pretence of equity; for, a ſingle benefice being ſometimes thought a ſcarce competency, the prieſt was allowed two: as his quality, or occaſions, increaſed, ſo the number of benefices that were to ſupport him were increaſed too. Hence ſome, affecting to equal princes in equality, pretend to revenues anſwerable to it.

BENEFICE *in Commendam*, is that, the direction and management whereof, upon a vacancy, is given, or recommended to an eccleſiaſtic, for a certain time, till it may be conveniently provided for.

BENEVOLENCE, inethics, denotes a hearty deſire for the good of mankind, evidencing itſelf, as ability and opportunity offer, in the cheartul and diligent practice of whatever may promote the well-being of all. Some have traced the origin of this affection in ſelf-love: others again in ſome INSTINCT or determination of our nature; antecedent to all reaſon from intereſt, which influences us to the love of others, and they have accordingly made it the foundation of univerſal VIRTUE: others more properly aſcribe it to the *intelligent* conſtitution of human nature, and obſerve, that it ariſes not from inſtinct, but from the nature and neceſſity of things. Hucheſon's Inquiry concerning Moral Good and Evil. Price's Review, &c. chap. iii.

BENEVOLENCE is uſed, both in our ſtatutes and chronicles for a voluntary gratuity given by the ſubjects to their ſovereign, to which each perſon contributes in proportion to his eſtate: and as *benevolences* had been extorted under many ſucceding princes, without a real and voluntary conſent, it was made an article in the petition of right, 3 Car. I. that no man ſhall be compelled to yield any gift, loan, or *benevolence*, &c. without common conſent by act of parliament. In this ſenſe, *benevolence* amounts to much the ſame with what in other nations is call *ſubſidium charitativum*, given ſometimes by tenants to their lords, by the clergy to their biſhops, &c.

BENZOIN, a medicinal kind of reſin, imported from the iſlands of Siam and Sumatra, and ſeveral other parts of the Eaſt-Indies. It is procured by a wound, or inciſion made in a tree, whoſe leaves reſemble thoſe of the lemon-tree, the *croton benzoë*, of Linnæus. The benzoin tree is plentiful in Virginia and Carolina, and has been brought from thence into England, where it grows with vigour in the open ground. The bark and leaves yield with rectified ſpirit a reſin like benzoin, though this tree diſcharges none naturally in our clime nor in America. It is of a yellowiſh colour, of an agreeable ſcent, and melts eaſily. There are three ſorts of benzoin. The firſt is called *amygdaloides*, becauſe of its being interſperſed with ſeveral white ſpots, which reſemble broken almonds: this comes from Siam, and is eſteemed the beſt. The ſecond is black, and very odoriferous: it drops from young trees, and comes from Sumatra; it is called *benzoinum de Boninas*. The third ſort is alſo black, but leſs odoriferous; this is found on the iſlands of Java and Sumatra. See Geoffry, p. 354.

Benzoin is uſed in phyſic as a pectoral, and anti-aſthmatic, and thrown on live coals, it ſerves to perfume houſes, &c. Some recommend benzoin diſſolved in ſpirit of wine as a cephalic. It makes a tincture commended for taking away freckles. It alſo enters the compoſition of ſome plaſters, as a diſcutient and ſtrengthener. Pharmaceutic writers ſpeak of a water and tincture of benzoin drawn with the ſpirit of wine, ſaid to be good againſt aſthmas, &c. Flowers of benzoin, procured by ſublimation, are eſteemed a powerful pectoral, and, ſnuffed up the noſe, are ſaid to be a powerful errhine. Spirit of benzoin is uſed as a diuretic; and oil of benzoin is accounted a good vulnerary. The principal uſe of this fragrant reſin, is in perfumes, and as a coſmetic for ſoftening and ſmoothing the ſkin. For this laſt purpoſe it is diſſolved in

ſpirit

ſpirit of wine, with the addition of ſtorax, and the ſolution mixed with water, makes a white liquor, which is called VIRGIN's *milk*.

BERBERIS, the BARBERRY, or *pipperidge buſh*: A genus of the monogynia order, belonging to the hexandria claſs of plants: the calyx conſiſt of ſix leaves; the petals are ſix, with two glands at the ungues; it has no ſtylus; and the berry contains two ſeeds.

The vulgaris, or common barberry, grows naturally in hedges in many parts of England, as alſo in ſome parts of Scotland: but is alſo cultivated in gardens on account of its fruit, which are uſed in tarts; this fruit is alſo uſed for garniſhing diſhes.

Medicinal and other qualities. The berries, which are ſo acid that birds will not feed upon them, are moderately aſtringent; and have been given with ſucceſs in bilious fluxes, and diſeaſes proceeding from heat, acrimony, and thinneſs of the juices. Among the Egyptians, barberries are uſed in fluxes and malignant fevers, for abating heat, quenching thirſt, raiſing the ſtrength, and preventing putrefaction; the fruit is macerated for a day and a night, in about 12 times its quantity of water, with the addition of a little fennel ſeed, or the like, to prevent offence to the ſtomach; the liquor ſtrained off, and ſweetened with ſugar or ſyrup of citrons, is given to the patient liberally to drink. Proſper Albinus, from whoſe treatiſe *De Medicina Egyptorum*, Dr. Lewis extracted this account, informs us, that he took this medicine himſelf with happy ſucceſs, in a peſtilential fever accompanied with an immoderate bilious diarrhœa. The leaves are alſo gratefully acid. The flowers are offenſive to the ſmell when near, but at a diſtance their odour is extremely fine. An infuſion of the bark in white wine is purgative. The roots boiled in ley die wool yellow. In Poland they dye leather of a moſt beautiful yellow with the bark of the root. The inner bark of the ſtems dyes linen of a fine yellow with the aſſiſtance of allum. This ſhrub ſhould never be permitted to grow in corn lands; for the ears of wheat that grow near it never fill, and its influence in this reſpect has been known to extend acroſs a field of 300 or 400 yards. Cows, ſheep, and goats eat it; horſes and ſwine refuſe.

BERGAMOT, a ſpecies of citron, produced at firſt caſually by an Italian's grafting a citron on the ſtock of a bergamot pear-tree, whence the fruit produced by this union participated both of the citron-tree and the pear-tree. The fruit hath a fine taſte and ſmell, and its eſſential oil is in high eſteem as a perfume. The eſſence of bergamot is alſo called *eſſentia de cedra*. It is extracted from the yellow rind of the fruit, by firſt cutting it in ſmall pieces, then immediately ſqueezing the oil out of them into a glaſs veſſel. This liquor is an etherial oil. A water is diſtilled from the peel as follows Take the outer rind of three bergamots, a gallon of pure proof-ſpirit, and four pints of pure water; draw off a gallon in a balneum mariæ, then add as much of the beſt white ſugar as will be agreeable. Or take of the eſſence of bergamot three drams and a half, of rectified ſpirit of wine three pints, of volatile ſal-ammoniac a dram: diſtil off three pints in a balneum mariæ.

BETA, the BEET; a genus of the dygynia order; belonging to the pentandria claſs of plants.

Species. 1. The maritima, or ſea-beet, grows naturally by the ſea-ſide, and in ſoft marſhes, in many parts of England, as alſo on the Baſs iſland at the mouth of the Forth in Scotland. It has been ſuppoſed by many to be only a variety of the common white beet: but Mr. Millar aſſures us he has been unable to make any variation in them by culture. 2. The hortenſis, or common white beet, is cultivated in gardens for the ſake of its leaves which are frequently uſed in ſoups. The root of this ſort ſeldom grows larger than a man's thumb; the ſpikes of flowers come out from the wings of the leaves, which are long, and have narrow leaves placed between the flowers. 3. The vulgaris, or red beet, with a pyramidal root, hath large, thick ſucculent leaves, which are for the moſt part of a dark green, or purple colour. The roots of this are large, and of a deep red colour. The larger theſe roots grow, the tenderer they are; and the deeper their colour, the more they are eſteemed. The varieties of theſe ſpecies are, the common red beet, the turnip-rooted beet, and the green-leaved red beet. 4. The cicla, or root of ſcarcity; for which ſee *Mangel Werzel*, in the Syſtem of AGRICULTURE, Sect. 15.

Medicinal and other uſes. Decoctions of beets gently looſen the belly; hence they have been ranked among the emollient herbs; the plants remaining after the boiling are ſuppoſed to have rather a contrary effect. They afford little nouriſhment, and are ſaid by ſome to be prejudicial to the ſtomach. The juice expreſſed from the roots is a powerful errhine. The root of the red beet is ſometimes uſed to improve the colour of claret; and Mr. Margraff found that good ſugar might be produced from the roots of the white kind, by the methods practiſed abroad for procuring it from the ſugar cane.

BETEL, an Indian plant in great uſe and eſteem throughout the Eaſt, where it makes a conſiderable article of commerce. The betel bears ſome reſemblance to the pepper-tree. Its leaves are like thoſe of ivy, only ſofter, and full of red juice, which, among the Orientals, is reputed of wonderful virtue for fortifying the teeth, and rendering the breath ſweet. The Indians are continually chewing theſe leaves, which renders their lips ſo red, and teeth black, a colour by them vaſtly preferred to the whiteneſs affected by the Europeans.

The conſumption of betel leaves is incredible, no body, rich, or poor, being without their box of betel, which they preſent to each other by way of civility, as we do ſnuff. In many places they chew the *areca* nut, either alone or mixt with the betel leaf and lime, and the leaves of this plant are ſometimes chewed alone; but they are too ſharp, and uſually injure the teeth, and it is not uncommon to find men of twenty-five wholly toothleſs in this part of the world, merely to their having chewed this plant to an exceſſive degree. The prepared betel is a very common preſent among the poorer ſort; and on taking leave of a friend, it is always the cuſtom to make him a preſent of a purſe of the leaves prepared for uſe. When the poorer ſort are to appear before the rich, they always chew a large quantity of betel, to give them a ſweet breath: and the women on certain occaſions, never fail to take largely of it as a provocative. On all viſits the company is regaled with prepared betel. The principal time of uſing it is after dinner, at which time they ſay, it prevents ſickneſs at the ſtomach; and they never abſtain from it, except on ſolemn occaſions of the funerals of their relations, and their days of faſting. Moderately uſed, it ſtrengthens the gums, corroborates the heart and ſtomach, diſcuſſes flatulencies, and purges both the ſtomach and brain. If chewed after breakfaſt, it makes the breath ſweet for the whole day. The Portugueſe women are as fond of the betel as the Indians themſelves, and cannot live a day without it.

BETHESDA, (called in the Greek, κολυμβηθρα προβατικη, and thence in the Vulgate, *Piſcina Probatica*, becauſe according to ſome, the ſheep were waſhed in it, which were appropriated for ſacrifices,) was the Hebrew name for a pool or public bath, which had five porticos, piazzas, or covered walks around it. This bath, for its ſingular uſefulneſs was called Betheſda, *Beth Chezda*, or the *Houſe of Mercy*, becauſe, as Pool, in his Annotations, obſerves, the erecting of baths was an act of great kindneſs to the common people, whoſe indiſpoſitions in hot countries required frequent bathing.

We are told (John, v. 2, 3, &c.) that in the porticos of this bath, at the time of a certain feaſt (which is generally ſuppoſed to have been the paſſover), there lay a multitude of impotent folk, ſuch as the blind, halt, and withered, waiting for the moving of the water: for an angel went down at a certain ſeaſon into the pool, and troubled the water; that is, moved it in a ſenſible manner. Whoſoever then firſt, after the troubling of the water, ſtepped into it, was made whole of whatever diſeaſe he had. Some writers confine the miracle of the pool of Betheſda to the ſeaſon of this particular feaſt mentioned in verſe 1, of this chapter, becauſe they underſtand κατα καιρον, *by times*, (verſe 4.) which our tranſlators render, *a certain ſeaſon*, meant *at that ſeaſon*; that is, the ſeaſon mentioned verſe 1.; and ſince the evangeliſt does not ſay that the waters of Betheſda had their ſanative quality at any other feaſt, we are at liberty to make what ſuppoſition ſeems moſt convenient. Perhaps the ſilence of Philo and Joſephus upon this miracle may induce ſome to think, that it happened only at one paſſover: for though many infirm people lay in Betheſda, if the angel, as is probable, deſcended frequently during that ſolemity, the miracle would be no ſooner known, than multitudes would come and wait at the pool to be cured by the moving of the waters: however, if the number of the ſick who gathered on this occaſion, and the phraſe κατα καιρον, ſhall incline any perſon to believe that the waters of Betheſda had an healing quality at other paſſovers alſo, Dr. Macknight obſerves, that the ſilence of the writers before-mentioned needs not be much regarded: it being well known that they have omitted greater tranſactions which they had an opportunity to know, viz. that multitude and variety of miracles which our Lord performed in the courſe of his miniſtry. That the waters of Betheſda ſhould at this time have obtained a miraculous healing quality was, without doubt, as that writer remarks, in honour of the perſonal appearance of the Son of God upon earth. Perhaps it was intended to ſhew that Ezekiel's (xlvii.) viſion of water iſſuing out of the ſanctuary was about to be fulfilled, of which waters it is ſaid (ib. verſe 9.) "They ſhall be healed, and every thing ſhall live whither the river cometh." But it muſt be obſerved that the fourth verſe of this chapter of St. John is not in the Cambridge MSS. which formerly was Beza's, nor in one or two more of great authority. See Dr. Mill's judgment of it, in that part of his *Prolegomena* to which he refers the reader in his note on the text.

BETULA, the BIRCH-TREE. A genus of the tetranda order, belonging to the monœcia claſs of plants. The calyx of the male is monophyllous, trifid, and triflorous; and the corolla is parted into four ſegments: The female calyx is monophyllous, trifid, and biflorous: The ſeeds have a membranaceous wing on both ſides.

Species. 1. The alba, or common birch-tree, is ſo well known as to need no deſcription. It is in general of humble growth; however, in a ſoil and ſituation congenial, it will riſe to a great height, and ſwell to a conſiderable ſize.

Uſes. In ſome of the northern parts of Europe, the wood of white birch is much uſed for making carriages and wheels, being hard and of long duration. In France it is generally uſed for making wooden ſhoes; and in Britain for making women's ſhoe-heels, packing boxes, brooms, &c. It alſo makes very good fuel, and is planted along with hazel to make charcoal for forges. The bark

bark of the birch tree ſeems in a manner incorruptible. In Sweden the houſes are covered with it, and it laſts many years. It frequently happens that the wood is entirely rotten, when the bark is perfectly ſound and good. In Kamptſchatka it is uſed for making drinking cups. It abounds with a reſinous matter, to which its durability is certainly owing. In conſequence of this matter, it is highly inflammable; and in the northern countries torches are made of this bark ſliced and twiſted together. The bark itſelf conſiſts of two different ſubſtances; a thick brittle browniſh red one; and ſeveral very thin, ſmooth, white, tranſparent membranes. In theſe laſt the inflammable property reſides. The thick brittle part is leſs reſinous, and has a roughiſh taſte. It has been thought to poſſeſs ſome medical virtues, but concerning theſe, experience has as yet determined nothing certain. Upon deeply wounding or boring the trunk of the tree in the beginning of ſpring, a ſweetiſh juice iſſues forth in large quantities: one branch will bleed a pint or more in a day. This juice is recommended in ſcorbutic diſorders, and other foulneſſes of the blood; its moſt ſenſible effect is to promote the urinary diſcharge. By proper fermentation, with the addition of ſugar, this juice makes a pleaſant wine. The bark of the Canada birch is very light, tough, and durable; and the inhabitants of America uſe it for canoes. Notwithſtanding theſe uſes to which the birch is applicable when already in poſſeſſion, the planting of it is not recommended, except in bleak and barren ſituations, where no other tree will thrive, and except as a ſkreen and guardian to nurſe up and defend from chilling blaſts plants of greater value.

The alder tree, a ſpecies of this genus, flouriſhes beſt in low marſhy ſituations, in which it is frequently planted to make hedges, and is alſo of great uſe for ſecuring the banks of rivers. Graſs grows well beneath this ſhade: the wood is ſoft and brittle; but laſts a long time under water, and conſequently is of uſe for pipes, and to lay under the foundations of buildings ſituated upon bogs. Women's ſhoe heels, ploughmen's clogs, and various articles of the turner kind, are made of it. The bark gives a red colour, and, with the addition of copperas, a black: it is chiefly uſed by fiſhermen to ſtain their nets. The whole plant is aſtringent, and its bark has been recommended of intermittent fevers. The bark of the black berry-bearing alder is ſaid to be the moſt certain purge for horned cattle in obſtinate conſtipations in the bowels. Horſes, cows, goats, and ſheep, eat the leaves of all the ſpecies of betula; but ſwine refuſe them. When eaten by cows, they are ſaid greatly to increaſe the quantity of the milk.

BEZOAR, in a more proper ſenſe, denotes a medicinal ſtone, brought from the Eaſt or Weſt Indies, compoſed of ſeveral coats, or laminæ, laid one over another, like an onion, generated in the ſtomach of an animal of the goat kind, and eſteemed a powerful antidote and cardiac. See the Article CAPRA, genus 7.

Oriental BEZOAR is in the moſt eſteem, and is brought from ſeveral parts of the Eaſt Indies, chiefly Golconda and Cananor: it is there found mingled with the dung of an animal of the goat kind, called pazan; in the belly whereof this ſtone is found.

There is generally, if not always, ſome foreign body in the centre of the bezoar, around which, as a nucleus, the bezoartic coats, or ſtrata, are ranged; as ſtraws, hair, marcaſites, pebbles, talc, ſand, &c. and ſtones, like cherry-ſtones; but the common nucleus is the pod of a fruit much like that of the ACACIA vera Egyptiaca; though at firſt ſight it reſembles a caſſia, or tamarind-ſtone. This fruit being taken into the ſtomach, cauſes, by its aſtringency, a condenſation of the liquors it there meets with, from which in time ariſes the bezoar. Phil. Tranſ. No. 282. p. 1284.

Occidental BEZOAR is heavier, more brittle, of a dirtier green colour, as alſo leſs gloſſy, and generally held much inferior in virtue to the oriental kind. It is ſaid to be found in the belly of ſeveral animals, eſpecially in Peru; as the guanacos, jachos, vicunnas, and taraguas; the bezoar of which laſt is the moſt eſteemed, this animal being much like the goat that produces the oriental. But that of the firſt is more common, viz. the guanacos, a creature about the ſize of a horſe, by ſome deſcribed as a ſpecies between a camel and a wild goat.

Bezoar, in a more extenſive ſenſe, includes all ſubſtances formed ſtratum ſuper ſtratum in the ſtomachs or inteſtines of animals: in which ſenſe pearls, the concretions called crabs-eyes, &c. belong to the claſs of bezoars. To this alſo belong the hippolithus, or bezoar equinum, a ſtone ſometimes found in the ſtomach or inteſtines of a horſe; the monkey-bezoar, a ſtone ſaid to be found in the ſtomachs of certain monkies in Brazil and the Eaſt Indies, harder than the oriental bezoar, of a dark green colour, and very coſtly on account of its ſcarcity. Bezoar bovinum, is a yellowiſh ſtone found in the ox's gall-bladder. Human bezoars are ſtony ſubſtances found in the inteſtines of ſeveral perſons, formed from the ſtones of plums, or other fruits, retained in the cæcum or other guts, and growing coated over, of which we have an inſtance given by Dr. Cole. Phil. Tranſ. No. 235. Bezoar microcoſmicum is the ſame with the human calculus, and is various in its degrees of hardneſs as well as in its ſize and figure. It has been uſed in the place of the more coſtly ſorts. As to the bezoar hyſtricis, a concretion found in the gall-bladder of an Indian porcupine; and the German bezoar, or that found in mountain-deer, eſpecially on the Alps; theſe, not being ſtones, are more properly called by late writers ægagropilæ; the former conſiſting of woolly fibres, and a bitter friable matter, having neither laminæ nor membranes; the latter being a ball of hair or herbs, or perhaps roots, compacted in the ſtomach of the animal. They are all, as medicines, unworthy of regard.

Bezoar has no ſmell or taſte, is not digeſtible in the ſtomach of the animal in which it is found, and is ſcarce capable of being acted on by any of the juices of the human body. It cannot be conſidered in any other light than as an abſorbent, and is much the weakeſt of all the common ſubſtances of that claſs. It has been given to half a drachm, and ſometimes a whole drachm, without any ſenſible effect; though the general doſe (on account of its great price) is only a few grains.

Bezoar was not known to the ancient Greeks, and is firſt taken notice of by the Arabians, who extol it in a great variety of diſorders, particularly againſt poiſons. Later writers alſo beſtow extraordinary commendations on it as a ſudorific and alexipharmacic; virtues to which it certainly has no pretence.

The oriental is moſt eſteemed, and is the only ſort retained by the London college. The Edinburgh, in the edition of the Pharmacopœia preceding the preſent, directed both; but they now ſeem to allow them to be uſed promiſcuouſly, retaining in their catalogue only the name *Bezoar lapis*. But they are getting greatly into diſuſe. See the article BALLS.

BIBLE (in Greek βιβλος, *the book*), a name applied by Chriſtians by way of eminence or diſtinction to the collection of ſacred writings, or the holy ſcriptures of the Old and New Teſtaments; known alſo by various other appellations, as, the Sacred Books, Holy Writ, Inſpired Writings, Scriptures, &c. The Jews ſtyled the Bible (that is, the Old Teſtament) mikra; which ſignifies leſſon or lecture.

This collection of the ſacred writings, containing thoſe of the Old and New Teſtament, is juſtly looked upon as the foundation of the Jewiſh as well as the Chriſtian religion. The Jews, it is true, acknowledged only the ſcriptures of the Old Teſtament, the correcting and publiſhing of which is unanimouſly aſcribed, both by the Jews and Chriſtians, to Ezra. Some of the ancient fathers, on no other foundation than that fabulous and apocryphal book, the ſecond book of Eſdras, pretend, that the ſcriptures were entirely loſt and deſtroyed at the Babyloniſh captivity, and that Ezra reſtored them all again by divine revelation. What is certain is, that in the reign of Joſiah there was no other book of the law extant beſides that found in the temple by Hilkiah; from which original, by order of that pious king, copies were made and diſperſed; yet, within a few years after, the authentic copy preſerved in the temple, was burnt, with the temple, by the Babylonians. It was reſtored again, after the return of the Jews from the Babylonian captivity, by Nehemiah, or rather by Ezra: ſome ſay, by divine inſpiration; others with greater probability, by collecting the fragments and copies which were ſtill remaining, comparing them together, and, out of them all, framing one complete copy, where the readings were adjuſted, and the ſeveral books ranged in their proper order. Pridd. Conn. P. i. lib. v. Du Pin. Diſſ. Prel.

The preſent Samaritan and Jewiſh copies of the Bible differ in many reſpects, chiefly in the chronology of the patriarchs, where the Samaritan comes nearer to the Septutagint. Other variations may be reſolved into the errors of tranſcribers, interpolations for explication's ſake, and, perhaps, the deſigned corruption of the Samaritan. Ezra got together as many copies as he could of the ſacred writings, and out of them all prepared a correct edition, diſpoſing the ſeveral books in their proper order, and ſettling the canon of ſcripture for his time. Theſe books he divided into three parts. 1. The Law. 2. The Prophets. 3. The Cetubin, or Hagiographia; i. e. *The holy writings*.

I. The Law contains, 1. Geneſis. 2. Exodus. 3. Leviticus. 4. Numbers. 5. Deuteronomy.

II. The writings of the prophets are, 1. Joſhua. 2. Judges, with Ruth. 3. Samuel. 4. Kings. 5. Iſaiah. 6. Jeremiah, with his Lamentations. 7. Ezekiel. 8. Daniel. 9. The twelve minor prophets. 10. Job. 11. Ezra. 12. Nehemiah. 13. Eſther.

III. And the Hagiographia conſiſts of, 1. The Pſalms. 2. The Proverbs. 3. Eccleſiaſtes. 4. The Song of Solomon. This diviſion was made for the ſake of reducing the number of the ſacred books to the number of the letters in their alphabet, which amount to 22. At preſent, the Jews reckon 24 books in their canon of ſcripture, in diſpoſing of which the law ſtands as it did in the former diviſion, and the prophets are diſtributed into the former and latter prophets.

The former prophets are,
Joſhua, Judges, Samuel, Kings.
The latter prophets are,
Iſaiah, Jeremiah, Ezekiel, and the 12 minor prophets.
And the Hagiographia conſiſts of
The Pſalms, the Proverbs, Job, the Song of Solomon, Ruth, the Lamentations, Eccleſiaſtes, Eſther, Daniel, Ezra, the Chronicles.

Under the name of Ezra, they comprehend Nehemiah. It is true this order hath not always been obſerved, but the variations from it are of little or no moment.

The five books of the law are divided into 54 ſections. This diviſion many of the Jews hold to have been appointed by Moſes himſelf; but others, with more probability, aſcribe it to Ezra. The deſign of this diviſion was, that one of theſe ſections might be read

in their ſynagogues every ſabbath-day. The number was 54, becauſe in their intercalated years, a month being then added, there were 54 ſabbaths. In other years, they reduced them to 52, by twice joining together two ſhort ſections. Till the perſecution of Antiochus Epiphanes, they read only the law; but the reading of it being then prohibited, they ſubſtituted in the room of it 54 ſections out of the prophets; and when the reading of the law was reſtored by the Maccabees, the ſection which was read every ſabbath out of the law ſerved for their firſt leſſon, and the ſection out of the prophets for their ſecond. Theſe ſections were divided into verſes, of which diviſion, if Ezra was not the author, it was introduced not long after him, and ſeems, to have been deſigned for the uſe of the Targumiſts or Chaldee interpreters: for after the return of the Jews from the Babyloniſh captivity, when the Hebrew language ceaſed to be their mother tongue, and the Chaldee grew into uſe inſtead of it, the cuſtom was that the law ſhould be read in the original Hebrew, and then interpreted to the people in the Chaldee language, for which purpoſe theſe ſhorter ſections or periods were very convenient.

The diviſion of the ſcriptures into chapters, as we at preſent have them, is of much later date. Some attribute it to Stephen Langton, archbiſhop of Canterbury, in the reigns of John and Henry III. But the true author of the invention was Hugo de Sancto Caro, commonly called *Hugo Cardinalis*, becauſe he was the firſt Dominican that ever was raiſed to the degree of cardinal. This Hugo flouriſhed about the year 1240. He wrote a comment on the ſcriptures, and projected the firſt concordance, which is that of the vulgar Latin Bible. The aim of this work being for the more eaſy finding out any word or paſſage in the ſcriptures, he found it neceſſary to divide the book into ſections, and the ſections into ſubdiviſions; for till that time the vulgar Latin Bibles were without any diviſion at all. Theſe ſections are the chapters into which the Bible hath ever ſince been divided. But the ſubdiviſion of the chapters was not then in verſes, as it is now. Hugo's method of ſubdividing them was by the letters A, B, C, D, E, F, G, placed in the margin at an equal diſtance from each other, according to the length of the chapters. The ſubdiviſion of the chapters into verſes as they now ſtand in our Bibles, had its original from a famous Jewiſh rabbi, named Mordecai Nathan, about the year 1445. This rabbi, in imitation of Hugo Cardinalis, drew up a concordance to the Hebrew Bible, for the uſe of the Jews. But though he followed Hugo in his diviſion of the books into chapters, he refined upon his invention as to the ſubdiviſion, and contrived that by verſes: this being found to be a much more convenient method, it has been ever ſince followed. And thus, as the Jews borrowed the diviſion of the books of the holy ſcriptures into chapters from the Chriſtians, in like manner the Chriſtians borrowed that of the chapters into verſes from the Jews.

The order and diviſion of the books of the Bible, as well of the Old as the New Teſtament, according to the diſpoſition made by the council of Trent, by decree I. ſeſſion iv, are ſo generally known as to preclude the neceſſity of here mentioning them in their order.

The original language of the Old Teſtament was doubtleſs the old Hebrew, at leaſt the greateſt part; for all the books do not appear to have been written in the ſame. Some chapters of Eſdras and Daniel are judged to have been compoſed in Chaldaic; and other chapters of this latter writer, as alſo the apocryphal books of Maccabees, of Wiſdom, &c. in Greek; Tobit and Eccleſiaſtes either in Greek, or Syriac. Du Plin. Diſſ. Prel. § 3. Calmer's Dict. Bib. tom. i. p. 493.

As for the New Teſtament, it was written in Greek, except the Goſpel of St. Matthew, which is thought by many to have been compoſed in the later Hebrew, that is, the Syriac. Some will have Mark's Goſpel to have been written in Latin; and the Epiſtle to the Hebrews in Hebrew. Calmet.

The apocryphal books (or books not canonical, or of uncertain authority) of the Old Teſtament, according to the Romaniſts, are, the book of Enoch, the third and fourth books of Eſdras, the third and fourth books of Maccabees, the prayer of Manaſſeh, the Teſtament of the twelve Patriarchs, the Pſalter of Solomon, and ſome other pieces of this nature.

The apocryphal books of the New Teſtament are, the epiſtle of St. Barnabas, the pretended epiſtle of St. Paul to the Laodiceans, ſeveral ſpurious goſpels, Acts of the Apoſtles, and Revelations; the book of Hermas, intitled, the Shepherd, Jeſus Chriſt's Letter to Abgarus, the epiſtles of St. Paul to Seneca, and ſeveral other pieces of the like nature, as may be ſeen in the collection of the apocryphal writings of the New Teſtament made by Fabricius.

The Books which are now loſt, and cited in the Old Teſtament, are theſe; the book of the *Righteous*, or of Jaſher, as our verſion of the Bible has it (Joſh. x. 13, and 2 Sam. i. 18.); the book of the wars of the Lord, (Numb. xxi. 14.); the annals of the kings of Iſrael, ſo often cited in the books of the Kings and Chronicles. The authors of theſe annals were the prophets, who lived in the kingdoms of Judah and Iſrael. We have likewiſe but a part of Solomon's 3000 proverbs and his 1005 ſongs, (1 Kings iv. 32.); and we have entirely loſt what he wrote upon plants, animals, birds, fiſhes, and reptiles. To which may be added, a book of Jeremiah, wherein he enjoined the captives who went to Babylon to take the ſacred fire and conceal it; alſo the precepts which that prophet gave the Jews to preſerve themſelves from idolatry, and his lamentations on the death of King Joſiah.

Ezra, in the opinion of moſt learned men, publiſhed the ſcriptures in the Chaldee character: for that language being grown wholly into uſe among the Jews, he thought proper to change the old Hebrew character for it, which hath ſince that time been retained only by the Samaritans, among whom it is preſerved to this day.

Prideaux is of opinion that Ezra made additions in ſeveral parts of the Bible, where any thing appeared neceſſary for illuſtrating, connecting, or completing the work; in which he appears to have been aſſiſted by the ſame ſpirit in which they were firſt written. Among ſuch additions are to be reckoned the laſt chapter of Deuteronomy, wherein Moſes ſeems to give an account of his own death and burial, and the ſucceſſion of Joſhua after him. To the ſame cauſe our learned author thinks are to be attributed many other interpolations in the Bible, which created difficulties and objections to the authenticity of the ſacred text, no ways to be ſolved without allowing them. Ezra changed the names of ſeveral places which were grown obſolete, and inſtead of them put their new names, by which they were then called in the text. Thus it is that Abraham is ſaid to have purſued the kings who carried Lot away captive as far as Dan; whereas that place in Moſes's time was called *Laiſh*; the name *Dan* being unknown till the Danites, long after the death of Moſes, poſſeſſed themſelves of it.

The Jewiſh canon of ſcripture was then ſettled by Ezra, yet not ſo but that ſeveral variations have been made in it. Malachi, for inſtance, could not be put in the Bible by him, ſince that prophet is allowed to have lived after Ezra; nor could Nehemiah be there, ſince mention is made, in that book, of Jaddus, as high prieſt, and of Darius Codomannus, as king of Perſia, who were at leaſt 100 years later than Ezra. It may be added, that in the firſt book of Chronicles, the genealogy of the ſons of Zerubbabel is carried down for ſo many generations as muſt neceſſarily bring it to the time of Alexander, and conſequently this book could not be in the canon in Ezra's days. It is probable, that two books of Chronicles, Ezra, Nehemiah, Eſther, and Malachi, were adopted into the Bible in the time of Simon the Juſt, the laſt of the men of the great ſynagogue.

The Jews, at firſt, were very reſerved in communicating their ſcripture to ſtrangers: deſpiſing and ſhunning the Gentiles, they would not diſcloſe to them any of the treaſures concealed in the Bible. We may add, that the people bordering on the Jews, as the Egyptians, Phœnicians, Arabs, &c. were not very curious to know the laws or hiſtory of a people, whom in their turn they hated and deſpiſed. Their firſt acquaintance with theſe books was not till after the ſeveral captivities of the Jews, when the ſingularity of the Hebrew laws and ceremonies induced ſeveral to deſire a more particular knowledge of them. Joſephus ſeems ſurpriſed to find ſuch ſlight foot-ſteps of the ſcripture-hiſtory interſperſed in the Egyptians, Chaldean, Phœnician, and Grecian hiſtory; and accounts for it hence, that the ſacred books were not as yet tranſlated into Greek or other languages, and conſequently not known to the writers of thoſe nations.

The firſt verſion of the Bible was that of the Septuagint into Greek, in the time of Ptolemy Philadelphus; though ſome maintain that the whole was not then tranſlated, but only the Pentateuch; between which and the other books in the verſion called the Seventy, the critics find a great diverſity in point of ſtyle and expreſſion, as well as of accuracy.

Hebrew BIBLES, are either manuſcript or printed. The beſt manuſcript Bibles are thoſe copied by the Jews of Spain. Thoſe copied by the Jews of Germany are leſs exact, but more common. The two kinds are eaſily diſtinguiſhed from each other; the former being in beautiful characters, like the Hebrew Bibles of Bomberg, Stephens, and Plantin; the latter in characters like thoſe of Munſter and Gryphius. F. Simon, obſerves, that the oldeſt manuſcript Hebrew Bibles are not above ſix or ſeven hundred years old; nor does Rabbi Menaham, who quotes a vaſt number of them, pretend that any of them exceed ſix hundred years.

Dr. Kennicott, in his Diſſertatio Generalis, prefixed to his Hebrew Bible, p. 12, obſerves, that the moſt ancient manuſcripts were written between the years 900 and 1100: but though thoſe that are the moſt ancient are not more than 800 or 900 years old, they were tranſcribed from others of a much more ancient date. The manuſcript preſerved in the Bodleian library is not leſs than 800 years old. Another manuſcript, not leſs ancient, is preſerved in the Cæſarean library at Vienna.

The moſt ancient printed Hebrew Bibles are thoſe publiſhed by the Jews of Italy, eſpecially of Peſaro and Breſſe. Thoſe of Portugal alſo printed ſome parts of the Bible at Liſbon, before their expulſion.---This may be obſerved in the general, that the beſt Hebrew Bibles are thoſe printed under the inſpection of the Jews; there being ſo many *minutiæ* to be obſerved, that it is ſcarce poſſible for any other to ſucceed in it.

In 1639, R. Jac. Lombroſo publiſhed a new edition in 4to at Venice, with ſmall literal notes at the bottom of each page, where he explains the Hebrew words by Spaniſh words. This Bible is much eſteemed by the Jews at Conſtantinople: in the text they have diſtinguiſhed between words where the point *cametz* is to be read with a *cametz-katuph*, that is by *o*, and not an *a*.

Of

Of all the editions of the Hebrew Bible in 8vo, the moſt beautiful and correct are the two of Jo. Athias, a Jew of Amſterdam. The firſt, of 1661, is the beſt paper: but that of 1667 is the moſt exact: that, however, publiſhed ſince at Amſterdam by Vander Hooght, in 1705, is preferable to any of them.

Houbigant publiſhed an elegant edition of the Hebrew Bible at Paris in 1753, contained in 4 vols. folio. The text is that of Vander Hooght, without points, to which he has added marginal notes, ſupplying the variations of the Samaritan copy. Dr. Kennicott, after almoſt twenty years laborious collation of near 700 copies, manuſcript and printed, either of the whole or particular parts of the Bible, did, in 1776, publiſh the firſt volume of his Hebrew Bible in folio. The text is that of Everard Van der Hooght, already mentioned, differing from it only in the diſpoſition of the poetical parts, which Dr. Kennicott has printed in heminichs, into which they naturally divide themſelves: however the words follow one another in the ſame order as they do in the edition of Van der Hooght. This edition is printed on an excellent type; the Samaritan text, according to the copy in the London Polyglott, is exhibited in a column parallel with the Hebrew text; thoſe parts of it only being introduced in which it differs from the Hebrew. The numerous variations both of the Samaritan manuſcripts from the printed copy of the Samaritan texts, and of the Hebrew manuſcripts from the printed text of Van der Hooght are placed ſeparately at the bottom of the page, and marked with numbers referring to the copies from which they are taken. The editor regrets that the Diſſertatio Generalis, which would help much to enrich this article, is not to be publiſhed till the ſecond volume is ready.

Engliſh BIBLES.—The firſt Engliſh Bible we read of was that tranſlated by J. Wickliffe, about the year 1360, but never printed; though there are MS. copies of it in ſeveral of the public libraries. J. de Treviſa, who died about the year 1398, is alſo ſaid to have tranſlated the whole Bible; but whether any copies of it are remaining, does not appear.

The firſt printed Bible in our language was that tranſlated by Will. Tindal, aſſiſted by Miles Coverdale, printed abroad in 1526; but moſt of the copies were bought up and burnt by Biſhop Tunſtal and Sir Thomas More. It only contained the New Teſtament, and was reviſed and republiſhed by the ſame perſon in 1530. The prologues and prefaces added to it reflect on the biſhops and clergy; but this edition was alſo ſuppreſſed, and the copies burnt. In 1532, Tindal and his aſſociates finiſhed the whole Bible except the Apocrypha, and printed it abroad; but while he was afterwards preparing for a ſecond edition, he was taken up and burnt for hereſy in Flanders.

On Tindal's death, his work was carried on by Coverdale, and John Rogers, ſuperintendant of an Engliſh church in Germany, and the firſt martyr in the reign of queen Mary, who tranſlated the Apocrypha, and reviſed Tindal's tranſlation, comparing it with the Hebrew, Greek, Latin, and German, and adding prefaces and notes from Luther's Bible. He dedicated the whole to Henry VIII. in 1537, under the borrowed name of Thomas Matthews; whence this has been uſually called *Matthews's Bible*. It was printed at Hamburgh, and licence obtained for publiſhing it in England by the favour of Archbiſhop Cranmer and the Biſhops Latimer and Shaxton.

The firſt Bible printed by authority in England, and publicly ſet up in churches, was the ſame Tindal's verſion, reviſed and compared with the Hebrew, and in many places amended, by Miles Coverdale, afterwards biſhop of Exeter; and examined after him by archbiſhop Cranmer, who added a preface to it; whence this was called *Cranmer's Bible*. It was printed by Graſton, of the largeſt volume, and publiſhed in 1540; and, by a royal proclamation, every pariſh was obliged to ſet one of the copies in their church under the penalty of forty ſhillings a month; yet, two years after, the popiſh biſhops obtained its ſuppreſſion of the king. It was reſtored under Edward VI. ſuppreſſed again under queen Mary, and reſtored again in the firſt year of queen Elizabeth, and a new edition of it given 1562.

Some Engliſh exiles at Geneva in queen Mary's reign, Coverdale, Goodman, Gilbie, Sampſon, Cole, Whittingham, and Knox, made a new tranſlation, printed there in 1560, the New Teſtament having been printed in 1557; hence called the *Geneva Bible*; containing the variations of readings, marginal annotations, &c. on account of which it was much valued by the puritan party in that and the following reigns.

Biſhop's.—Archbiſhop Parker reſolved on a new tranſlation for the public uſe of the church, and engaged the biſhops and other learned men to take each a ſhare or portion. Theſe being afterwards joined together, and printed with ſhort annotations in 1568, in a large folio, made what was afterwards called the *Great Engliſh Bible*, and commonly the *Biſhop's Bible*. The following year it was alſo publiſhed in 8vo, in a ſmall but fine black letter: and here the chapters were divided into verſes; but without any breaks for them, in which the method of the Geneva Bible was followed: which was the firſt Engliſh Bible where any diſtinction of verſes was made. It was afterwards printed in large folio, with corrections, and ſeveral prolegomena, in 1572: this is called *Matthew Parker's Bible*. The initial letters of each tranſlator's name were put at the end of his part: *e. gr.* at the end of the Pentateuch, W. E. for William Exon; that is, William Biſhop of Exeter, whoſe allotment ended there: at the end of Samuel, R. M. for Richard Menevenſis, or Biſhop of St. Davids, to whom the ſecond allotment fell: and the like of the reſt. The Archbiſhop overſaw, directed, examined, and finiſhed the whole. This tranſlation was uſed in the churches for forty years, though the Geneva Bible was more read in private houſes, being printed above thirty times in as many years. King James bore it an inveterate hatred on account of the notes, which at the Hampton-court conference he charged as partial, untrue, ſeditious, &c. The Biſhop's Bible too had its faults. The king frankly owned he had yet ſeen no good tranſlation of the Bible in Engliſh; but he thought that of Geneva the worſt of all.

King James's.—The laſt Engliſh Bible was that which proceeded from the Hampton-court conference in 1603, where many exceptions being made to the Biſhop's Bible, king James gave order for a new one; not as the preface expreſſes it, for a tranſlation altogether new, nor yet to make of a bad one a good one, but to make a good one better, or of many good ones one beſt. Fifty-four learned perſons were appointed to this office by the king, as appears by his letter to the archbiſhop, dated in 1604; which being three years before the tranſlation was entered upon, it is probable ſeven of them were either dead, or had declined the taſk, ſince Fuller's liſt of the tranſlators makes but 47; who being ranged under ſix diviſions, entered on their province in 1607. It was publiſhed in 1613, with a dedication to James, and a learned preface, and is commonly called *King James's Bible*. After this, all the other verſions dropped and fell into diſuſe, except the Epiſtles and Goſpels in the Common Prayer Book, which were ſtill continued according to the Biſhops' tranſlation, till the alteration of the liturgy in 1661, and the Pſalms and Hymns, which are to this day continued as in the old verſion.

The judicious Selden, in his Table Talk, ſpeaking of the Bible, ſays, "The Engliſh tranſlation of the Bible is the beſt tranſlation in the world, and renders the ſenſe of the original beſt, taking in for the Engliſh tranſlation the Biſhops' Bible, as well as King James's. The tranſlators in King James's time took an excellent way. That part of the Bible was given to him who was moſt excellent in ſuch a tongue (as the Apocrypha to Andrew Downs,) and then they met together, and one read the tranſlation, the reſt holding in their hands ſome Bible, either of the learned tongues, or French, Spaniſh, Italian, &c. If they found any fault they ſpoke; if not, he read on."

King James's Bible is that now read by authority in all the churches in Britain.

Welch BIBLES.—There was a Welch tranſlation of the Bible made from the original in the time of queen Elizabeth, in conſequence of a bill brought into the Houſe of Commons for this purpoſe in 1563. It was printed in folio in 1588. Another verſion, which is the ſtandard tranſlation for that language, was printed in 1620. It is called *Parry's Bible*. An impreſſion was printed in 1690, called *Biſhop Lloyd's Bible*. Theſe were in folio. The firſt 8vo. impreſſion of the Welch Bible was made in 1630.

Iriſh BIBLE.—Towards the middle of the 16th century, Bedell, biſhop of Kilmore, ſet on foot a tranſlation of the Old Teſtament into the Iriſh language; the New Teſtament and the Liturgy having been before tranſlated into that language. The biſhop appointed one King to execute this work, who, not underſtanding the oriental languages, was obliged to tranſlate it from the Engliſh. This work was received by Bedell, who after having compared the Iriſh tranſlation with the Engliſh, compared the latter with the Hebrew, the LXX. and the Italian verſion of Diodati. When this work was finiſhed, the biſhop would have been himſelf at the charge of the impreſſion, but his deſign was ſtopped, upon advice given to the lord lieutenant, and the archbiſhop of Canterbury, that it would prove a ſhameful thing for a nation to publiſh a Bible tranſlated by ſuch a deſpicable hand as King. However, the manuſcript was not loſt, for it went to preſs in the year 1685.

Erſe BIBLE—There is alſo (lately finiſhed at Edinburgh) a verſion of the Bible in the Gaëlic or Erſe language.

Divers kinds of books have been compoſed on the Bible, either to explain the ſenſe, or make its doctrines more obvious, to facilitate the remembrance of it, or to eſtabliſh particular opinions from it; as introductions, apparatuſes, ſummaries, manuels, hiſtories, expoſitions, commentaries, harmonies, &c.

BIGAMY, properly ſignifies a double marriage; but with us is uſed as ſynonymous to polygamy, or having a plurality of wives at once. Such ſecond marriage, the former huſband or wife being alive, is ſimply void, and a mere nullity, by the eccleſiaſtical law of England: and yet the legiſlature has thought it juſt to make it felony, by reaſon of its being ſo great a violation of the public œconomy and decency of a well ordered ſtate. For polygamy can never be endured under any rational civil eſtabliſhment, whatever ſpecious reaſons may be urged for it by the Eaſtern nations, the fallaciouſneſs of which has been fully proved by many ſenſible writers: but in northern countries the very nature of the climate ſeems to reclaim againſt it; it never having obtained in this part of the world, even from the time of our German anceſtors,

tors, who, as Tacitus informs us, "*prope ſoli barbarorum ſingulis uxoribus contenti ſunt.*" It is therefore puniſhed by the laws both of ancient and modern Sweden with death. And in Britain it is enacted by ſtatute 1 Jac. I. c. 11. that if any perſon being married, do afterwards marry again, the former huſband or wife being alive, it is felony; but within the benefit of clergy. The firſt wife in this caſe ſhall not be admitted as an evidence againſt her huſband, becauſe ſhe is the true wife; but the ſecond may, for ſhe indeed is no wife at all: and ſo, *vice verſa*, of a ſecond huſband. This act makes an exception to five caſes, in which ſuch ſecond marriage, though in the three firſt it is void, is yet no felony. 1. Where either party hath been continually abroad for ſeven years, whether the party in England hath notice of the other's being alive or not. 2. Where either of the parties hath been abſent from the other ſeven years within this kingdom, and the remaining party hath had no knowledge of the other's being alive within that time. 3. Where there is a divorce (or ſeparation *a menſa et thoro*) by ſentence in the eccleſiaſtical court. 4. Where the firſt marriage is declared abſolutely void by any ſuch ſentence, and the parties looſed *a vinculo*. Or, 5. Where either of the parties was under the age of conſent at the time of the firſt marriage; for in ſuch caſe the firſt marriage was voidable by the diſagreement of either party, which the ſecond marriage very clearly amounts to. But, if at the age of conſent the parties had agreed to the marriage, which completes the contract, and is indeed the real marriage; and afterwards one of them ſhould marry again, Judge Blackſtone apprehends that ſuch ſecond marriage would be within the reaſon and penalties of the act.

BILARIUS PORUS, BILARY *pore*, or *hepatic duct*, a conſiderable appendage of the liver, formed from the concurrence of a multitude of ſmall ramifications ſpringing from the glands of the liver, which unite into ſeveral trunks equal in magnitude to the branches of the hepatic arteries; and accompany them branch for branch through the whole ſubſtance of the liver; being wrapped up in the ſame capſula with the porta. For a copious explanation of this ſubject, ſee the Syſtem of Anatomy, Part III. Sect. 8.

BILE, a yellow bitter juice, ſeparated from the blood in the liver, collected in the porus bilarius and gall-bladder, and thence diſcharged by the common duct into the duodenum. The word bile comes from the latin *bilis*, which ſome derive farther, from the Greek βια, violence; becauſe bilious people are inclined to anger; others derive it from the Latin *bullire*, to boil. Bile is of two kinds; hepatic and cyſtic. The firſt, moſt properly called bile, is ſeparated immediately from the glands of the liver into the porus bilarius. The ſecond more properly called gall, is ſeparated likewiſe from the glands of the liver into the gall-bladder, by roots or ducts proper to itſelf. See the Syſtem of Anatomy, Part III. Sect. 9; and the Syſtem of Chemiſtry, Part V. Chap. 9.

The influence of the bile upon the animal œconomy is allowed to be very great. By its fermentative quality it promotes digeſtion: in which reſpect, it differs widely from vegetable bitters, which are retarders of fermentation. However, in one thing it agrees with them, viz. as a corrector of acidities.

Bile ſpeedily corrupts, but not to ſuch an high and offenſive degree as the blood or fibrous parts of the body. To this corruption of the bile as one cauſe, Dr. Pringle attributes the paroxyſms in bilious fevers; nay, all bilious diſorders, as the cholera morbus, dyſentery, &c. are thought to be chiefly owing to a redundance or corruption of the bile. Hence the reaſon why theſe diſorders are moſt frequent in hot countries, and in armies when much expoſed to the ſun, is, that the bile, if not more abundant, is, in ſuch circumſtances, more corrupted than uſual.

The bile is a juice of great importance, with regard to the good or ill habitude of the animal. Dr. Woodward has traced its effects throughout the body very minutely, and makes no ſcruple to aſcribe moſt of the diſeaſes thereof to ſome diſorder of the bile. This he takes to be the chief ſpring in the animal machine, and from this accounts for moſt of the phenomena of a body, whether healthy or diſeaſed: and yet the ancients generally took it to be no more than an excrement, for which they could not find any uſe.

Many of the moderns, from the ſmall quantity of bile ſecreted, have been led into a miſtake, that this ſecretion is not the ſole end of ſo conſiderable a viſcus as the liver. Dr. Keil obſerves, that in a dog, whoſe common duct was near as big as that of a man, he gathered at the rate of about two drachms an hour: though, in a human body, there is reaſon to think the quantity ſecreted to be greater.

The bile is a part found in all animals; even pigeons, &c. which have no gall-bladder, yet have bile: their liver being found very bitter. Mr. Tauvry obſerves, that the bile becomes one of the principal cauſes of thirſt, by mixing with the ſalival juice. Sometimes the bile from yellow becomes greeniſh, like verdigriſe, and frequently pale, like the yolks of eggs, and that without any other apparent cauſe than a little motion, a convulſion, or a violent paſſion of the mind. This occaſions many and terrible diſeaſes; as nauſeas, an abhorrence of food, anxiety, ſighing, cardialgias, wind, diarrhœas, dyſenteries, acute diſeaſes, fevers and convulſions. Sometimes it becomes black, and takes the name of choler: in this caſe it ſometimes taſtes like a very ſharp vinegar; ſometimes like putrefied blood; gnawing, burning, diſſolving, conſuming, occaſioning inflammations, gangrenes, mortifications, violent pains, and terrible fermentations.

Of ATRA *bilis*, or *black bile*, Boerhaave diſtinguiſhes three kinds; firſt, the mildeſt, ariſing from the matter of the blood, put in too great a motion, which hence takes the name of *aduſt*: the ſecond is an aggravation of the firſt, ariſing from the ſame cauſes only heightened: the third is a corrupt parched bile, which if it ariſe from a greeniſh or paliſh ſort is ſtill worſe. See the Article ATRA BILIS.

Too great an evacuation of the bile, either upwards or downwards, robs the chylefaction of its main inſtrument: hence it prevents digeſtion, ſecretion, excretion of the fæces, and produces an acid temperature, coldneſs, weakneſs, paleneſs, ſwoonings, &c. When the ſtomach is full, the cyſtic bile is more copiouſly diſcharged into the duodenum; when it is empty, the hepatic bile is more freely ſecreted in the gall-bladder. If the bile when prepared, be prevented its diſcharge into the inteſtines it produces a jaundice and an overflowing of the gall. For the manner in which the bile is ſeparted from the liver, according to the opinions of ſeveral eminent profeſſors of anatomy, ſee the Syſtem, Part III. Sec. 8 and 9.

BILIARY concretions, found in the paſſage of the bile, or in the gall-bladder, commonly called gall-ſtones, are not of a cretaceous nature, but merely coagula of the bile, formed by an acid; which, being allowed to ſtagnate, acquire a ſtony hardneſs. For a more particular account, ſee the Syſtem of Anatomy, Part III. Sect. 9.

BILIOUS FEVER, a term uſed by medical writers to expreſs ſuch fevers as ariſe from an immediate effuſion of the bile. Theſe often ariſe from violent fits of anger in the patient. Of this nature are the *cholerica febris* and *cauſus*.

BILL, *in Parliament*, denotes a paper containing propoſitions offered to the houſes, to be paſſed by them, and then to be preſented to the king to paſs into an act or law. For the peculiar forms attached to the bringing a bill into parliament, and the mode of giving the royal aſſent, ſee the Article PARLIAMENT, No. IV.

BILL *of Exchange*, a ſhort note, or writing, ordering the payment of a ſum of money in one place, to ſome perſon aſſigned by the drawer or remitter, in conſideration of a like value paid to him in another place. The whole eſtate and effects of merchants often conſiſt in bills of exchange. A bill of exchange is an inſtrument ſo noble and excellent, that though it wants thoſe formalities required by the common law, as ſeal, delivery, and witneſſes; and ſo cannot be deemed a ſpecialty; yet it is ſuperior to any to any bond or ſpecialty by the reſpect that is paid it, and the punctuality and preciſeneſs of the payment. There is ſome diſpute about the nature and ſanction of a bill of exchange: ſome take it to be a contract of permutation, or exchange; but the more general opinion is, that it is a mere contract of buying and ſelling; that the money given the perſon who draws the bill is the price of ſale; and that paid at the appointed place, the thing bought and ſold.

Bills of exchange may be divided into inland and outland. Outland or foreign bills are thoſe made for money taken up in ſome other country, and to be paid in England; or *vice verſa*. Inland bills are thoſe made for money taken up in one part of the kingdom, and to be paid in another.—By the ſtat. 9 and 10 Will. III. theſe latter are made equally binding with the former: and the method of proteſting ſuch bills is further regulated by 3 and 4 Anne. For a copious account of the forms which relate to this important branch of commerce, ſee the article EXCHANGE.

BILL *of Lading*, an acknowledgement ſigned by the maſter of a ſhip, and given to a merchant, &c. containing an account of the goods which the maſter hath received on board from that merchant, &c. with a promiſe to deliver them at an intended place for a certain ſalary. Each bill of lading muſt be treble, one for the merchant who loads the goods, another to be ſent to the perſon to whom they are conſigned, and the third to remain in the hands of the maſter of the ſhip. It muſt be obſerved, however, that a bill of lading is uſed only when the goods ſent on board the ſhip are but part of the cargo: for when a merchant loads a whole veſſel for his own perſonal account, the deed paſſed between him and the maſter of the ſhip is called *charter-party*.

BILL *of Rights*. For an ample diſcuſſion of the ſeveral particulars which appertain to this bulwark of the Britiſh conſtitution; ſee articles LIBERTY and RIGHTS.

BILL *of Sale*, is when a perſon wanting a ſum of money delivers goods as a ſecurity to the lender, to whom he gives this bill, impowering him to ſell the goods, in caſe the ſum borrowed is not repaid with intereſt, at the appointed time.

BILL *of Entry*, an account of goods entered at the cuſtom-houſe, both inward and outward; wherein is expreſſed, the merchant importing or exporting, the quantity of goods, and the ſorts, and from whence imported or to what place exported.

BILLA VERA, *the Bill is true*. The grand jury indorſing a bill whereby any crime puniſhable in that court, is preſented to them, with the words *billa vera*, ſignify thereby, that the preſenter has furniſhed his preſentment with probable evidence, and worthy of farther conſideration: whereupon the party preſented is ſaid to ſtand

ſtand indicted of the crime, and bound to make anſwer therefore, either by confeſſing or traverſing the indictment.

BINOMIAL, in Algebra, a root conſiſting of two members connected by the ſign +, or −. Thus $a+b$, and $8-3$, are binomials, conſiſting of the ſums and differences of theſe quantities. See the Syſtem of ALGEBRA, Sect. I.

BINOMIAL *theorem*. The famous theorem invented by Sir Iſaac Newton for the readily involving algebraical quantities to any aſſigned power. See the SYSTEM, Sect. III. Art. 2.

BIOGRAPHY, a ſpecies of hiſtory which records the lives and characters of remarkable perſons. This is at once the moſt entertaining and inſtructive kind of hiſtory. It admits of all the painting and paſſion of romance; but with this capital difference, that our paſſions are more keenly intereſted, becauſe the characters and incidents are not only agreeable to nature, but ſtrictly true. It repreſents great men more diſtinctly, unincumbered with a crowd of other actors, and deſcending into the detail of a man's actions and characters, gives more light into human nature, as well as excites us more to imitation. No books are ſo proper to be put into the hands of young people. See an excellent paper on biography in the Idler, and in the Annual Regiſter, vol. i. p. 436, an. 1759.

BIQUADRATE, or BIQUADRATIC, is the next power above the cube, or the ſquare multiplied by itſelf.

BIQUADRATIC *equation*, in Algebra, an equation raiſed to the fourth power, or where the unknown quantity of one of the terms has four dimenſions: Thus $x^4+ax^3+bx^2+cx+d=0$ is a biquadratic equation. For the method of ſolving biaquadratic and all ſorts of equations, ſee the Syſtem of ALGEBRA, Sect. VI. Art. 11. Biquadratic Parabola, in Geometry, a curve line of the third order, having two infinite legs tending the ſame way. See the SYSTEM, Part II. Sect. I. Biquadratic power of any number, is the fourth power or ſquared ſquare of that number: thus 16 is the biquadratic power of 2; for $2\times2=4$, and $4\times4=16$. Biquadratic root of any number, is the ſquare root of the ſquareroot of that number: thus the biquadratic root of 81 is 3; for the ſquare root of 81 is 9, and the ſquare root of 9 is 3. To find the biquadratic root, &c. ſee the SYSTEM of ALGEBRA, Sect. III. Art. 2.

BIRCH *tree*, *Betula*, in Botany. For its deſcription and uſes, ſee the Article BETULA.

BIRCH-*bark*, being bituminous, and conſequently warm and emollient, is uſed in fumigations to correct a diſtempered air. The inner ſilken bark was anciently uſed for writing-tables, before the invention of paper; though Ray rather aſſigns the office of paper to the cuticle or outer ſkin, which peels off yearly. And with the outward, thicker, and coarſer part of the bark, the houſes in Ruſſia, Poland, and other northern parts are covered, inſtead of ſlates and tyle. Hiſt. Plant. The Indians make pinnaces with white cedar, which they cover with large flakes of birch-bark, ſewing them with thread of ſpruce roots, and pitching them; as the ancient Britons did with the willow. Pliny ſpeaks of a bitumen actually procured from the birch-tree. Hiſt. Nat. lib. xvi. c. 18.

BIRD, *Avis*, the ſecond claſs in the animal kingdom called zoology. For a curious account of the propagation and preſervation of this claſs, ſee the Treatiſe on NATURAL HISTORY, Sect. IV. for the claſſification, ſee the Syſtem of ORNITHOLOGY; for deſcription of the genera and moſt remarkable ſpecies, ſee the alphabet at large; for their ſtructure and œconomy, ſee the Syſtem of COMPARATIVE ANATOMY, Chap. II. and Plate II; and for their general repreſentation, ſee the plates annexed to the Syſtem of ORNITHOLOGY.

BIRD-*catching*, the art of taking birds or wild fowl, whether for food, for the pleaſure of their ſong, or for their deſtruction as pernicious to the huſbandman, &c. The methods are by bird-lime, nets, decoys, &c. See DECOY.

Near London a peculiar method of bird-catching has been long practiſed, and is brought to a moſt ſyſtematical perfection, and attended with conſiderable expence. The nets are a moſt ingenious piece of mechaniſm; are generally twelve yards and a half long, and two yards and a half wide; and no one, on bare inſpection, would imagine that a bird (who is ſo very quick in all its motions) could be catched by the nets flapping over each other, till he becomes witneſs of the pullers ſeldom failing. The wild birds *fly* (as the bird-catchers term it) chiefly during the month of October, and part of September and November; as the flight in March is much leſs conſiderable than that of Michaelmas. It is to be noted alſo, that the ſeveral ſpecies of birds of *flight* do not make their appearance preciſely at the ſame time, during the months of September, October, and November. The pippet (a ſmall ſpecies of lark), for example, begins to fly about Michaelmas; and then the woodlark, linnet, goldfinch, chaffinch, greenfinch, and other birds of flight ſucceed; all of which are not eaſily to be caught, or in any numbers, at any other time, and particularly the pippet and the woodlark. Theſe birds, during the Michaelmas and March flights, are chiefly on the wing from day-break to noon, though there is afterwards a ſmall flight from two till night; but this however is ſo inconſiderable, that the bird-catchers always take up their nets at noon. It may well deſerve the attention of the naturaliſt whence theſe periodical flights of certain birds can ariſe. As the ground, however, is ploughed during the months of October and March for ſowing the winter and ſpring corn, it ſeems that they are thus ſupplied with a great profuſion both of ſeeds and inſects, which they cannot ſo eaſily procure at any other ſeaſon.

The common way of taking larks, of which ſo many are uſed at our tables, is in the night, with thoſe nets which are called *trammels*. Theſe are uſually made of 36 yards in length, and about 6 yards over, with 6 ribs of pack-thread, which at the ends are put upon two poles of about 16 feet long, and made leſſer at each end. Theſe are to be drawn over the ground by two men, and every five or ſix ſteps the net is made to touch the ground, otherwiſe it will paſs over the birds without touching them, and they will eſcape. When they are felt to fly up againſt the net, it is clapped down, and then all are ſafe that are under it. The darkeſt nights are beſt for this ſport; and the net will not only take larks, but all other birds that rooſt on the ground; among which are woodcocks, ſnipes, partridges, quails, field-fares, and ſeveral others.

But the moſt ſingular ſpecies of bird-catching is on the holm of Noſs, a vaſt rock ſevered from the iſle of Noſs by ſome unknown convulſion, and only about ſixteen fathoms diſtant. It is of the ſame ſtupendous height as the oppoſite precipice, with a raging ſea between; ſo that the intervening chaſm is of matchleſs horror. Some adventurous climber has reached the rock in a boat, gained the height, and faſtened ſeveral ſtakes on the ſmall portion of earth which is to be found on the top; correſpondent ſtakes are placed on the edge of the correſpondent cliffs; a rope is fixed to the ſtakes on both ſides, along which a machine, called a cradle, is contrived to ſlide; and by the help of a ſmall parallel chord faſtened in like manner, the adventurer wafts himſelf over, and returns with his booty.

BIRTH, the natural excluſion of a perfect fœtus from the womb by the vagina. See the Articles FŒTUS, GENERATION, and the Syſtem of MIDWIFERY.

An immature BIRTH, is called an abortion. See ABORTION, and the Syſtem of MEDICINE, Genus 32.

Seven months BIRTH, that which happens on the hundred and eighth, or hundred and eighty-ſecond day after impregnation. This, phyſicians allow, may not only be a living, but a vital birth; though it does not often prove long lived. A child born in the ſeventh month oftener lives than a child born in the eighth; perhaps becauſe the premature birth in the firſt caſe is owing to the ſtrength of the child, and in the ſecond to the weakneſs of the mother.

Eight months BIRTH, ſeldom if ever produces a living or lively child. An eight month's birth is always weak and ſickly, and ſcarce ever ſurvives the fortieth day.

Præternatural BIRTHS. For the moſt approved methods of practice in thoſe births or labours which are termed *præternatural*, ſee the Syſtem of MIDWIFERY. Part VII. Sect. I. II. and III. and the figures on the plate to which it refers.

After BIRTH. For the methods of proceeding with reſpect to the after-birth, ſee Part. VIII. Sect. III.

BIRTH is uſed for a perſon's deſcent; and is ſaid to be high or low according to the circumſtances of his anceſtry. There is ſcarce any truth (Mr. Knox obſerves in his Eſſays) of which the world has been more frequently reminded by the moraliſts, than the unreaſonableneſs of that veneration which is paid to birth. They have been told that virtue alone is true nobility; but though they have acknowledged the aſſertion to be founded in reaſon, they have continued, with uniform perſeverance, in the ſame error. The luminous glory of an illuſtrious anceſtor, ſeems to have diffuſed a brilliancy over a long line of deſcendants, too opaque of themſelves to emit any original irradiations. "Gratitude (continues our elegant author), which firſt raiſes a benefactor to a diſtinguiſhed rank in civil honours, is willing to continue its kindneſs to his immediate offspring. The diſtinction is rendered hereditary. This predilection for an anceſtor ſoon leads to the accumulation of honours and poſſeſſions in his ſucceſſors; and the incenſe originally offered, becauſe it was deſerved, is at laſt laviſhed at the ſhrine of opulence, independently of merit. Subordination is, indeed, eſſential to ſociety. The order of nobles, as hereditary guardians of the laws, is found an uſeful political eſtabliſhment; and none ſeem ſo well adapted to ſupply it, as they who have been raiſed to eminence by their anceſtors, and who poſſeſs a territorial patrimony in the land which they are to protect. All that is contended for is, that the recommendation of birth may not ſet aſide or depreciate real merit, the praiſe of learning, and the intrinſic value of virtuous exertions.

"It is a remarkable circumſtance in the hiſtory of mankind, that ſome of the beſt books have been written, and ſome of the greateſt achievements performed, by thoſe whoſe origin was truly plebeian. The politeſt and genteeleſt books, whether the ſentiments or the ſtyle be conſidered, have been produced by ſlaves, or the deſcendants of ſlaves. Horace, Phædrus, and Terence, wrote in a ſtyle which muſt have been the ſtandard of a court, to

an intercourſe with which they were by no means entitled by their extraction. The founders of the moſt diſtinguiſhed families emerged from the midde and lower claſſes, by the ſuperior vigour of their natural abilities, or by extraordinary efforts, aſſiſted by fortune: and unleſs the adventitious circumſtances of wealth and civil honours can effect a change in the conſtituent principles of the mind and body, there is certainly no real ſuperiority to be derived in a boaſted pedigree of Tudors and Plantagenets. And yet there have appeared flatterers who have indirectly ſuggeſted, that the minds of the nobility ſeem to be caſt in a finer mould, and to have an elegance inherent in their original conſtitution. According to this hypotheſis, we muſt go on to ſuppoſe, that the mind of a commoner, exalted to the higher order of ſenators, catches this elegance by the contagion of inviſible effluvia. On his creation he undergoes a kind of new birth, and puts off the exuviæ which encumbered and degraded him in the lower regions. Thus are all the occult perfections of noble blood to be infuſed by the mandate of a monarch. 'But no,' ſaid Maximilian to a man who aſked to be ennobled by him, 'though I can give you riches and a title, I cannot make you noble.' "In truth there is many a nobleman, according to the genuine idea of nobility, even at the loom, at the plough, and in the ſhop; and many more in the middle ranks of mixed ſociety. This genuine idea contains in it generoſity, courage, ſpirit, and benevolence, the qualities of a warm and open heart, totally unconnected with the accidental advantages of riches and honour; and many an Engliſh ſailor has poſſeſſed more of the real hero than a lord of the admiralty.

" If indeed there is any ſubſtantial difference in the quality of their blood, the advantage is probably on the ſide of the inferior claſſes. Their indigence and their manual employments require temperance and exerciſe, the beſt purifiers of the animal juices. But the indolence which wealth excites, and the pleaſures which faſhionable life admits without reſtraint, have a natural tendency to vitiate and enfeeble the body as well as the mind: and among the many privileges inherited by him who boaſts nobility in his veins, he commonly receives the ſeeds of the moſt painful and the impureſt diſeaſes. He diſplays indeed a coronet on his coat of arms, and he has a long pedigree to peruſe with ſecret ſatisfaction; but he has often a gout or a ſcrophula, which makes him wiſh to exchange every drop derived from his Norman anceſtors, for the pure tide that warms a peaſant's boſom.

" The ſpirit of freedom, moral, mental, and political, which prevails in Britain, precludes that unreaſonable attachment to birth, which, in the countries of deſpotiſm, tends to elevate the noble to a rank ſuperior to humanity. In Germany, Ruſſia, Spain, &c. the implicit veneration paid to birth, adds to the weight of legal oppreſſion. There a man of the plebeian order attends to a Count or a Marquis with all the ſilent ſubmiſſion of idolatry: on the contrary, there is no doubt but that an Engliſh gondolier would box with the beſt lord in the land, if he were affronted by him, without the leaſt regard to his ſtar and ribbon. It would indeed be an additional pleaſure to the natural delight of conqueſt, to have bruiſed a puny lord. Even the more refined and poliſhed do not idoliſe illuſtrious birth. In truth, wealth appears to be the object of more univerſal veneration. Noble blood and noble titles, without an eſtate to ſupport them, meet with great compaſſion, but with little reſpect: nor is the man who raiſed himſelf to eminence, and who behaves well in it, neglected and deſpiſed becauſe he derives no honour from his foreſathers. In a commercial country, where gain is the general object, they who have been moſt ſucceſsful in its purſuit, will be revered by many, whatever was their origin. In France, when it was under a monarchy, honour was purſued from the monarch to the cleanſer of a jakes; the diſtinction of birth, even with extreme poverty, was enviable. The brother of a Marquis would rather ſtarve on a beggarly penſion, than pollute himſelf with a trade by which he might require the revenues of a German kingdom. In our land of good ſenſe this folly is loſing ground; and the younger brothers of noble houſes, often think it no diſgrace to rival the heir in a princely fortune acquired by honourable merchandiſe.

" As the world becomes more enlightened, the exorbitant value which has been placed on things not really valuable will decreaſe. Of all the effects of man's capricious admiration, there are few leſs rational than the preference of illuſtrious deſcent to perſonal merit, of diſeaſed and degenerate nobility to health, to courage, to learning and to virtue. Of all the objects of purſuit which are not in our own power, the want of diſtinguiſhed birth may moſt eaſily be diſpenſed with, by thoſe who poſſeſs a ſolid judgment of that which makes and keeps us happy. There may be ſome reaſon to repine at the want of wealth and fame; but he who has derived from his parent health, vigour, and all the powers of perception, need not lament that he is unnoticed at the herald's office.

" It has been obſerved, that virtue appears more amiable when accompanied with beauty; it may be added, that it is more uſeful when recommended to the notice of mankind by the diſtinction of an honourable anceſtry. It is then greatly to be wiſhed, that the nobly born would endeavour to deſerve the reſpect which the world pays them with alacrity, by employing their influence to benevolent purpoſes; to thoſe purpoſes which can at all times be accompliſhed, even when the patriotic exertions of the field and cabinet are precluded.

BISHOP, a prelate or perſon conſecrated for the ſpiritual government and direction of a dioceſe. The word comes from the Saxon *biſchop*, and that from the Greek ἐπισκοπος, an *overſeer* or *inſpector*. A biſhop differs from an archbiſhop in this, that an archbiſhop with biſhops conſecrate a biſhop, as a biſhop with prieſts ordain a prieſt; that the archbiſhop viſits a province, as the biſhop a dioceſe; that the archbiſhop convocates a provincial ſynod, as the biſhop a dioceſan; and that the archbiſhop has canonical authority over all the biſhops of his province, as the biſhop over the prieſts in his dioceſe. It is a long time that biſhops have been diſtinguiſhed from mere prieſts or preſbyters; but there appear no inſtances of any inſtitution of biſhops, diſtinct from prieſts, in the ſcriptures; neither do the oppoſers thereof pretend to ſhew any mark of any other form of church government therein: ſo that it may ſeem probable the apoſtles did not ſettle any thing of this kind at all; but either left the ſpiritual œconomy in the hands of the preſbyterians, or of thoſe together with the people. Accordingly, new occaſions requiring new meaſures, in a little time the functions of the prieſthood were divided, and the prieſts diſtinguiſhed into degrees; the political part of religion being aſſigned principally to biſhops, and the evangelical to the prieſts, &c. or rather, as ſome will have it, the functions of teaching and preaching were reſerved to the biſhop, and that of ordination ſuperadded; which was their principal diſtinction, and the mark of their ſovereignty in their dioceſe.

By the ancient diſcipline, biſhops were to be married once, and not to put away their wives on pretence of religion: but a ſecond marriage was a diſqualification for this order. If they lived chaſte, they were ranked as confeſſors. Some biſhops in the middle age, on account of their *regalia*, or temporalities, were obliged to a military ſervice called *hoſtis*, by which they were to lead their vaſſals into the field and attend the king in his military expeditions. This Charlemagne excuſed, and even forbid: but the prohibition was little regarded, ſince we find the thing often practiſed afterwards.

The election of biſhops was anciently placed in the clergy, and the people of the pariſh, province, or dioceſe; but afterwards, princes and magiſtrates, patriarchs and popes, uſurped the power. The election was to be within three months after the vacancy of the ſee; and the perſon to be choſen out of the clergy of that church. Formerly the biſhop claimed a ſhare in the election of an archbiſhop; but this was ſet aſide by the popes. In England, during the Saxon times, all eccleſiaſtical dignities were confirmed by the king in parliament. At length, however, after ſeveral conteſts, eſpecially between archbiſhop Anſelm and Henry I. in conſequence of a grant of king John, recogniſed in Magna Charta, and eſtabliſhed by ſtat. 25 Edw. III. ſtat. 6 § 3. biſhops were elected by the chapters of monks or canons, ſome ſhadow of which ſtill remains in the preſent method of diſpoſing of biſhoprics. But by ſtat. 25 Hen. VIII. cap. 20. the right of nomination was reſtored to the crown. Ordinarily, at leaſt three biſhops are required in the ceremony of conſecrating a biſhop; but, in ſome caſes, a ſingle on might ſuffice. The Engliſh ſucceſſion of proteſtant biſhops ſtands on this laſt ground.

In England, the king being certified of the death of a biſhop by the dean and chapter, and his leave requeſted to elect another, the *congé d'elire* is ſent to them, with a letter miſſive, nominating the perſon whom he would have choſen. The election is to be within twelve days after the receipt of it, otherwiſe the king by letter patent appoints whom he pleaſes; and the chapter, in caſe of refuſing the perſon named by the king, incurs a *præmunire*.—After election, and its being accepted of by the biſhop, the king grants a mandate under the great ſeal for confirmation, which the archbiſhop conſigns to his vicar-general, conſiſting moſtly in a ſolemn citation of ſuch as have any objections to the biſhop elect, a declaration of their contumacy in not appearing, and an adminiſtratiion of the oaths of allegiance and ſupremacy, of ſimony, and canonical obedience. Sentence being read by the vicar-general, the biſhop is inſtalled in the province of Canterbury by the arch-deacon: the fact is recorded by a public notary; and the biſhop is inveſted with full powers to exerciſe all ſpiritual juriſdictions, though he cannot ſue for his temporalities, till after conſecration. Then follows the conſecration by the archbiſhop or ſome other biſhop appointed by lawful commiſſions, and two aſſiſtant biſhops: the ceremony of which is much the ſame as in the Romiſh church, ſave that, having put on the epiſcopal robes, the archbiſhop and biſhops lay their hands on the new prelate's head, and conſecrate him with a certain form of words. The fees of the whole proceſs amount to about 600l. The proceſs of the tranſlation of a biſhop to another biſh opric only differs in this, that there is no conſecration. The age of a biſhop is to be at leaſt thirty years; and, by the ancient diſcipline, none were to be choſen but thoſe who had paſſed through all the inferior orders; but, in ſome caſes of neceſſity, this was diſpenſed with, and deacons, nay laymen, were raiſed *per ſaltum* to the epiſcopal dignity.

The

The functions of a bishop in England may be considered as two-fold; viz. what belongs to his order, and what belongs to the jurisdiction. To the episcopal order belong the ceremonies of dedication, confirmation, and ordination; to the episcopal jurisdiction, by the statute law, belong the licensing of physicians, chirurgeons, and school-masters, the uniting small parishes (though this last privilege is now peculiar to the bishop of Norwich), assisting the civil magistrate in the execution of statutes relating to ecclesiastical matters, and compelling the payment of tenths and subsidies due from the clergy. By the common law, the bishop is to certify the judges, touching legitimate and illegimate births and marriages; and by that and the ecclesiastical law, he is to take care of the probate of wills, and granting administrations: to collate the benefices, grant institutions on the presentation of other patrons, command induction, order the collecting and preserving the profits of vacant benefices for the use of the successors, defend the liberties of the church, and visit his diocese once in three years. To the bishop also belongs suspension, deprivation, deposition, degradation and excommunication.

All bishops of England are peers of the realm, except the bishop of Man; and, as such, sit and vote in the House of Lords: they are barons in a threefold manner, viz. feudal in regard to the temporalities annexed to their bishoprics; by writ, as being summoned by writ to parliament; and lastly, by patent and creation: accordingly they have the precedence of all other barons, and vote as barons and bishops; and claim all the privileges enjoyed by the temporal lords, excepting that they cannot be tried by their peers, because, in cases of blood, they themselves cannot pass upon the trial, for they are prohibited by the canons of the church to be judges of life and death. They have the title of *Lords and Right Reverend Fathers in God*. Besides two archbishops, there are 24 bishops in England, exclusive of the bishop of Sodor and Man, who has no seat in the House of Peers. There is now also a bishop in our settlement of Nova Scotia.—In Scotland, before the Presbyterian establishment, there were two archbishoprics and 12 bishoprics.

With respect to the order of precedency among one another, the archbishop of Canterbury takes the lead; then the archbishop of York; next to him the bishops of London, of Durham, and of Winchester. The other bishops follow according to the seniority of their consecration; excepting only, that a bishop being a privy counsellor, takes place after the bishop of Durham. Bishops have two special privileges next to regal; the first, that in their courts they sit, and pass sentence, of themselves and of their own authority: the bishop's courts not being like other courts, but writs, are sent out in their own name, *teste* the bishop, not in the king's name, as is done in the king's courts. The second, that, like the king, they can depute their authority to another, as their suffragan, chancellor, commissary, &c. They have also this advantage over laylords, that, in whatever christian country they are, their episcopal degree and dignity are acknowledged; and they may, *quatenus* bishops, ordain, &c.

They have several immunities, as from arrests, outlawries, distress, &c. liberty to hunt in the king's forests, &c. to have certain tuns of wine duty-free, &c. Their persons may not be seized, as lay-peers may, upon contempt, but their temporalities alone. They may qualify as many chaplains as a duke, viz. six. But, as they have no right to be tried themselves in the court of the lord high steward, as peers, they ought not to be judges there. By law the crime of episcopicide, which a clergyman commits by killing his bishop, is petty-treason.

BISHOPS, in the Lutheran church, are those more usually called superintendents. The Calvinists allow of no other bishops besides presbyters; but the Lutherans make some distinction, and give a superiority or pre-eminence over the rest of their bishops, superintendents, or overseers.

BISHOP'S *see* denotes the city or place where the residence of the bishop is fixed. Every bishop's see was anciently called *sedes apostolica*; though the appellation has since been restrained to the see of Rome. Anciently bishops seem to have had a right in England to sit as judges in the hundred and county-courts. In after-times they were forbid to sit in secular courts, and had separate courts erected for them; which proved an occasion of much dispute between the two jurisdictions. No church-tenant might be sued in any court but the bishop's. There are also traces of a separate court of the bishops much earlier, among our Saxon ancestors, in the eighth century. The regard borne to the character of bishops, made them the common arbitrators even of secular causes: they had the cognizance of all causes, concerning land, in *frank-almoign*; and for ecclesiastics, were judges even in capital causes.

BISHOPRIC, the jurisdiction of a bishop: or the district within which it is comprised; called also *diocese*. To the old bishoprics subsisting before the times of the Reformation, Henry VIII. by letters patent added five more bishoprics, viz. those of Chester, Gloucester, Peterborough, Bristol, and Oxford, stat. 34 and 35 Hen. VIII. cap. 17. In Ireland the state of the church is not changed in consequence of the Union, so that in it there remain as before eighteen bishoprics, and four archbishoprics; in Scotland there are none.

BISKET, denotes a delicate kind of bread prepared by the confectioners, of fine flour, eggs, sugar, and rose or orange-water; or of flour, eggs, and sugar, with anise-seeds and citron-peels; baked in the oven in tin or paper moulds. The word comes from the Latin *bis*, *twice*, and the French *cuit*, *coctus*, q. d. *baked*. We find divers sorts of such biskets, as seed-bisket, fruit-bisket, long-bisket, round-bisket, Naples-bisket, spunge-bisket, &c. *See* BISKET is a sort of bread much dried, by passing the oven twice, to make it keep for the service of the sea. For long voyages they bake it four times, and prepare it six months before the embarkation. It will hold good a whole year. To preserve sea-biskets from insects, Dr. Hales advises to make the fumes of burning brimstone pass through the casks full of bread. Bisket may be likewise preserved a long time by keeping it in casks, well calked, and lined with tin. The ancients had their bisket prepared after the like manner, and for the like use as the moderns.

BISMUTH, a mineral body, of the semi-metallic kind; by many supposed to be composed of the first matter of tin, while yet imperfect. It is found usually in tin mines, sometimes also in silver mines. Its weight and colour discover it to be of a mercurial or metallic nature. In common menstruums, it undergoes much the same alterations, and assumes much the same forms as lead. Quincy says, there is always some silver in it. Mr. Boyle mentions a medicine prepared from bismuth by calcination, and the addition of spirit of vinegar and *cremor tartari*, which has been extolled in the dropsy. He also mentions a prepration of it with common sublimate into a white powder, a few grains of which purge gently. Works abr. p. 501. Its medicinal virtue is much the same with that of the dross of lead, being seldom used except in external forms, as containing an arsenical salt, very dangerous to be taken inwardly; yet, M. du Clos made a purgative of it, to be used in the dropsy. Add that bismuth being dissolved in spirit of nitre, yields a fume, which, being precipitated with water, produces a white powder, called magistery of bismuth, and Spanish white, found a good diaphoretic in acute cases. But its chief use among the ancients, as well as moderns, is as a cosmetic. Other menstrua, and other precipitates, have been used for producing this powder; but by whatever means it is prepared, it retains a corrosive quality, and injures the complexion. Sig. Poli, by repeated distillations of bismuth with an equal quantity of corrosive sublimate, procured a running mercury, and a fine powder, of the colour of pearl, which might be of use in counterfeiting the oriental pearl. Hist. Acad. Sc. 1713. Bismuth readily amalgamates with mercury, and the compound adheres to iron. On exposing the iron, thus coated with amalgam, to a considerable heat, the mercury exhales, and the greatest part of the bismuth adheres to the iron, which thus looks as if it had been silvered. If mixtures of bismuth with some other metals, particularly lead, be amalgamated, the lead becomes so thin as to pass through leather along with the mercury; but on standing, the bismuth is thrown up to the surface, in form of a dark-coloured powder, the quicksilver and lead remaining united. From this property it is too often used for the purpose of adulterating quicksilver; as rendering a very considerable portion of lead intimately combined with it. One part of this metal with another of bismuth, may be united with three of quicksilver, without affecting its fluidity. The quicksilver thus adulterated, is not only unfit for medicinal uses, but even for the common mechanical purposes of gilding and silvering; as the workmen find, in this case, that it leaves a leaden hue upon the gold or silver, which spoils the fine appearance of the work. If the abuse happens to be discovered, the mercury may be purified by distillation to a certain degree, though, according to Boerhaave, it is impossible ever to free it totally from a mixture of any of the imperfect metals. For a further account of the properties, ores, alloys, &c. of this semi-metal, see the System of CHYMISTRY, Part III. Chap. I. Sect. III.

BISON, in the system of Mammalia, a species of the genus Bos. For description of the genus, and several species, see BOS; for classification, see the SYSTEM, for representation of the species Bison, see Plate X. Genus 32, Species 3.

BISSEXTILE, or *Leap-year*, in Chronology, a year consisting of 366 days, happening once each four years, by reason of the addition of a day in the month of February, to recover the six hours which the sun spends in his course each year, beyond the 365 days ordinarily allowed for it. See the Article KALENDAR. By the statute *de anno bissextile*, 21 Hen. III. to prevent misunderstandings, the intercalary day, and that next before it, are to be accounted as one day. The astronomers concerned in reforming the kalendar, by order of pope Gregory, XIII. in 1582, observing, that the bissextile in four years added 44 minutes more than the sun spent in returning to the same point of the zodiac; and computing that these supernumerary minutes in 133 years would form a day; to prevent any changes being thus insensibly introduced in the seasons, directed that, in the course of 400 years, there should be three bissextiles retrenched; so that every centesimal year, which, according to the Julian account, is bissextile, or leap-year, is

is a common year in the Gregorian account, unleſs the number of centuries can be divided by 4, without a remainder. Thus 1600 and 2000 are biſſextile; but 1700, 1800, and 1900, are common. The Gregorian computation was received in moſt foreign countries ever ſince the reforming of the kalendar; and by act of parliament, paſſed anno 1751, it commenced in all the dominions under the crown of Great Britain, in the year following, ordering that the natural day following the ſecond of September, ſhould be accounted the fourteenth; omitting the intermediate eleven days of the common kalendar.

BISTORT, in Botany. There are three different ſpecies of this plant which are found wild in England, but they are ſeldom planted in gardens: the common ſort only is uſed in medicine. Phil. Tranſ. vol. xlix. part ii. N°. 112. The root of biſtort, which is the only part that is uſed, is drying and binding; of ſervice in all kinds of fluxes and hæmorrhages, either from the bowels, or any other part; they help the incontinence of urine, and the making bloody water; they are alſo alexipharmic, and good in peſtilential fevers, reſiſt poiſon and the bites and ſtings of venomous creatures.

BITE is defined to be a ſolution of the continuity of a ſoft part, cauſed by the impreſſion of an animal's teeth. For the poiſonous or venomous bites of vipers, &c. ſee VIPER, ARANEA, &c. The beſt remedy for it is ſucking the wound; a kind of cure for which the ancient Marſi and Pſilli are celebrated. The beſt cure for the bite of a rattle-ſnake is an actual cautery; e. gr. a hot burning coal held on the wound. Phil. Tranſ. N°. 210. The bites of divers creatures, when mad, are poiſonous, which at other times are not ſo, as of dogs, cats, men. See HYDROPHOBIA, in the Syſtem of MEDICINE, Genus 47.

BITTERN, in Ornithology, the Engliſh name of a ſpecies of the genus Ardea. For deſcription of the genus and moſt remarkable ſpecies, ſee ARDEA.

BITTERNESS, a kind of ſavour or ſenſation, oppoſite to ſweetneſs. According to Grew, bitterneſs is produced by a ſulphur well impregnated with a ſalt, either alkaline or acid, and ſhackled with earth. Hence it is, that the bittereſt plants uſually yield the greateſt quantity of lixivial ſalt; and that many diſtilled oils, digeſted with any ſtrong acid, acquire a bitter taſte. Add, that the leaves of all ſweet roots are bitter; the fig-tree, which bears a ſweet fruit, bleeds a bitter milk; and that the roots of plants, which bear a bitter ſtalk, are not bitter, but hot. That the earthy parts contribute conſiderably to the bitterneſs of bodies, appears hence, that moſt bodies of that kind are fixed; or, if they do emit fumes, do not loſe their bitter taſte therewith. Diſc. of Taſte of Plants, cap. iv. § 12. Bitterneſs, Neumann obſerves, is extracted both by water and ſpirit; does not ariſe in diſtillation; is freed from its ſmell by boiling in water, and covered with acids. He has given the chymical hiſtory of bitter vegetables. See his works. The extinguiſhing, or removing of bitterneſs, is called dulcifying, ſweetening, &c. M. Bon has given methods of removing or diſcharging the bitterneſs of olives and Indian cheſnuts. Mem. Acad. Sc. 1720. p. 600. The bitterneſs of ſea water has been ſuppoſed to ariſe from the diſſolution of the beds, or ſtrata of bitumen; as its ſaltneſs does from a diſſolution of the ſtrata of ſalt. Ibid. 1770. p. 33. The qualities of bitter bodies are ſuppoſed to be dry, warm, aſtringent, and earthy. According to Grew, all plants which are bitter and pungent, either on the tongue, or in the throat, are good cleanſers, e. gr. daiſy, anagallis, &c. The ſame author adds, that moſt purgative and emetic plants, which have any ſenſible taſte, are bitter; either ſimply, as colocynthis; or bitter and aſtringent, as aloes, &c. Bitter things are generally reputed ſtomachic; yet, according to Abercromby, they are naturally the reverſe, and hurtful to the ſtomach; and only become beneficial to it, where their aſtringency renders them proper. Phil. Tranſ. N°. 171. p. 1026. Bitters are ſaid to prevent putrefaction, and moderate fermentation: hence appears their uſe in putrid diſorders. See PUTREFACTION. Bitters likewiſe correct acidities, and aſſiſt digeſtion, by bracing the fibres of the ſtomach.

BITUMEN, in a general ſenſe, a fatty, tenacious, mineral juice, very inflammable; or a foſſil body, which readily takes fire, yields an oil, and is not ſoluble in water. The origin of bitumens has not yet been aſcertained: ſome ſuppoſe that they belong to the mineral kingdom, and others that they proceed originally from vegetable ſubſtances. Macquer inclines to the latter opinion; though Dr. Lewis, the tranſlator of Neumann's works, diſtinguiſhes between mineral bitumens and vegetable reſins. Naturaliſts diſtinguiſh three kinds of bitumens; hard, ſoft, and liquid, or oily; each of which they ſubdivide into ſeveral ſpecies. Among the hard or ſolid bitumens are ranked, yellow amber, ambergris, aſphaltum, and ſulphurs. [See thoſe articles.] The ſoft are maltha, bitumen of Calao, and of Surinam. Laſtly, the naphtha of Italy, and petroleum, are ranked among the liquid bitumens. Of bitumens, ſome again are foſſil, others are found floating on the ſurface of certain lakes, and others ſpring from the earth like fountains, as at Pitchford in Shropſhire, &c. Some bitumens are ſo hard, that they are uſed in forges, inſtead of coals: others ſo glutinous, that they ſerve inſtead of cement, or mortar, in buildings, of which kind that was wherewith the famous walls of Babylon were built: and others ſo liquid, that they are burnt in lamps inſtead of oil. The bitumen in moſt eſteem is that of Judæa, called *bitumen Judaicum*. See the Article ASPHALTUM.

From the origin and inflammability of bitumens, it appears they bear a near affinity to ſulphurs, and are ſuppoſed both formed of the ſame principles or ingredients; only differing in this, that ſulphurs are harder and more brittle, bitumens more fatty and tenacious. Bitumens are uſually divided into two ſpecies, liquid and ſolid; though ſome diſtinguiſh three kinds, as before mentioned. Dr. Woodward gives a different diviſion of the Engliſh bitumens, or bituminous foſſils. The firſt are thoſe of a more lax and coarſe conſtitution; and which, when wetted, yield a groſſer, or pitchy matter. Such are the lapis piceus, or pitch-ſtone, the lapis impelites, obſidianus, or canel, and the lithanthrax or coal. The ſecond is of a more denſe and fine conſtitution, and yields an oil; ſuch are the gagates, or jet; and ſuccinum, or amber. Bitumen is ſuppoſed the chief fuel of the ſubterranean fires. There are bitumens mixed in ſeveral places with the water of the ſea. Barbadoes tar is found floating on the ſea, being waſhed in great quantities from the rocks; and Count Marſigli obſerved ſpiral filaments ariſing from the ſurface of the ſea Marmora, near Conſtantinople, which concreted into bitumen, exactly of the ſame kind with that he obſerved at Zant, flowing from the ſides of a bituminous mountain. On ſome of the coaſts of Italy, they ſkim off a kind of liquid bitumen, or petroleum, from the ſurface of the ſea. Some think that ambergris is a bitumen of the ſea, and many travellers tell us of a fatty ſubſtance on the ſurface of it, that gives light in the night. For a copious account of the nature and properties of this ſubſtance, ſee the Article AMBERGRIS. All bitumens have this good quality in their burning, that they will do without a wick. Dr. Plott therefore conjectures, that the famous ſepulchral lamps of the ancients were contrived of theſe bitumens, particularly of the liquid kind, becauſe any thing that would require a wick, would be liable to its choaking up, and being deſtroyed.

BITUMINOUS, ſomething that relates to, or partakes of the nature and qualities of bitumen. All bituminous bodies are offenſive to the head. Their ſmell or ſtench cauſes the epilepſy to diſcover itſelf.

BIVALVE, or BIVALVULAR, a term uſed by the writers of natural hiſtory, for ſuch ſhell-fiſh as have two ſhells, e. gr. cockles, muſcles, oyſters, &c. which are ſaid to be of the bivalvular kind. Theſe are a leſs numerous claſs than the univalves, and have been arranged according to the Syſtem of Linnæus into 14 genera. For the claſſification of the ſeveral genera and deſcription of each genus, with the ſpecies appertaining to them, ſee the Syſtem of CONCHOLOGY, Order II. See alſo the Synoptical Table annexed to the Syſtem.

BIVENTER, or DIGASTRICUS, from *bis*, and *venter*, *belly*; in Anatomy, a denomination given to the ſixth muſcle of the lower jaw; being the laſt of thoſe ſerving to depreſs or open it: thus called, as having two bellies for its two extremities, and a tendon in the middle. For its origin, inſertion, and uſe, ſee the SYSTEM, Part II. Table of Muſcles, Art. 10.

BLACK, ſomething opake and porous, that imbibes all the light falling on it, reflects none, and therefore exhibits no colour. See BLACKNESS. Bodies of a black colour are found more inflammable, becauſe the rays of light falling on them are not reflected outwards, but enter the body, and are often reflected and refracted within it, till they be ſtifled and loſt. They are alſo found lighter, *cæteris paribus*, than white bodies, being more porous. It may be added, that cloaths dyed of this colour wear out faſter than thoſe of any other, becauſe their ſubſtance is more penetrated and corroded by the vitriol neceſſary to ſtrike their dye, than other bodies are by the galls and alum which ſuffice for them. The inflammability of black bodies, and their diſpoſition to conceive heat, beyond thoſe of other colours, is eaſily evinced. Some appeal to the experiment of a white and black glove worn in the ſame ſun; the conſequence will be, a very ſenſibly greater degree of heat in the one hand than the other. Others alledge the phænomena of burning-glaſſes, by which black bodies are always found to kindle ſooneſt. Mr. Boyle gives other proofs ſtill more obvious: he took a large tile, and having whited over one half of its ſuperficies, and blacked the other, expoſed it to the ſummer ſun: where having let it lie a convenient time, he found, that while the whited part remained ſtill cool, the black part was grown very hot. For farther ſatisfaction, the ſame author has ſometimes left on the ſurface of the tile a part retaining its native red, and expoſing all to the ſun, has found the latter to have contracted a heat in compariſon of the white part, but inferior to that of the black. So alſo on his expoſing two pieces of ſilk, one white, the other black, in the ſame window to the ſun, he often found the latter conſiderably heated, when the former has remained cool. It is obſervable, likewiſe, that

rooms

rooms hung with black are not only darker, but warmer than others. Boyle's Works abridg. tom. i. p. 144, and tom. ii. p. 36.

Dr. Watſon of Cambridge covered the bulb of a thermometer with a black coating of Indian ink; in conſequence of which, the mercury roſe ten degrees. Phil. Tranſ. vol. lxiii. part i. p. 40. Concerning black colours in general, we have the following remarks by Dr. Lewis.

"1. Of black, as of other colours, there are many ſhades or varieties; different bodies, truly and ſimply black, or which have no ſenſible admixture of any of the reſt of the colours, as black velvet, fine black cloth, the feathers of the raven, &c. appearing, when placed together, of tints very ſenſibly different. 2. One and the ſame body alſo aſſumes different degrees of blackneſs, according to the diſpoſition of the ſenſible part of its ſurface; and in this reſpect, there is not, perhaps, any other colour which is ſo much affected by an apparent mechaniſm. Thus black velvet, when the pile is raiſed, appears intenſely black, much more ſo than the ſilk it was made from; but on preſſing the pile ſmooth, it looks pale, and in certain poſitions ſhows ſomewhat even of a whitiſh caſt. 3. This obſervation is agreeable to the phyſical theory, which aſcribes the blackneſs of bodies to the luminous rays, that fall upon them, being in great part abſorbed or ſtifled in their pores. When the ſurface is compoſed of a multitude of looſe filaments, or ſmall points, with the extremities turned towards the eye, much of the light is ſtifled in the interſtices between them, and the body appears dark: when the filaments are preſſed cloſe, or the ſurface ſmoothed and poliſhed, more of the light is reflected from it, and the intenſity of the blackneſs is diminiſhed; though the beauty may be improved by the gloſſineſs which reſults from the ſmoothing. 4. There is one caſe, however, in which a high poliſh may, on the ſame principle, produce blackneſs, in bodies otherwiſe even white. We find the ſpecula of white metal, or of quickſilvered glaſs, which reflect the rays of light to one point or in one direction, look always dark, unleſs when the eye is directly oppoſed to the reflected rays. 5. As the abſorption of the luminous rays, except in the caſe juſt mentioned, makes the phyſical cauſe of blackneſs; it is concluded that black bodies receive heat more freely than others, as before obſerved."

The juices of moſt aſtringent vegetables produce a black with iron, and for this purpoſe ſome of them are uſed in dyeing and callico-printing. See Treatiſe on DYEING, Sect. II. There are alſo a number of black colours artificially prepared for the uſe of painters, ſuch as lamp-black, ivory-black, German-black, &c.

BLACK-*Bird*, *merula*, in Ornithology, a ſpecies of the genus Turdus. For deſcription of the genus and moſt remarkable ſpecies, ſee the article TURDUS.

BLACK-*lead*. For the nature, properties, and uſes of this mineral, ſee the article LEAD.

BLACK-*rod*. Gentleman-uſher of the Black-rod, is the chief gentleman-uſher to the king. His duty is to bear the rod before the king at the feaſt of St. George at Windſor; he has alſo the keeping of the chapter-houſe door, when a chapter of the order of the garter is ſitting; and, in the time of parliament, attends the houſe of peers. His badge is a *black-rod*, with a lion in gold a-top. This rod has the authority of a mace: and to his cuſtody all peers queſtioned for any crime are firſt committed.

BLACKNESS, the quality of a black body; or a colour ariſing from ſuch a texture and ſituation of the ſuperficial parts of the body, as does, as it were, deaden, or rather abſorb, the light falling on it, without reflecting any, or very little of it, to the eye. In which ſenſe, *blackneſs* ſtands directly oppoſed to *whiteneſs*; which conſiſts in ſuch a texture of parts, as indifferently reflects all the rays thrown upon it, of what colour ſoever they be. Deſcartes, ſays Dr. Prieſtley, though miſtaken with reſpect to the nature of light and colours, yet diſtinguiſhes juſtly between *black* and *white*, obſerving, that black ſuffocates and extinguiſhes the light that falls upon it; but that white reflects it. This, adds the hiſtorian of philoſophy, is the firſt diſtinct account I have met with of this ſenſible hypotheſis. Hiſt. of Viſion, p. 127 and 143, &c.

Sir Iſaac Newton, in his Optics, ſhews, that for the production of black colours, the corpuſcles muſt be leſs than thoſe which exhibit any other colours; becauſe, where the ſizes of the component particles are greater, there is too much light reflected to conſtitute this colour: but, if there be a little leſs than is requiſite to reflect the white, and very faint blue of the firſt order, they will reflect ſo little light, as to appear intenſely black; and yet may, perhaps, reflect it variouſly to and fro within them ſo long, till it happen to be ſtifled and loſt; by which means they will appear black in all poſitions of the eye, without any tranſparency. And from hence it appears why fire, and putrefaction, by dividing the particles of ſubſtances, turn them black: why ſmall quantities of black ſubſtances impart their colours very freely, and intenſely, to other ſubſtances, to which they are applied; the minute particles of theſe, by reaſon of their very great number, eaſily overſpreading the groſs particles of others. Hence alſo appears, why glaſs, ground very elaborately with ſand, on a copper plate, till it be well poliſhed, makes the ſand, together with what by rubbing is worn off from the glaſs and copper, become very black; and why black ſubſtances do, ſooneſt of all others, become hot in the ſun's light, and burn (which effect may proceed partly from the multitude of refractions in a little room, and partly from the eaſy commotion of ſuch very ſmall particles): alſo, why blacks are uſually a little inclined towards a bluiſh colour; for, that they are ſo, may be ſeen by illuminating white paper with light reflecting from black ſubſtances, where the paper will uſually appear of a bluiſh white; and the reaſon is, that black borders on the obſcure blue of the firſt order of colours; and therefore reflects more rays of that colour, than of any other.

BLADDER, in Anatomy, a thin expanded membranous body, found in ſeveral parts of an animal, ſerving as a receptacle of ſome juice, or of ſome liquid excrement; from whence it takes various denominations, as *urine-bladder*, *gall bladder*, &c. See the Syſtem of ANATOMY, Part III. Sect. IX. and XII.

BLADDER, by way of eminence, is a large veſſel which ſerves as a receptacle of the urine of animals, after its ſecretion from the blood in the kidneys. This is ſometimes alſo called, by way of diſtinction, the *urinary-bladder*, *veſica urinaria*. The bladder is ſituated in the pelvis of the abdomen; in men immediately on the rectum; in women on the vagina uteri. Though the urinary bladder be naturally ſingle, yet there have been inſtances of nature's varying from herſelf in this particular. The bladder of the famous Caſaubon, upon diſſecting his body after his death, was found to be double; and in the Philoſophical Tranſactions, we have an account of a triple bladder found in the body of a gentleman who had long been ill, and no one could gueſs the cauſe. The urinary bladders of brutes are differently contrived from the human bladder, and from each other, according to the ſtructure, œconomy, and manners of living of each creature. See the Syſtem of COMPARATIVE ANATOMY. Sect. I.

The diſeaſes to which the bladder is ſubject are ulcers, wounds, deſcents or ruptures, preternatural contents, particularly ſtones and gravel, *ſchirrhus*, palſies, inflammations of its neck, &c. To theſe diſeaſes may be added incontinence of urine. The operations performed on the bladder are chiefly ſection, and extraction of the ſtone; to which may be added injection, dilatation, the application of lithontriptic diuretics, &c. Phil. Tranſ. N°. 236. p. 15, ſeq. where Hippocrates's aphoriſm, that the ſections of the bladder are always mortal, is defended; and the beſt method of extracting the ſtone out of the bladder, eſpecially in women, is ſhewn to be by a gradual dilatation of the urethra. See alſo Hiſt. Acad. Scienc. ann. 1720. p. 33, where the great impediments to the diſſolution of the ſtone in the bladder by lithontriptics, are repreſented to be the medicines not continuing long enough in the bladder, and its being altered by the urine. Birds are uſually ſaid to be without bladders, as being without urine; yet does not this hold univerſally; ſince in an oſtrich diſſected by the French academy, a bladder was found ſituate at the extremity of the rectum, big enough to hold both fiſts, and in it eight ounces of urine. See the Syſtem of COMPARATIVE ANATOMY, Sect. II. Many have alſo denied a bladder of urine to fiſhes; but the more exact obſervers find this part in all, at leaſt the greater part of the fiſhy kind. See the Syſtem of COMPARATIVE ANATOMY, Sect. III. Tortoiſes, Ariſtotle obſerves, have large bladders, and they need ſuch; ſince being covered with a thick ſhell, and having no pores or perſpirative veſſels whereby to carry off their moiſture, it is retained within them, and accumulated in the bladder of urine. In the lion, the bladder is ſmall, as is the kidney; for that creature rarely drinks.

BLADDERS, when below a certain magnitude, are more uſually denominated by the diminutive veſicles, *veſiculæ*. Of theſe we meet with many ſorts both in the animal and vegetable world; ſome natural, as in the lungs, eſpecially of frogs, and as ſome alſo imagine, in the muſcles; others morbid or preternatural, as the *hydatides*, and thoſe obſervable in the itch. Naturaliſts have alſo diſcovered bladders in the thorax and abdomen of birds, as well as others in the belly of fiſhes, called air-bladders and ſwims. Vegetable bladders are found every where, in the ſtructure of the bark, the fruit, pith, and *parenchyma*, or pulp; beſides thoſe morbid ones raiſed on the ſurface of leaves by the puncture of inſects.

BLANC-MANGER, Fr. q. d. white Food, is a preparation of diſſolved iſinglaſs, milk, ſugar, cinnamon, &c. boiled into a thick conſiſtence, and garniſhed for the table with blanched almonds. It is cooling and ſtrengthening.

BLANCHING, among Gardeners, an operation whereby certain ſallads, roots, &c. are rendered whiter than they would otherwiſe be. It is thus: After pruning off the tops and roots of the plants to be blanched, they plant them in trenches about ten inches wide, and as many deep, more or leſs, as is judged neceſſary; as they grow up, care is taken to cover them with earth, within four or five inches of their tops: this is repeated from time to time, for five or ſix weeks; in which time they will be fit for uſe, and of a whitiſh colour where covered by the earth.

BLANKET, in Commerce, a warm woolly ſort of ſtuff, light and looſe woven; chiefly uſed in bedding. The manufacture of blankets is chiefly confined to Witney in Oxfordſhire, where it is advanced to that height, that no other place comes near it. Some attribute a great part of the excellency of the Witney blankets to the abſterſive nitrous water of the river Windruſh, wherewith they are ſcoured; others think they rather owe it to a peculiar way of looſe ſpinning, which the people have thereabouts. Be this as it will, the place has ingroſſed almoſt the whole trade of the nation for this commodity; inſomuch, that the wool fit for it centers here, from the farthermoſt parts of the kingdom. Plott, Hiſt. Oxf. chap. 9. § 163. Blankets are made of felt wool, i. e. wool from off ſheepſkins, which they divide into ſeveral ſorts. Of the head wool, and bay wool, they make blankets of twelve, eleven, and ten quarters broad; of the ordinary and middle ſort, blankets of eight and ſeven quarters broad; of the beſt tail wool, blankets of ſix quarters broad, commonly called cuts, ſerving for ſeamens' hammocks.

BLASPHEMY, *blaſphemia*, or *blaſphemium*, denotes ſimply the blaming or condemning of a perſon or thing. The word is Greek, βλασφημια, from βλαπτω, *lædo*. Among the Greeks, to blaſpheme was to uſe words of evil omen, or that portended ſomething ill, which the ancients were careful to avoid, ſubſtituting in lieu of them other words of ſofter and gentler import, ſometimes the very reverſe of the proper ones.

Blaſphemy is more peculiarly reſtrained to evil or reproachful words ſpoken of the Deity. According to Lindwood, blaſphemy is an injury offered to God, by denying that which is due and belonging to him; or attributing to him what is not agreeable to his nature. By the Moſaic law, blaſphemy was puniſhed with death. Levit. chap. xxiv. ver. 13—16. As alſo by the civil law. Novel. 77. In Spain, Naples, France, and Italy, the pains of death are not now inflicted. In the empire, either amputation, or death, is made the puniſhment of this crime.

By the canon law, blaſphemy was puniſhed only by a ſolemn penance; and by cuſtom, either by a pecuniary or corporal puniſhment. By the Engliſh laws, blaſphemies of God, as denying his being, or providence, and all contumelious reproaches of Jeſus Chriſt, &c. are offences by the common law, and puniſhable by fine, impriſonment, and pillory. And, by the ſtatute law, he that denies one of the perſons in the Trinity, or aſſerts there are more than one God, or denies Chriſtianity to be true; for the firſt offence, is rendered incapable of any office; for the ſecond, adjudged incapable of ſuing, being executor or guardian, receiving any gift or legacy, and to be impriſoned for three years. 9 and 10 W. III. c. 32. According to the law of Scotland, the puniſhment of blaſphemy is death. The firſt ſpecies thereof conſiſts in railing at, or curſing God, and here the ſingle act conſtitutes the crime. The ſecond conſiſts in denying the exiſtence of the Supreme Being, or any of the perſons of the Trinity; and therein obſtinately perſevering to the laſt. For reiterated denial does not fully conſtitute the crime, becauſe the ſtat. of Charles II. 1661, admits of repentance before conviction, as a complete expiation. This ſtatute of 1661, is ratified by a ſtatute of W. III. whereby the calling in queſtion the exiſtence of God, or any of the perſons of the Trinity, or the authority of Scripture, or the Divine Providence, is made penal. For the firſt offence, impriſonment, till ſatisfaction given by public repentance in ſack-cloth. For the ſecond, a fine of a year's valued rent of the real eſtate, and twentieth part of the perſonal eſtate. And the trial in both theſe caſes is competent to inferior judges. The trial of the third offence is death, to be tried only by the juſtices.

BLAST, in Agriculture and Gardening, is what is otherwiſe called a blight. See BLIGHT. Blaſts differ from mildews. The ſmut of corn is a ſpecies of blaſt. For a particular account, ſee the Syſtem of AGRICULTURE, Sect. III.

BLASTS, or blaſtings, are by ſome ſuppoſed owing to cold; by others, to the want of a due ſupply of ſap; by others, to aſcending fumes of the earth; by others, to ſharp winds and froſts, immediately ſucceeding rains. Phil. Tranſ. N° 44. That ſpecies, called *uredines*, or fire blaſts, is ſuppoſed by Dr. Hales owing to the ſolar rays reflected from, or condenſed in, the clouds, or even collected by the denſe ſteams in hop-gardens, and other places. Ibid. N°. 399. The effect of them is to wither, ſhrivel, ſcorch, turn black, and, as it were, burn up the leaves, bloſſoms, and fruits of trees, ſhrubs, herbs, graſs, corn, even for whole tracts of ground. Phyſicians alſo ſpeak of a kind of blaſts affecting human bodies, and cauſing eryſipelas, palſies, &c.

BLATTA, or COCKROACH, a genus of inſects belonging to the order of hemiptera, or ſuch as have four ſemicruſtaceous incumbent wings. For the characteriſtic deſcription and claſſification, ſee the Syſtem of ENTOMOLOGY. Order 2. The moſt remarkable ſpecies is the orientalis, which is of a duſky aſh-colour, has ſhort elytra, with an oblong furrow in them. This ſpecies is frequent in America. They get into cheſts, &c. and do much hurt to cloaths; they infeſt people's beds in the night, bite like bugs, and leave a very unſavoury ſmell behind them. They avoid the light, and ſeldom appear but in the night-time. The female reſembles a kind of caterpillar, as it has no wings; ſhe lays an egg of about one half the bulk of her belly. They eat bread, raw or dreſſed meat, linen, books, ſilkworms and their bags, &c. Sir Hans Sloane ſays, that the Indians mix their aſhes with ſugar, and apply them to ulcers, in order to promote the ſuppuration.

BLAZONING, or BLAZONRY, in Heraldry, the decyphering the arms of noble families. The word originally ſignified the blowing or winding of a horn; and was introduced into heraldry as a term denoting the deſcription of things borne in arms, with their proper ſignifications and intendments, from an ancient cuſtom the heralds, who were judges, had of winding an horn at juſts and tournaments, when they explained and recorded the achievements of knights. See the Syſtem of HERALDRY throughout, and the Plates annexed.

BLEA, in Vegetables, is that part of a tree, which lies immediately under the bark, and between that and the hard wood, and is the firſt progreſs of the alteration of the bark into wood by the natural growth and ſtrengthening of the fibres. While the blea remains yet ſoft, and retains ſomething of the nature of bark, it may maintain a feeble vegetation; but when it is grown abſolutely hard and woody, it can contribute nothing to the growth of the tree. The vegetation of the young branches of trees is the moſt lively and vigorous, and the only one that goes as far as the flowers and fruit, becauſe theſe branches are little elſe but bark. For a full and characteriſtic deſcription of this branch of vegetation, ſee the Article MICROSCOPIC OBJECTS.

BLEACHING, the art of whitening linen-cloth, thread, &c. which is conducted in the following manner by the bleachers of this country.

The new method of bleaching is founded upon that remarkable property which dephlogiſticated ſpirit of ſalt poſſeſſes of deſtroying vegetable colours; and various attempts have been made to introduce it into practice, though in this country the difficulties or diſadvantages attending it have prevented it from coming into general uſe. M. Scheele was the inventor of this ſubſtance; but M. Berthollet ſeems to have been the firſt who attempted to apply it to the practice of bleaching. In conſequence of his obſervations, a treatiſe has appeared on the new method of bleaching, collected and tranſlated from his works by Mr. Kerr, ſurgeon in Edinburgh; of which the following is an abridgment.

1. M. Berthollet having procured the dephlogiſticated ſpirit in as ſtrong and concentrated a ſtate as he could, immerſed into it thread and cloth; which, by that means, were conſiderably whitened. In a ſhort time the liquor ſeemed to loſe its ſtrength; upon which it was poured off, and more put in its place; and ſo on until the ſubſtance immerſed became perfectly white. Thus, however, the proceſs was not only very expenſive, but the ſtuff was conſiderably injured; ſometimes even loſing its coheſion altogether, ſo that there was a neceſſity for trying ſome other method. 2. Uſing a diluted ſpirit, he ſucceeded perfectly in rendering the cloths completely white; but by keeping them for ſome time, or expoſing them for a little to the action of an alkaline lye, they became again brown or yellow. 3. On conſidering the proceſs of bleaching in the common method, he found that the action of the ſun and air are ſubſervient to bleaching only as they prepared the colouring particles for being diſſolved and ſeparated by alkaline lixivia. To inveſtigate this ſubject, he examined the nature of the dews, both ſuch as are precipitated from the atmoſphere and thoſe which tranſpire from vegetables. Both of theſe were found ſo ſtrongly impregnated with dephlogiſticated air, that they deſtroyed the colour of paper when faintly tinged with turnſole. Hence our author obſerves, that it is by no means improbable that the ancient prejudices concerning May dews might have ariſen from ſome obſervations analogous to this, more eſpecially as in that month the tranſpiration of plants is extremely copious. 4. By imitating with the dephlogiſticated marine acid and alkaline lye the common proceſs of bleaching, he ſucceeded in making a perfect and permanent white. For this purpoſe an alkaline lixivium was employed alternately with the dephlogiſticated marine acid; the latter being no longer uſed in a concentrated ſtate. Thus he avoided both the inconvenience ariſing from the ſuffocating ſmell of the liquid, and that of its deſtroying the texture of the ſtuff immerſed in it. 5. The cloth is prepared for bleaching in this manner by ſteeping it 24 hours in water, to extract the dreſſing it receives from the weaver: a little old lye, which has already loſt the greateſt part of its ſtrength in other proceſſes, may be uſed with advantage. It is next to be expoſed once or twice to the action of ſome good freſh alkaline lye: in order to ſeparate, by means of this cheaper liquid, all the colouring matter which it can extract, and thereby ſave the dephlogiſticated acid. 6. The ſtuff muſt now be carefully waſhed with water, to ſeparate any remains of the lye which might adhere to it, and weaken the action of the liquor. It is then to be diſpoſed of in wooden troughs, ſo that the dephlogiſticated acid may paſs freely through every part of it; to allow which, it muſt lie quite looſe, without being tightened or ſtraitened in any part. All theſe troughs ought to be conſtructed entirely of wood without

without any iron, as that would eaſily be corroded, and ſtain the cloth. 7. The firſt immerſion in the dephlogiſticated acid is to continue three hours; after which the cloth is to be removed, and the liquor wrung out of it. It muſt then be waſhed a ſecond time with alkaline lye; which being alſo waſhed out, it is to be again immerſed in dephlogiſticated acid. 8. The ſecond immerſion in the acid is to continue only about half an hour; after which it is to be taken out and wrung as before. The ſame liquor may ſerve for ſeveral immerſions; only when it appears to be much exhauſted, it is to be reſtored by an addition of freſh liquor. 9. After the cloth ſeems to be ſufficiently whitened, excepting only ſome few black threads and the ſelvages, it is to be filled with black ſoap, and ſtrongly rubbed for ſome time; after which it is to be again waſhed in alkaline lye, and receive another immerſion in the acid liquor. 10. It has not yet been determined what number of immerſions in the acid are neceſſary to whiten linen cloth, though our author ſuppoſes from ſix to eight to be ſufficient for the purpoſe. 11. To prepare the dephlogiſticated acid, M. Berthollet recommends ſix ounces of black manganeſe finely powdered, 16 ounces of ſea-ſalt likewiſe in powder, and 12 ounces of concentrated vitriolic acid diluted with eight ounces of water; though the quantity of this laſt muſt be variable according to the ſtrength of the acid and the dryneſs of the ſalt. If the manganeſe is impure, its quantity is to be augmented in proportion to the ſuppoſed impurity; and it is known whether a ſufficient quantity has been employed, by a portion remaining behind and retaining its black colour. When the materials are prepared, the manganeſe and common ſalt, both reduced to fine powder, muſt be mixed accurately together, and put into the diſtilling veſſel placed in a ſand-bath: the vitriolic acid diluted with water and allowed to cool is then to be poured upon them, and the junctures exactly luted. The receiver may be of wood covered in the inſide with wax, and of a very large ſize; for the gas is abſorbed in proportion to the ſurface of the water it acts upon. Our author deſcribes an apparatus rather complicated, and which our limits will not allow us to deſcribe in this place, eſpecially as the preparation of this liquid is not as yet ſo generally practiſed that it can be determined how far one apparatus is preferable to another. The requiſites are, that the receiver ſhould not only be capacious but broad, in order that the gas, which is very volatile, may meet with a large ſurface of water to abſorb as much of it as poſſible. It is very improbable, however, that all the gas can be abſorbed by a ſingle receiver let us make it as large as we will; for which reaſon it will be proper to have ſeveral of them connected with each other by glaſs tubes, ſo that what eſcapes from one may be abſorbed by another. Thus we are ſure of having the water fully impregnated with the gas; though we cannot by any means concentrate this liquid like the mineral acids. By means of condenſing engines, indeed, a greater quantity of it might be forced into the water than it can naturally contain; but this could anſwer no uſeful purpoſe; for the moment that a bottle containing ſuch liquor was opened, the ſuperfluous gas would fly off with violence and danger to the perſon who opened it. The bottles themſelves would alſo be liable to burſt on every ſlight alteration of temperature in the atmoſphere. It is proper, therefore, not to attempt the preparation of the liquor in any great degree of ſtrength; though this is indeed attended with a very conſiderable inconvenience, viz. the difficulty of tranſporting it from the place where it is prepared to the bleachfield, on account of the great bulk and weight of it. M. Berthollet propoſes to have it made at the place where the cloth is to be bleached; and ſo near, that the dephlogiſticated ſpirit of ſalt might be conveyed by ſpouts to the troughs which contain the cloth. This, however, muſt in many caſes, be impracticable, unleſs we ſuppoſe the generality of bleachers to be poſſeſſed of a ſkill in managing chemical operations which at preſent they have not. When great quantities of liquor are to be brought from diſtant places, however, it muſt undoubtedly be a great diſcouragement, eſpecially if the beſt methods have not been uſed in the preparation, ſo that the liquor could not be afforded at a very low price.

It would add much to the importance of this new method if a comparative eſtimate of the expences of it and of the old one were fairly laid before the public, and the preference in this reſpect appeared juſtly due to the former. This has not yet been done; nor even the firſt and moſt eſſential ſtep towards it taken, viz. the determining how much ſtuff a certain quantity of dephlogiſticated ſpirit of ſalt will whiten. From ſuch experiments as we have made on the ſubject, it is probable that the acid drawn from one pound of ſalt will whiten four of linen cloth, without any addition.—This may ſeem a ſmall expence; but if we conſider the vitriolic acid to be made uſe of, and that the reſiduum is uſeleſs, it would ſoon be found very conſiderable. Glauber's ſalt may indeed be prepared from the reſiduum of the diſtillation; but ſo much of that article is prepared otherwiſe, that at preſent the making of it is no object. M. Berthollet mentions the ſeparation of the mineral alkali from the reſiduum; and ſays he has received ſome inſtructions on this head from M. Morveau and others, but conceals them on account of their being communicated as ſecrets. Under the article CHYMISTRY, we have taken notice that ſome celebrated chymiſts aſſert that the calces of lead, or lead itſelf, will decompoſe ſea-ſalt, and thus afford an eaſy method of procuring the mineral alkali. On this principle indeed attempts have been made to procure it, but hitherto without ſucceſs; and from ſuch experiments as we have made it ſeems to be totally impracticable. The method of decompoſing Glauber's ſalt and other vitriolic ſalts by means of charcoal, deſcribed under the article CHYMISTRY, is the only one that ſeems to promiſe ſucceſs. The difficulty here is, that the ſalt is converted into an hepar ſulphuris, which cannot be decompounded but by means of an acid. A method of applying ſorrel for this purpoſe has lately been tried with great probability of ſucceſs. The particulars hitherto diſcovered concerning this method are, 1. Sea-ſalt yields one half its weight of pure alkali. 2. From 20 to 25 pounds of freſh ſorrel leaves are to be uſed for every pound of ſea-ſalt. 3. The plant is eaſily cultivated, yields three crops annually if properly managed, and is ſuperior in acidity in its cultivated ſtate to the wild ſorrel. The above calculation was made with wild ſorrel. 4. An acre of ground will produce as much ſorrel as is ſufficient for making from a ton to a ton and a half of alkali. It will not thrive except in moiſt ground. From theſe particulars it is probable, that, by combining the proceſs of making dephlogiſticated ſpirit of ſalt with that of preparing the mineral alkali, bleaching might be performed at an eaſier and cheaper rate than has yet been done; tho' even here there is ſome doubt, that without an encouragement from government, by taking off the duties from ſalt and ſulphur uſed in the different operations, a project of this kind might miſcarry, to the great detriment of the individual who ſhould attempt it. The reaſon of ſuch difficulty in the new method of bleaching is, that little or none of the alkali commonly uſed can be ſaved. The air alſo and light of the ſun, which in the common way is had for nothing, muſt in the new way be bought at a certain price. The only advantage therefore is, that in the new method, a conſiderable portion of time is ſaved. Hence it is impoſſible to make an exact comparative calculation of the expence of both methods, without eſtimating how much labour is ſaved in the new way. If the price of the labour ſaved exceeds that of the dephlogiſticated ſpirit of ſalt, there is no doubt that the uſe of it will be attended with profit, but not otherwiſe. It is aſſerted, by M. Berthollet, that in the new way of bleaching, the texture of the cloth is leſs hurt than in the old one: this too muſt be reckoned an advantage; though by the bleachers, and indeed by the public in general, it will probably be overlooked, unleſs they are induced by the *cheapneſs* to prefer the new to the old method.

With regard to the various methods of bleaching with lime, we cannot help remarking, that from the different experiments we have occaſionally made on the ſubject, this ſubſtance ſeems to poſſeſs no power whatever of whitening cloth; on the contrary, in all caſes where we either tried it ourſelves, or ſaw it tried by others, it manifeſtly prevented the effect of the ſun and air in a remarkable degree. When alkali is mixed with it, we are not to aſcribe the effect to the lime, but to the alkali; for by the attraction of fixed air from the ſalt the lime is converted into chalk, and becomes wholly inert, while the alkali has its activity augmented by being rendered cauſtic. Lime-water is totally inſignificant, unleſs we put the cloth with it into a cloſe veſſel; for lime-water when expoſed to the atmoſphere inſtantly loſes its activity, the lime being converted into a mild calcareous earth, and falling in that ſtate to the bottom. The reaſon of its deſtroying the cloth is ſuppoſed to be its retaining a quantity of moiſture among the threads, ſo that it never allows the cloth to dry thoroughly: to prevent which, it has been recommended to put the limed cloth through a weak ſolution of ſalt, which would no doubt anſwer the purpoſe of diſſolving the calcareous earth; but when we conſider that the lime is a ſubſtance, if not pernicious, at leaſt totally uſeleſs, it ought certainly to be diſcouraged as much as poſſible in the practice of bleaching.

We have been favoured with the following new mode of bleaching of muſlins, and fine cottons, &c. as practiſed by the whitſters in Lancaſhire, which we here preſent to our readers, in conformity to our plan of attending to every new improvement in the liberal and mechanical arts.

After taking the muſlins, &c. from the looms, they are well mill-waſhed, to clear them of the ſoap, ſize, and dirt, then bucked in the common way; afterwards waſhed and put into the ſowring ciſtern, filled with water, acidulated with oil of vitriol, in the proportion of two ounces to a gallon. When the cloth is run dry, it is put into a leaden ciſtern that contains chymical bleaching liquor, which has the ſingular property of imbibing all the oily particles left in the cloth. In a few hours it becomes perfectly white, but muſt be ſouſed and well waſhed, and, when dry, it is finiſhed. The old mode of bleaching or whitening requires two weeks in performance, but it is effected in as many days by the new; conſequently the goods may be brought ſooner to market, which is one important advantage; and it may be obſerved, as another, no leſs important, that they will not be ſo liable to damage either from the weather, cattle, or vermin.

Explanation of the machine conſtructed for the preparation

of

of the chymical liquor uſed in the new mode of bleaching, as repreſented in Plate I. of miſcellaneous ſubjects, fig. 26, and 27. A in fig. 26, is a long tubulated glaſs matraſs which will hold ſix gallons. B, a glaſs tube, crooked at both ends. C, a leaden ciſtern, which will hold one gallon. At D, there ſhould be a pipe to fix a receiver into the ciſtern; but, through the neglect of the engraver, it was omitted in the engraving. E, a cucurbite, or common earthen bottle, containing about three gallons. Fig. 27, repreſents a plank of boards to fix the matraſs on, with the neck downward.

The whitſters method of preparing their chymical liquor for bleaching, is as follows: They take a cucurbite, or common earthen bottle, E, place it on a ſand bank, fill about one-third part of it with manganeſe and marine acid, in equal quantities, ſtop the hole in the cucurbite with a cork, having a hole firſt bored through it to receive one end of a ſmall glaſs tube, and the other end to the tube of a matraſs, A, which being firſt filled with a cold lixivium, or lye of aſhes and water, with its neck hung downwards into a ſmall ciſtern, C, filled with the ſame lixivium; immediately ſmall bubbles of air will ariſe from the cucurbite along the tube, B, and up the tube of the matraſs, A, to the top: conſequently, it will drive the liquor downwards into a receiver fixed to the pipe, D, of the ſmall ciſtern below. As often as the matraſs, A, is emptied, it muſt be ſupplied with another ready filled. When the ebullition begins to abate, they apply a ſmall fire, till darkiſh fumes begin to ariſe along the tube; then it is neceſſary to ſtop it by plucking the tube out of the matraſs, or the liquor will be ſpoiled.

BLEACHING *of ſilk*. While it is yet raw, it is put into a thin linen bag, and thrown into a veſſel of boiling river water, wherein ſoap has been diſſolved, then boiled two or three hours, and the bag being turned ſeveral times, it is taken out, beaten and waſhed in cold water, ſlightly wrung out, and thrown into a veſſel of cold water, mixed with ſoap and a little indigo: the indigo gives it the blueiſh caſt always obſerved in white ſilks. After taking it out of the ſecond veſſel, it is wrung out, and all the water and ſoap expreſſed, ſhook out to untwiſt and ſeparate the thread, and hung up in the air, in a kind of ſtove made on purpoſe, wherein is burned ſulphur: the vapour whereof gives the laſt degree of whiteneſs to the ſilk.

BLEACHING *or ſcouring of woollen ſtuff*. There are three ways of whitening woollens; the firſt with water and ſoap; the ſecond with vapour of ſulphur; the third with chalk, indigo, and vapour of ſulphur. For the firſt, the ſtuffs being taken from the fulling-mill, are put into ſoaped water a little warm, and worked afreſh by force of arms over a bench, which finiſhes the whitening the fulling-mill had begun; and laſtly, waſhed out in clear water and dried; this is called the natural way of bleaching. In the ſecond method, they begin with waſhing the ſtuff in river water; it is then laid to dry on poles, and, when half dry, ſpread out in a kind of ſtove well cloſed, wherein is burnt ſulphur: the vapour whereof diffuſing itſelf, ſticks by little and little over all the ſtuff, and gives it a fine whitening: this is commonly called bleaching by the flower. In the third method, after the ſtuffs have been waſhed, they are thrown into cold water, impregnated with chalk and indigo; after they have been well agitated here, they are waſhed afreſh in clear water, half dried on poles, and ſpread in a ſtove to receive the vapour of the ſulphur: which finiſhes the operation. This is not eſteemed the beſt method of bleaching, though agreeable enough to the ſight. It may be here obſerved, that when a ſtuff has once received the ſteam of ſulphur, it will ſcarce receive any beautiful dye but black or blue.

BLEEDING, PHLEBOTOMY, an operation in Surgery; being the opening of a vein with a lancet, for the evacuation of corrupt, or redundant blood. Some phyſicians extol bleeding as the ſureſt, and moſt efficacious ſpecies of evacuants. Yet it was very rare among the ancients, however frequent among the moderns. Bleeding is a ſpecies of evacuation of the utmoſt importance in medicine; an idea of its effects, with the reaſon of its uſe, may be conceived from what follows. It is evident that the blood thrown out of the heart, while it ſtrikes upon the antecedent blood, and drives it forwards, transfers to it part of its own motion, and it is therefore ſo much retarded in its own motion. Hence, if blood be drawn out of the baſilic vein of the right arm; the ſucceeding blood, or that carried by the axillary artery, or right ſubclavian, will be leſs hindered in its motion than it was before that vein was opened; for part of the blood being taken away by the opening of that vein, there remains behind a leſſer quantity in the axillary vein, or leſs is contained between the farther extremity of the axillary artery and the heart, than was before: therefore the blood being let out of the vein, the remainder in the artery will be leſs impeded in its motion than before. Hence the blood of that artery, which communicates with the vein that is opened, will flow with a greater velocity after the aperture is made than before. Conſequently, while the blood is flowing out of the vein in the arm, that thrown out of the heart into the *aorta*, will find leſs reſiſtance in the aſcending trunk than in the deſcending; and will therefore flow faſter in the aſcending than in the deſcending trunk: and thence too it will find leſs reſiſtance in the right ſubclavian artery than in the left. Laſtly, it hence appears, that the blood being let out of a vein in the right arm, the remaining blood in the right axillary artery runs with a greater velocity into the artery of that arm that is contiguous to it, than through the thoracic artery, or the right ſcapulary, which is likewiſe contiguous to it; becauſe, when the blood is not ſuppoſed to be drawn out from any vein correſponding to the thoracic artery, or into which this diſcharges itſelf, there is proportionably a greater impediment to the motion of the blood in the thoracic artery than in that of the arm. But becauſe the velocity of the blood in the ſubclavian artery, or the right axillary, is greater than in the left; the velocity in the right thoracic will alſo be greater than in the left thoracic artery. Hence it is manifeſt, that the blood being let out of a vein in the right arm; the greateſt velocity of the remaining blood will be in the artery of that arm, becauſe it immediately empties its blood into the vein that is opened; and the next greateſt velocity will be in the thoracic artery, or ſcapulary of the ſame ſide, going out from the axillary artery. But the velocity of the blood will be far leſs in the brachial, axillary, and thoracic artery on the left and oppoſite ſide; and leaſt of all in the arteries ariſing from the deſcending trunk of the aorta.

On this view it may eaſily be gathered what is to be done in the ſeveral circumſtances of blood-letting: for inſtance, if we would prevent the increaſe of any humour from the blood ſtagnating in the left leg, or bring it about, that as little blood as poſſible ſhould flow to that leg in any given ſpace of time; firſt, blood is to be taken from the arm or leg of the right ſide: becauſe this is truly making what is called a *revulſion*. Again, if the blood be drawn away on the ſame ſide, and from ſome vein that receives the blood from a branch of that trunk which tranſmits it to the ſwelled part; it will occaſion a great derivation of blood to that limb for a few moments: and this is all that can make any difference between the different parts from which the blood is drawn. As to what relates to the whole habit; in all lentors and viſcidities, if there be a due ſtrength and elaſticity remaining in the ſolids, phlebotomy will make the remaining blood circulate the faſter, and become thinner and warmer; but in a plethora, from a debauch, or too large quantities of ſpirituous nouriſhment, or from a diminution of perſpiration, where the blood yet retains its natural fluxility, phlebotomy will make the remaining maſs circulate ſlower, and become cooler. In the former caſe, a diminution of the reſiſtance in the blood-veſſels will increaſe the contractile powers of thoſe veſſels, and make them beat faſter, and circulate their contents with greater velocity; but in the latter caſe a diminution of the quantity of ſpirituous blood will leſſen the quantity of ſpirit ſecreted in the brain, the conſequence of which will be, that the heart and arteries will not contract ſo often and ſo ſtrongly as before, and therefore the blood will move ſlower, and become cooler. And on theſe things depends the whole doctrine of blood-letting.

Bleeding, according to Dr. Pringle, is the moſt indiſpenſible of all remedies in inflammatory diſeaſes; to the delaying of which too long, or not repeating it, are chiefly owing the bad conſequences of colds, as dangerous fevers, rheumatiſms, and conſumptions. He obſerves farther, that, in general, young practitioners are apt to be too ſparing in letting blood, by which means many lives are loſt: for a ſurgeon may be aſſured a ſoldier will never complain of a cough, or pains with inflammatory ſymptoms, wherein *bleeding* is not neceſſary; and from the fizineſs of the blood, and continuance of the complaints, he is to judge of the neceſſity of repeating it, which, in caſe of a ſtitch, or difficult breathing, is never to be delayed. In inflammatory caſes, from twelve to fifteen ounces may be taken for the firſt bleeding, and ſomewhat leſs for all the reſt; and when it is neceſſary to exceed this quantity, it may be proper to follow Celſus's rule, in minding the colour of the blood whilſt it flows, and when it is of a blackiſh caſt, which is always the caſe in difficult breathing and great inflammations, to let it run till it becomes more florid. In all caſes, where plentiful bleeding is indicated, it is beſt to do it in bed, to prevent fainting; and we may obſerve, that a perſon will bear the loſs of a much greater quantity of blood if the ſtream is ſmall, than by a large orifice, which ſome have thought neceſſary for making a more ſpeedy revulſion.

Bleeding is highly neceſſary in the phrenitis, ophthalmia, quinſey, rheumatiſm, cough, hectic fits, and, in general, in all inflammatory caſes. See Pringle's Obſervations on the Diſeaſes of the Army, paſſim. It is to be obſerved, however, that, in malignant and putrid diſorders, bleeding frequently renders them more malignant; it is therefore to be omitted, or at leaſt not repeated, unleſs there appear evident marks of inflammation. For a further account of the reſpective maladies alluded to, with the advantages reſulting from the operation, as they occur under the ſeveral Genera, ſee the Syſtem of MEDICINE.

As to the method of the operation, the puncture ſhould neither be too ſmall nor too large. Different ſurgeons open the vein in three different directions; ſome make the orifice in a ſtraight line with the courſe of the vein; others tranſverſely; but moſt make it obliquely; and if the patient is to be blooded in

in the left arm, the ſurgeon ſhould be able to uſe his left hand, inſtead of his right. If the blood ſtops after a ſhort time, looſen the bandage a little, to give way to more blood's deſcending by the artery, and it will bleed freſhly again; and if the orifice be obſtructed by too great a tenſion of the ſkin, or an intruſion of the *membrana adipoſa*, the piece of fat ſhould be returned by preſſing of the finger, or a bit of ſponge, and the ſkin relaxed by bending the arm; and, laſtly, if the orifice be obſtructed by thick grumous blood, that impediment may be removed by wiping with a ſponge, dipped in warm water.

When a ſufficient quantity of blood is diſcharged, the ligature muſt be immediately taken off, and the ſkin about the orifice gently ſtroaked or preſſed together by the two fore-fingers of the left hand; by which means, the lips of the divided vein are cloſed: then the ſmaller of the two compreſſes is to be applied, firſt letting what little blood there may be between the orifice and the vein be diſcharged; the larger compreſs ſhould then be laid on the ſmaller, and preſſed ſlightly down with the thumb; then wiping the blood from the arm, the bandage is to be applied. Some wet the compreſſes in vinegar, water, or ſpirit of wine; but it is not neceſſary, and they ſit eaſieſt when applied dry.

In bleeding it ſometimes happens that an artery is opened either inſtead of, or together with, the vein: an accident of this kind is attended with the utmoſt danger. An artery is known to be wounded when the blood ſpins out very forcibly from the orifice, and that by ſtarts or leaps, not in an even ſtream, and extends itſelf in a greater arch from the orifice to the baſon. The colour of the blood from an artery is alſo much more florid than from a vein; to which, add, that on preſſing the finger on the veſſel below the orifice, the blood ſtarts out more violently than before; and ſtops, or at leaſt abates, on preſſing above the orifice; quite the contrary of what happens on the opening of a vein.

In an accident of this kind, the ſurgeon ſhould have preſence of mind not to betray the caſe, by his fears, to the patient, or attendants: he ſhould obſerve whether the blood flows freely from the orifice, or whether it inſinuates itſelf in any conſiderable quantity between the integuments. If the firſt is the caſe, he muſt take a large quantity of blood away, even till the patient faints, perſuading the attendants that the heat of the blood requires it; and while the patient is in his fainting fits, as the flux then ceaſes, he may commodiouſly dreſs and bind up the wound; and by this precaution hinder a freſh hæmorrhage, or an aneuriſm. The ſurgeon muſt place ſome ſmall piece of money between the folds of the firſt compreſs; and on this place two, three, or more compreſſes, each larger than the other: and then, bending the cubitus, apply two bandages in this manner, as after bleeding in the vein, only a little tighter; and lay a thick, long, and narrow compreſs over the artery, from the cûbitus to the axilla: and the patient muſt be warned to wear his arm in a ſling, pinned to his cloaths, for a fortnight, and refrain from all uſe of it.

If the blood from the wounded artery is found to inſinuate itſelf between the integuments, the orifice muſt be immediately compreſſed, and tied up as before directed; and the arm often inſpected, to ſee whether a bleeding within the integuments does not yet continue. The patient muſt be frequently bled in the other arm, and, if a large quantity of blood ſhould be lodged from the wounded artery under the integuments, it will be neceſſary to open the integuments to diſcharge it.

It is too common an accident to find a nerve or tendon punctured in bleeding; and this is generally known to be the caſe by the patient's making a ſevere outcry at the time; and eſpecially if he complains afterwards of acute pains, and the limb begins to ſwell and be inflamed, convulſed, ſtiff, and extended as in the cramp: which ſymptoms, if not timely relieved, threaten convulſions of the whole body, a gangrene of the part, and even death in a ſhort time. The beſt method to be taken in theſe accidents is, to firſt bathe the part with a mixture of oil of turpentine and ſpirit of wine, and then inveſt the whole arm with the diachalcitis plaſter, melted down in oil of vinegar and roſes, retaining it on by the expulſive bandage; which, beginning upon the hand, aſcends gradually by ſpiral turns to the top of the ſhoulder; by which means the impulſe of the blood on the part is not only much abated, but alſo the pain and inflammation much diminiſhed: and, laſtly, the following cataplaſm ſhould be applied to the arm, to complete the cure: take of flour of barley and of bitter vetch, of each two ounces; chamomile flowers and melilot flowers, of each two handfuls; freſh butter, an ounce and half: boil theſe into a cataplaſm with ſoap ſuds, and apply them to the arm till the pain and other bad ſymptoms are removed.

BLESENSIS *bolus*, *bole of Blois*, in the Materia Medica, a very valuable medicinal earth dug about Saumur, Blois, and Burgoyne in France, and ſeeming to poſſeſs all the virtues of the Armenian bole of Galen, which it alſo much reſembles in external appearance. It is a very valuable medicine in fluxes and many other caſes, and might be had in any quantities, at a ſmall price; but the common red French bole, or a counterfeit of it, or the ſubſtance called bole armenic, is generally ſold for it.

BLIGHT, a diſeaſe incident to plants, and affecting them variouſly; the whole plant ſometimes periſhing by it, and ſometimes only the leaves and bloſſoms, which will be ſcorched and ſhrivelled up, the reſt remaining green and flouriſhing. This diſorder ſeldom happens but upon the blowing of ſharp eaſterly winds, which are moſt frequent with us about March; whence that month proves, of all others, the moſt fatal to plants. From this circumſtance, ſome imagine the colds that then reign, being exaſperated by the eaſtern winds, effect blights; but Mr. Bradley furniſhes a more plauſible account: for on this principle it were hard to ſay why one plant, or one part of a plant, ſhould be blighted more than another. He obſerves then, that caterpillars and other inſects generally attend thoſe winds; and that they infect ſome kinds of trees more than others, and even ſome particular branch more than others; and thence infers, either that the eggs of thoſe inſects, or the inſects themſelves, are brought to us by the eaſterly winds; or that the temperature of the air, when the eaſtern winds blow, is neceſſary to hatch thoſe creatures, ſuppoſing the eggs to have been already laid on the infected parts. Now each of theſe cauſes ſeems to have its effect: thoſe blights attended with large worms, or caterpillars, ſeem hatched by the eaſtern winds; and thoſe others, which only produce the ſmall inſects, that occaſion the curling of the leaves of trees, may proceed from ſwarms of them, either ready hatched, or in the egg, brought with the wind. The coldneſs of thoſe winds he ſhews to be no objection againſt their being fitted to hatch inſects; different inſects requiring vaſtly different degrees of heat. To this he adds, that every inſect has its proper plant, or tribe of plants, which it naturally requires for its nouriſhment, and will feed on no other; and in which, therefore, it lays its eggs: it is no wonder then, that one kind of tree ſhould be infected, and all the reſt eſcape. That wind, v. gr. which brings or hatches the caterpillars on the apple-tree, will not infect the pear, plum, or cherry; becauſe, were the ſhoals of inſects natural to the apple to light on thoſe other trees mentioned, they would either want their proper matrix to hatch in; or, were they ready hatched, would periſh for want of proper food. So that it is morally impoſſible all kinds of plants ſhould be blighted at the ſame time, unleſs the eggs of every kind of inſect natural to each tree could be brought at one time with the wind; or, that an eaſterly wind could contain in it, at once, as many different degrees of cold, or heat, as would be required to hatch and maintain each different claſs of inſects. Nor is it any objection, that in blights there are not frequently any animals immediately perceivable. By the microſcope, we diſcover animalcules a million of times leſs than the ſmalleſt which come under ordinary notice; theſe, the gentleſt air may be conceived capable of blowing from place to place; ſo that it is no wonder if they be brought to us from the remoteſt regions, eſpecially the north-eaſt part of Great Tartary, &c. where the cold is intenſe enough to give them life; and from whence there is not ſea enough, by the warmth and ſaltneſs of whoſe vapours they might be ſuffocated. Thoſe brought from the north-eaſt parts of America are probably deſtroyed by paſſing the vaſt Atlantic ocean, which may be the reaſon why the north-weſt wind is not ſo infectious.

Dr. Hales aſcribes blights to the obſtruction of perſpiration in bloſſoms and leaves, occaſioned by a continued dry eaſterly wind, without ſhowers or dew; in conſequence of which the perſpirable matter becomes glutinous, and adheres to the ſurfaces of leaves, hereby affording a proper nutriment for inſects, which prey on the leaves and tender branches of fruit trees, when the blight happens, though they are not the firſt cauſe of it. To prevent blights, the more intelligent among country-people, while the eaſterly winds blow, are accuſtomed to guard againſt them by burning heaps of weeds, chaff, and other combuſtibles, on the wind-ſide of their orchards, that the ſmoak may either poiſon the inſects or their eggs, as they paſs along. It may be added, that theſe fires are often made with good ſucceſs, to deſtroy the caterpillars, even after they are hatched, and have begun to devour the trees.—Another method of preſerving trees from blights is, by ſprinkling tobacco-duſt, or pepper-duſt, or waſhing the leaves with water wherein tobacco-ſtalks have been infuſed; which, it is ſaid, is preſent death to all inſects and animalcules. Another is by pulling off the leaves when withered, and cutting off the ſmaller branches, when they produce crooked and unnatural ſhoots. Dr. Hales recommends waſhing and ſprinkling the trees occaſionally with fair water: and if their ſhoots ſeem to be much infected, waſhing them with a woollen cloth, ſo that their perſpiration may not be obſtructed. But there is another ſort of blight, againſt which it is more difficult to guard fruit-trees; that is occaſioned by ſharp, pinching, froſty mornings, which often happen at a time when the trees are in flower, or while the fruit is very young, and occaſion the bloſſoms or fruit to drop off; and ſometimes the tender parts of the ſhoots and leaves are greatly injured thereby. The only method yet found out to prevent this miſchief is, by carefully covering the walls, either with mats or canvas, &c. which being faſtened ſo as not to be diſturbed with the wind, and ſuffered to remain on during the night, are to be taken off every day, if the weather permits.

☞ *The* Binder *is deſired to obſerve, that this Sheet* [5 M 2] *is to be placed after* [5 M 1]; *it being a* duplicate Signature, *introduced in the* New Edition *of the Work, to enlarge on the Articles* Birth, Bishop, Bleeding, Blight, *and* Blind.

Another ſort of blight, which ſometimes happens in April or May, and which is often very deſtructive to orchards and open plantations, and againſt which we know of no remedy, is what is called a fire-blaſt, which in a few hours hath not only deſtroyed the fruit and leaves, but many times parts of the trees, and ſometimes whole ones have been killed by it. This more frequently happens in cloſe plantations, where the ſtagnating vapours from the earth, and the plentiful perſpirations from the trees, are pent in, for want of a free air to diſſipate and diſpel them; than in thoſe planted at a greater diſtance, or ſurrounded with hills or woods.

Corn is liable to blights, like other ſorts of grain. Blight of corn is called SMUT. For the methods of preventing and remedying this diſeaſe, ſee the Syſtem of AGRICULTURE, Sect. III.

BLIND, an epithet applied to a perſon or ſenſitive creature deprived of the uſe of his eyes; or, in other words, to one from whom light, colours, and all the glorious variety of the viſible creation, are intercepted by ſome natural or accidental diſeaſe. Such is the literal acceptation of the term: but it is likewiſe uſed in a metaphorical ſenſe, to ſignify mental or intellectual darkneſs; and frequently implies, at the ſame time, ſome moral or ſpiritual depravity in the ſoul thus blinded, which is either the efficient or continuing cauſe of this internal malady. Yet, even in metaphor, the epithet of blind is ſometimes applied to a kind of ignorance, which neither involves the ideas of real guilt, nor of voluntary error.

It is, however, our preſent intention to conſider the word not in its figurative, but in its natural and primary ſenſe. Nor do we mean in this place to regard it as a ſubject of medical ſpeculation, or to explore its cauſes and enumerate its cures. Theſe are in the department of another ſcience. It is rather our deſign to conſider by what means this inexpreſſible misfortune may be compenſated or alleviated to thoſe who ſuſtain it; what advantages and conſolations they may derive from it; of what acquiſitions they may be ſuſceptible; what are the proper means of their improvement; or by what culture they may become uſeful to themſelves, and important members of ſociety.

There is not, perhaps, any ſenſe or faculty of the corporeal frame, which affords ſo many reſources of utility and entertainment as the power of viſion; nor is there any loſs or privation which can be productive of diſadvantages or calamities ſo multiform, ſo various, and ſo bitter, as the want of ſight. By no avenue of corporeal perception is knowledge in her full extent, and in all her forms, ſo acceſſible to the rational and inquiring ſoul, as by the glorious and delightful medium of light. For this not only reveals external things in all their beauties, in all their changes, and in all their varieties; but gives body, form, and colour, to intellectual ideas, and abſtract eſſences; ſo that the whole material and intelligent creation lie in open proſpect, and the majeſtic frame of nature in its whole extent, is, if we may ſpeak ſo, perceived at a ſingle glance. To the blind, on the contrary, the viſible univerſe is totally annihilated; he is perfectly conſcious of no ſpace but that in which he ſtands, or to which his extremities can reach. Sound, indeed, gives him ſome ideas of diſtant objects; but thoſe ideas are extremely obſcure and indiſtinct. The living and comprehenſive eye darts its inſtantaneous view over expanſive valleys, lofty mountains, protracted rivers, illimitable oceans. It meaſures, in an indiviſible point of time, the mighty ſpace from earth to heaven, or from one ſtar to another. By the aſſiſtance of teleſcopes, its horizon is almoſt indefinitely extended, its objects prodigiouſly multiplied, and the ſphere of its obſervation nobly enlarged. By theſe means, the imagination, inured to vaſt impreſſions of diſtance, can not only recall them in their greateſt extent with as much rapidity as they were at firſt imbibed; but can multiply them, and add one to another, till all particular boundaries and diſtances be loſt in immenſity. Thus nature, by profuſely irradiating the face of things, and clothing objects in a robe of diverſified ſplendour, not only invites the underſtanding to expatiate on a theatre ſo extenſive, ſo diverſified, and ſo attractive; but entertains and inflames the imagination with every poſſible exhibition of the ſublime or beautiful. The blind not only may be, but really are, during a conſiderable period, apprehenſive of danger in every motion towards any place from whence their contracted powers of perception can give them no intelligence. All the various modes of delicate proportion, all the beautiful varieties of light and colours, whether exhibited in the works of nature or art, are to them irretrievably loſt. Dependent for every thing, but mere ſubſiſtence, on the good offices of others; obnoxious to injury from every point, which they are neither capacitated to perceive nor qualified to reſiſt; they are, during the preſent ſtate of being, rather to be conſidered as priſoners at large, than citizens of nature. The ſedentary life, to which by privation of ſight they are deſtined, relaxes their frame, and ſubjects them to all the diſagreeable ſenſations which ariſe from dejection of ſpirits. Hence the moſt feeble exertions create laſſitude and uneaſineſs. Hence the native tone of the nervous ſyſtem, which alone is compatible with health and pleaſure, deſtroyed by inactivity, exaſperates and embitters every diſagreeable impreſſion. Natural evils, however, are always ſupportable; they not only ariſe from blind and undeſigning cauſes, but are either mild in their attacks, or ſhort in their duration: it is the miſaries which are inflicted by conſcious and reflecting agents alone, that can deſerve the name of evils. Theſe excruciate the ſoul with ineffable poignancy, as expreſſive of indifference or malignity in thoſe by whom ſuch bitter portions are cruelly adminiſtered. The negligence or wantonneſs, therefore, with which the blind are too frequently treated, is an enormity which God alone has juſtice to feel or power to puniſh.

Thoſe amongſt them who have had ſenſibility to feel, and capacity to expreſs, the effects of their misfortunes, have deſcribed them in a manner capable of penetrating the moſt callous heart. The venerable father of epic poetry, who in the perſon of Demodocus, the Phæatian bard, is ſaid to have deſcribed his own ſituation, proceeds thus:

Τον περι Μυσ' επιλησε διδυ δ' αγαθον τε, κακοισι,
Οφθαλμων μεν αμερσε διδυ δ' ηδειαν αοιδην

ODYS.

Dear to the muſe, who gave his days to flow
With mighty bleſſings mix'd with mighty wo,
In clouds and darkneſs quench'd his viſual ray,
Yet gave him power to raiſe the lofty lay.

POPE.

Milton, in his addreſs to light, after a ſublime deſcription of his arduous and gloomy journey from the regions of primeval darkneſs to this our viſible diurnal ſphere, thus continues to apoſtrophiſe the celeſtial beam:

Taught by the heav'nly muſe to venture down
The dark deſcent, and up to reaſcend,
Though hard and rare; thee I reviſit ſafe,
And feel thy ſov'reign vital lamp: But thou
Reviſit'ſt not theſe eyes, that roll in vain
To find thy piercing ray, and find no dawn;
So thick a drop ſerene hath quench'd their orbs,
Or dim ſuffuſion veil'd. Yet not the more
Ceaſe I to wander, where the muſes haunt
Clear ſpring, or ſhady grove, or ſunny hill,
Smit with the love of ſacred ſong: but chief
Thee, Sion, and the flow'ry brooks beneath,
That waſh thy hallow'd feet, and warbling flow,
Nightly I viſit; nor ſometimes forget
Thoſe other two equall'd with me in fate,
So were I equall'd with them in renown,
Blind Thamyris, and blind Mæonides,
And Tirehas and Phineas prophets old:
Then feed on thoughts, that voluntary move
Harmonious numbers; as the wakeful bird
Sings darkling, and in ſhadieſt covert hid
Tunes her nocturnal note. Thus with the year
Seaſons return; but not to me returns
Day, or the ſweet approach of ev'n or morn,
Or ſight of vernal bloom, or ſummer's roſe,
Or flocks, or herds, or human face divine;
But cloud inſtead, and ever during dark,
Surrounds me, from the cheerful ways of men
Cut off, and for the book of knowledge fair
Preſented with a univerſal blank,
Of nature's works to me expung'd and ras'd,
And wiſdom at one entrance quite ſhut out.

PAR. LOST, Book III.

The ſame inimitable author, in his tragedy of Sampſon Agoniſtes, and in the perſon of his hero, deplores the misfortune of blindneſs with a pathos and energy ſufficient to extort the deepeſt ſighs from the moſt unfeeling hearts:

——————— But chief of all,
O loſs of ſight, of thee I muſt complain!
Blind among enemies, O worſe than chains,
Dungeon, or beggary, decrepid age.
Light, the prime work of God, to me is extinct,
And all her various objects of delight
Annull'd, which might in part my grief have eas'd,
Inferior to the vileſt now become
Of man or worm. The vileſt here excel me:
They creep, yet ſee; I dark in light expos'd
To daily fraud, contempt, abuſe, and wrong,
Within doors, or without, ſtill as a fool,
In power of others, never in my own;
Scarce half I ſeem to live, dead more than half.
O dark, dark, dark, amid the blaze of noon,
Irrecoverably dark, total eclipſe,
Without all hope of day!
O firſt created Beam, and thou great Word
Let there be light, and light was over all;
Why am I thus bereav'd thy prime decree?
The ſun to me is dark,
And ſilent, as the moon
When ſhe deſerts the night,
Hid in her vacant interlunar cave.
Since light ſo neceſſary is to life,
And almoſt life itſelf, if it be true
That light is in the ſoul,

She

She all in every part; why was the ſight
To ſuch a tender ball as th' eye confin'd?
So obvious, and ſo eaſy to be quench'd?
And not, as feeling, throughout all parts diffus'd,
That ſhe might look at will through ev'ry pore?
Then had I not been thus exil'd from light,
As in the land of darkneſs, yet in light
To live a life half dead, a living death;
And buried; but yet more miſerable!
Myſelf the ſepulchre, a moving grave;
Bury'd, yet not exempt
By privilege of death and burial
From worſt of other evils, pains and wrongs,
But made hereby obnoxious more
To all the miſeries of life.

Oſſian, the Caledonian bard, who lived before the authenticated hiſtory of his nation, dates its origin, who in his old age participated the ſame calamity, has in more than one paſſage of his works deſcribed his ſituation in a manner ſo delicate, yet ſo pathetic, that it pierces the inmoſt receſſes and excites the fineſt feelings of the heart. Of theſe paſſages, take the following:

"O thou that rolleſt above, round as the ſhield of my fathers! whence are thy beams, O ſun! whence thy everlaſting light? Thou comeſt forth in thy awful beauty, and the ſtars hide themſelves in the ſky; the moon, cold and pale, ſinks in the weſtern wave. But thou thyſelf moveſt alone: who can be a companion of thy courſe? The oaks of the mountains fall; the mountains themſelves decay with years; the ocean ſhrinks and grows again; the moon herſelf is loſt in heaven: but thou art for ever the ſame; rejoicing in the brightneſs of thy courſe. When the world is dark with tempeſt; when thunder rolls and lightning glances through the heavens; thou lookeſt in thy beauty from the clouds, and laugheſt at the ſtorm. But to Oſſian thou lookeſt in vain; for he beholds thy beams no more; whether thy yellow hair flows on the eaſtern clouds, or thou trembleſt at the gates of the weſt. But thou art, perhaps, like me, for a ſeaſon and thy years will have an end: thou ſhalt ſleep in thy clouds, careleſs of the voice of the morning.—Exult then, O ſun, in the ſtrength of thy youth! age is dark and unlovely; it is like the glimmering light of the moon, when it ſhines through broken clouds, and the miſt is on the hills, the howling blaſt of the north is on the plain, the traveller ſhrinks in the midſt of his journey."

Thus dependent on every creature, and paſſive to every accident, can the world, the uncharitable world, be ſurpriſed to obſerve moments when the *blind* are at variance with themſelves and every thing elſe around them? With the ſame inſtincts of ſelf-preſervation, the ſame iraſcible paſſions which are common to the ſpecies, and exaſperated by a ſenſe of debility either for retaliation or defence; can the blind be real objects of reſentment or contempt, even when they ſeem peeviſh or vindictive? This, however, is not always their character. Their behaviour is often highly expreſſive, not only of reſignation, but even of cheerfulneſs; and though they are often coldly, and even inhumanly, treated by men, yet are they rarely, if ever, forſaken of heaven. The common Parent of nature, whoſe benignity is permanent as his exiſtence, and boundleſs as his empire, has neither left his afflicted creatures without conſolation nor reſource. Even from their loſs, however oppreſſive and irretrievable, they derive advantages; not indeed adequate to recompenſe, but ſufficient to alleviate their miſery. A blind man, when walking ſwiftly, or running, is kindly and effectually checked by nature from rudely encountering ſuch hard and extended objects as might hurt or bruiſe him. When he approaches bodies of this kind, he feels the atmoſphere more ſenſibly reſiſt his progreſs; and in proportion as his motion is accelerated, or his diſtance from the object diminiſhed, the reſiſtance is increaſed. He diſtinguiſhes the approach of his friend from far by the ſound of his ſteps, by his manner of breathing, and almoſt by every audible token which he can exhibit. Prepared for the dangers which he may encounter from the ſurface of the ground upon which he walks, his ſtep is habitually firm and cautious. Hence he not only avoids thoſe falls which might be occaſioned by its leſs formidable inequalities, but from its general bias he collects ſome ideas how far his ſafety is immediately concerned; and though theſe conjectures may be ſometimes fallacious, yet they are generally ſo true, as to preſerve him from ſuch accidents as are not incurred by his own temerity. The rapid torrent and the deep caſcade not only warn him to keep a proper diſtance, but inform him in what direction he moves, and are a kind of audible ſynoſures to regulate his courſe. In places to which he has been accuſtomed, he as it were recogniſes his latitude and longitude from every breath of varied fragrance that tinges the gale, from every aſcent or declivity in the road, from every natural or artificial ſound that ſtrikes his ear, if theſe indications be ſtationary, and confined to particular places. Regulated by theſe ſigns, the *blind* have not only been known to perform long journeys themſelves, but to conduct others through dangerous paths at the dark and ſilent hour of midnight, with the utmoſt ſecurity and exactneſs.

We have read, in authors of good credit, of a very ſurpriſing blind guide who uſed to conduct the merchants through the ſands and deſarts of Arabia. Vide Leo Afric. Deſcr. Afr. lib. vi. p. 246. and Caſaub. Treat. of Enthuſ. c. ii. p. 45. An inſtance not leſs marvellous, exiſts at this preſent time, and in our own country. John Metcalf, a native of the neighbourhood of Mancheſter, where he is well known, became blind at a very early age, ſo as to be entirely unconſcious of light and its various effects. This man paſſed the younger part of his life as a waggoner, and occaſionally as a guide in intricate roads during the night or when the tracks were covered with ſnow. Strange as this may appear to thoſe who can ſee, the employment he has ſince undertaken is ſtill more extraordinary: it is one of the laſt to which we could ſuppoſe a blind man would ever turn his attention. His preſent occupation is that of a projector and ſurveyor of highways in difficult and mountainous parts. With the aſſiſtance only of a long ſtaff, I have ſeveral times met this man traverſing the roads, aſcending precipices, exploring valleys, and inveſtigating their ſeveral extents, forms, and ſituations, ſo as to anſwer his deſigns in the beſt manner. The plans which he deſigns, and the eſtimates he makes, are done in a method peculiar to himſelf; and which he cannot well convey the meaning of to others. His abilities in this reſpect are nevertheleſs ſo great, that he finds conſtant employment. Moſt of the roads over the Peak in Derbyſhire, have been altered by his directions; particularly thoſe in the vicinity of Buxton; and he is at this time conſtructing a new one betwixt Wilmſlow and Congleton, with a view to open a communication to the great London road, without being obliged to paſs over the mountains. Vide account by Dr. Bew, publiſhed in the Tranſactions of the Mancheſter Society.

From this extraordinary vivacity and accuracy of external ſenſation, and from the aſſiduous and vigorous applications of a comprehenſive and attentive mind alone, we are able to account for the rapid and aſtoniſhing progreſs which ſome of them have made, not only in thoſe departments of literature which were moſt obvious to their ſenſes and acceſſible to their underſtandings, but even in the moſt abſtract, and (if we may be allowed the expreſſion) in the moſt occult ſciences. What, for inſtance, can be more remote from the conceptions of a blind man than the abſtract relations and properties of ſpace and quantity? yet the incomprehenſible attainments of Dr. Saunderſon in all the branches of mathematics are now fully known and firmly believed by the whole literary world, both from the teſtimony of his pupils and the publication of his works. But ſhould the fact be ſtill uncertain, it might be ſufficiently verified by a living prodigy of this kind with which our country is at preſent honoured. The gentleman of whom we now ſpeak, though blind from his infancy, by the ardour and aſſiduity of his application, and by the force of a genius to which nothing is impenetrable, has not only made incredible advances in mechanical operations, in muſic, and in the languages; but is likewiſe profoundly ſkilled in geometry, in optics, in algebra, in aſtronomy, in chymiſtry, and in all the other branches of natural philoſophy, as taught by Newton, and received by an admiring world. We are ſorry that neither the modeſty of this amiable philoſopher, nor the limits of this article, will permit us to delineate his character in its full proportions. All we can do is to exhibit his example, that by it the vulgar prejudice, which preſumes to think blindneſs and learning incompatible, may be diſſipated; and that an inſtance of ſucceſs ſo noble and recent may inflame the emulation and encourage the efforts of ſuch as have genius and opportunity to purſue the ſame laudable path.

As particular anecdotes of this aſtoniſhing genius have been, ſince the former edition of the Encyclopædia, delivered to the Mancheſter Society by G. Bew, M. D. and afterwards publiſhed, we ſhall here take the liberty to tranſcribe them from the original volume in which they are inſerted. "Dr. Henry Moyes, who occaſionally read Lectures on Philoſophical Chymiſtry at Mancheſter, like Dr. Saunderſon, the celebrated profeſſor of Cambridge, loſt his ſight by the ſmall-pox in his early infancy. He never recollected to have ſeen: 'but the firſt traces of memory I have (ſays he), are in ſome confuſed ideas of the ſolar ſyſtem.' He had the good fortune to be born in a country where learning of every kind is highly cultivated, and to be brought up in a family devoted to learning. Poſſeſſed of native genius, and ardent in his application, he made rapid advances in various departments of erudition; and not only acquired the fundamental principles of mechanics, muſic, and the languages, but likewiſe entered deeply into the inveſtigation of the profounder ſciences, and diſplayed an acute and general knowledge of geometry, optics, algebra, aſtronomy, chymiſtry, and in ſhort of moſt of the branches of the Newtonian philoſophy. Mechanical exerciſes were the favourite employments of his infant years. At a very early age he made himſelf acquainted with the uſe of edge tools ſo perfectly, that notwithſtanding his entire blindneſs, he was able to make little windmills; and he even conſtructed a loom with his own hands, which ſtill ſhew the cicatrices of wounds he received in the execution of theſe juvenile exploits. By a

moſt

moſt agreeable intimacy and frequent intercourſe which I enjoyed with this accompliſhed blind gentleman, whilſt he reſided in Manchester, I had an opportunity of repeatedly obſerving the peculiar manner in which he arranged his ideas and acquired his information. Whenever he was introduced into company, I remarked that he continued ſome time ſilent. The ſound directed him to judge of the dimenſions of the room, and the different voices of the number of perſons that were preſent. His diſtinction in theſe reſpects was very accurate; and his memory ſo retentive, that he ſeldom was miſtaken. I have known him inſtantly recognize a perſon, on firſt hearing him ſpeak, though more than two years had elapſed ſince the time of their laſt meeting. He determined pretty nearly the ſtature of thoſe he was ſpeaking with by the direction of their voices; and he made tolerable conjectures reſpecting their tempers and diſpoſitions, by the manner in which they conducted their converſation. It muſt be obſerved, that this gentleman's eyes were not totally inſenſible to intenſe light. The rays refracted through a priſm, when ſufficiently vivid, produced certain diſtinguiſhable effects on them. The red gave him a diſagreeable ſenſation, which he compared to the touch of a ſaw. As the colours declined in violence, the harſhneſs leſſened, until the green afforded a ſenſation that was highly pleaſing to him, and which he deſcribed as conveying an idea ſimilar to what he felt in running his hand over ſmooth poliſhed ſurfaces. Poliſhed ſurfaces, meandering ſtreams, and gentle declivities, were the figures by which he expreſſed his ideas of beauty: Rugged rocks, irregular points, and boiſterous elements, furniſhed him with expreſſions for terror and diſguſt. He excelled in the charms of converſation; was happy in his alluſions to viſual objects; and diſcourſed on the nature, compoſition, and beauty of colours, with pertinence and preciſion. "Dr. Moyes was a ſtriking inſtance of the power the human ſoul poſſeſſes of finding reſources of ſatisfaction, even under the moſt rigorous calamities. Though involved 'in ever during darkneſs,' and excluded from the charming views of ſilent or animated nature; though dependent on an undertaking for the means of his ſubſiſtence, the ſucceſs of which was very precarious; in ſhort, though deſtitute of other ſupport than his genius, and under the mercenary protection of a perſon whoſe integrity he ſuſpected, ſtill Dr. Moyes was generally cheerful, and apparently happy. Indeed it muſt afford much pleaſure to the feeling heart to obſerve this hilarity of temper prevail almoſt univerſally with the blind. Though "cut off from the ways of men, and the contemplation of the human face divine, they have this conſolation; they are exempt from the diſcernment and contagious influence of thoſe painful emotions of the ſoul that are viſible on the countenance, and which hypocriſy itſelf can ſcarcely conceal. This diſpoſition likewiſe may be conſidered as an internal evidence of the native worth of the human mind, that thus ſupports its dignity and cheerfulneſs under one of the ſevereſt misfortunes that can poſſibly befal us."

If theſe glorious attempts ſhould neither be perceived nor rewarded by an unfeeling world, if human nature ſhould forget to recognize its own excellence ſo nobly diſplayed in inſtances of this kind; yet beſides the enjoyments reſulting from a ſublime and comprehenſive underſtanding, beſides the immortal and inexhauſtible ſources of delight which are the peculiar portion of a ſelf approving mind, theſe happy pupils and favourites of Nature are as it were indulged with her perſonal intercourſe. They become more intimately acquainted with her laws, till by exploring the beneficence of her œconomy, the ſublimity of her ends, the regularity of her procedure, and the beauties of her frame, they imbibe the ſpirit, and feel the preſence, of her glorious Author:

> By ſwift degrees the love of nature works,
> And warms the boſom; till at laſt ſublim'd
> To rapture and enthuſiaſtic heat,
> We feel the preſent deity, and taſte
> The joys of God to ſee a happy world.—THOMSON.

Much labour has been beſtowed to inveſtigate, both from reaſon *a priori* and from experiment, what might be the primary effects of light and luminous objects upon ſuch as have been born blind, or early deprived of ſight, if at a maturer period they ſhould inſtantaneouſly recover their viſual powers. But upon this topic there is much reaſon to fear, that nothing ſatisfactory has yet been ſaid. It is far from being certain, that trials of this kind have ever been fairly made. Such readers as may wiſh to ſee a more minute detail of theſe queſtions, may conſult M. Diderot's Lettre *ſur les aveugles, a l'uſage de ceux qui voyent:* "A letter concerning the blind for the uſe of thoſe who ſee." To theſe may be added, Mr. Cheſelden's Anatomy, and Locke's Eſſay on the human underſtanding.

When we ruminate on the numberleſs advantages derived from the uſe of ſight, and its immenſe importance, in extending the human capacity, or in improving and cultivating every faculty and every function of the mind, we might be ſtrongly tempted to doubt the fidelity of thoſe reports which we have heard concerning ſuch perſons as, without the aſſiſtance of light, have arrived at high degrees of eminence even in thoſe ſciences which appear abſolutely unattainable but by the interpoſition of external mediums. It has, however, been demonſtrated by a late ingenious author, that *blind* men, by proper inſtruction, are ſuſceptible almoſt of every idea, and of every truth which can be impreſſed on the mind by the mediation of light and colours, except the ſenſations of light and colours themſelves. It is poſſible for the blind, by a retentive memory, to tell you, That the ſky is an azure: that the ſun, moon, and ſtars, are bright; that the roſe is red, the lily white or yellow, and the tulip variegated. By continually hearing theſe ſubſtantives and adjectives joined, he may be mechanically taught to join them in the ſame manner: but as he never had any ſenſation of colour, however accurately he may ſpeak of coloured objects, his language muſt be like that of a parrot; without meaning, or without ideas. Homer, Milton, and Oſſian, had been long acquainted with the viſible world before they were ſurrounded with clouds and ever-during darkneſs. They might, therefore, ſtill retain the warm and pleaſing impreſſions of what they had ſeen. Their deſcriptions might be animated with all the rapture and enthuſiaſm which originally fired their boſoms when the grand or delightful objects which they delineated were immediately beheld. Nay, that enthuſiaſm might ſtill be heightened by a bitter ſenſe of their loſs, and by that regret which a ſituation ſo diſmal might naturally inſpire. But how ſhall we account for the ſame energy, the ſame tranſport of deſcription, exhibited by thoſe on whoſe minds viſible objects were either never impreſſed, or have been entirely obliterated. Yet, however unaccountable this fact may appear, it is no leſs certain than extraordinary. But delicacy and other particular circumſtances forbid us to enter into this diſquiſition with that minuteneſs and preciſion which it requires. We only mention the fact as one amongſt the few reſources for entertainment, and avenues to reputation, which are ſtill reſerved for the *blind*. Whoever thinks the ſubject of ſufficient conſequence to merit a nicer ſcrutiny, may conſult the Preface to Blacklock's Poems, written by G. G. Eſq. and printed at Edinburgh 1754; or the account of his life and writings by the Rev. Mr. Spence, prefixed to a quarto edition of his poems publiſhed at London in 1756. Blacklock will appear to poſterity a fabulous character: even now he is a prodigy. It will be thought a fiction and a paradox, that a man quite blind ſince he was three years old, beſides having made himſelf ſo good a maſter of various languages, of Greek, Latin, Italian, and French, ſhould alſo be a great poet in his own; and without hardly ever having ſeen the light, ſhould be ſo remarkably happy in deſcription.

There is perhaps no rank of beings in the ſenſible univerſe, who have ſuffered from nature or accident, more meritorious of public compaſſion, or better qualified to repay its generous exertions, than the blind. They are meritorious of compaſſion; for their ſphere of action and obſervation is infinitely more limited than that of the deaf, the lame, or of thoſe who labour under any other corporeal infirmity conſiſtent with health. They are better qualified to repay any friendly interpoſition for their happineſs; becauſe free from the diſtraction which attends that multiplicity of objects and purſuits that are continually obvious to the ſight, they are more attentive to their own internal œconomy, to the particular notices of good and evil impreſſed on their hearts, and to that peculiar province in which they are circumſcribed by the nature and cultivation of their powers.

It will eaſily occur to the reader, that, if the pupil ſhould not be placed in eaſy circumſtances, muſic is his readieſt and moſt probable reſource. Civil and eccleſiaſtical employments have either ſomething in their own nature, or in the invincible prejudices of mankind, which renders them almoſt entirely inacceſſible to thoſe who have loſt the uſe of ſight. No liberal and cultivated mind can entertain the leaſt heſitation in concluding, that there is nothing, either in the nature of things, or even in the poſitive inſtitutions of genuine religion, repugnant to the idea of a blind clergyman. But the novelty of the phenomenon, while it aſtoniſhes vulgar and contracted underſtandings, inflames their zeal to rage and madneſs. Beſides, the adventitious trappings and ceremonies aſſumed by ſome churches as the drapery of religion, would, according to theſe ſyſtems, render the ſacerdotal office painful, if not impracticable, to the blind. Dr. Nicholas Bacon, deſcended from the ſame family with the celebrated lord Verulam, was with high approbation created doctor of laws, in the city of Bruſſels. He was deprived of ſight at nine years of age by an arrow from a croſs-bow whilſt he was attempting to ſhoot it. When he had recovered his health, which had ſuffered by the ſhock, he purſued the ſame plan of education in which he had been engaged: and having heard that one Nicaſius de Vourde, born blind, who lived towards the end of the 15th century, after having diſtinguiſhed himſelf by his ſtudies in the univerſity of Lovain, took his degree as doctor of divinity in the univerſity of Cologne; this motive prevailed with him to make the ſame attempt. But the public, curſed with prejudices for which the meaneſt ſenſitive nature might bluſh, prejudices equally beneath the brutality and ignorance of the loweſt animal-inſtinct, treated his intention with ridicule: even the profeſſors

feſſors were not far from being of that ſentiment; and they admitted him into their ſchools, rather from an impreſſion that it might amuſe him, than become of any uſe to him. He had the good fortune, however, contrary to their expectations, to obtain the firſt places among his condiſciples. It was then ſaid, that ſuch rapid advances might be made in the preliminary branches of his education; but would ſoon be effectually checked by ſtudies of a more profound and abſtracted nature. This, it ſeems, was repeated from ſchool to ſchool, through the whole climax of his purſuits; and when, in the courſe of academical learning, it became neceſſary to ſtudy poetry, it was the general voice that all was over, and that at length he had reached his *ne plus ultra*. But here he likewiſe confronted their preconceſſions, and taught them the immenſe difference between blindneſs of body and blindneſs of ſoul. After continuing his ſtudies in learning and philoſophy for two years more, he applied himſelf to law, took his degree in that ſcience, commenced pleading counſellor or advocate in the council of Brabant, and has had the pleaſure of terminating almoſt every ſuit in which he has been engaged to the ſatisfaction of his clients. Had it not been for a fact ſo ſtriking and ſo well authenticated, though there could have been no doubt that a blind man might diſcharge the office of a chamber-counſel with ſucceſs; yet, as a barriſter, his difficulties muſt have appeared more formidable, if not abſolutely inſuperable. For he ſhould remember all the ſources, whether in natural equity or poſitive inſtitutions, whether in common or ſtatutory law, from whence his argument ought to be drawn. He muſt be able to ſpecify, and to arrange in their proper order, all the material objections of his antagoniſts: theſe he muſt likewiſe anſwer as they were propoſed, *extempore*.

When, therefore, it is conſidered how difficult it is to temper the natural aſſociations of memory with the artificial arrangements of judgment, the deſultory flights of imagination with the calm and regular deductions of reaſon, the energy and perturbation of paſſions with the coolneſs and tranquillity of deliberation; ſome idea may be formed of the arduous taſk which every blind man muſt achieve, who undertakes to purſue the law as a profeſſion. Perhaps aſſiſtances might be drawn from Cicero's treatiſe on Topics and on Invention; which if happily applied and improved, might leſſen the diſparity of a blind man to others, but could ſcarcely place him on an equal footing with his brethren. And it ought to be fixed as an inviolable maxim, that no blind man ought ever to engage in any province in which it is not in his power to excel. This may at firſt ſight appear paradoxical; but it is eaſily explained. For the conſciouſneſs of the obvious advantages poſſeſſed by others, habitually prediſpoſes a blind man to deſpondency: and if he ever gives way to deſpair, adieu, for ever adieu, to all proficiency. In this recapitulation of the learned profeſſions, we have intentionally omitted phyſic; becauſe the obſtacles which a blind man muſt encounter, whether in the theory or practice of that art, will be more eaſily conceived by our readers than deſcribed in detail.

The moſt important view which we can entertain in the education of a perſon deprived of ſight, is to redreſs as effectually as poſſible the natural diſadvantages with which he is encumbered; or, in other words, to enlarge as far as poſſible the ſphere of his knowledge and activity. This can only be done by the improvement of his intellectual, imaginative, or mechanical, powers; and which of theſe ought to be moſt aſſiduouſly cultivated, the genius of every individual alone can determine. Were men to judge of things by their intrinſic natures, leſs would be expected from the blind than others. But by ſome pernicious and unaccountable prejudice, people generally hope to find them either poſſeſſed of preternatural talents, or more attentive to thoſe which they have than others: For it was not Rocheſter's opinion alone,

> That if one ſenſe ſhould be ſuppreſs'd,
> It but retires into the reſt.

From the original drawing, therefore, of reaſon and ſpirit, the parents and tutors of the blind ought to inculcate this maxim, That it is their indiſpenſible duty to excel, and that it is abſolutely in their power to attain a high degree of eminence. To impreſs this notion on their minds, the firſt objects preſented to their obſervation, and the firſt methods of improvement applied to their underſtanding, ought, with no great difficulty, to be comprehenſible by thoſe internal powers and external ſenſes which they poſſeſs. Not that improvement ſhould be rendered quite eaſy to them, if ſuch a plan were poſſible: For all difficulties, which are not really or apparently inſuperable, heighten the charms and enhance the value of thoſe acquiſitions which they ſeem to retard. But care ſhould be taken that theſe difficulties be not magnified or exaggerated by imagination; for it has before been mentioned, that the blind have a painful ſenſe of their own incapacity, and conſequently a ſtrong propenſity to deſpair continually awake in their minds.

There are few ſciences in which the blind have not diſtinguiſhed themſelves: even thoſe whoſe acquiſition ſeemed eſſentially to depend upon viſion, have at laſt yielded to genius and induſtry, though deprived of that advantage. Mr. Sanderſon, has left behind him the moſt ſtriking evidences of aſtoniſhing proficiency in thoſe retired and abſtract branches of mathematics which appeared leaſt acceſſible to perſons of his infirmity. For Sanderſon's method of calculation, both in arithmetic and algebra, ſee the account prefixed to his own treatiſe on that ſubject.

Sculpture and painting are not, perhaps, the moſt practicable arts for a blind man; yet he is not excluded from the pleaſing creation and extenſive regions of fancy. However unaccountable it may appear to the abſtract philoſopher, yet nothing is more certain in fact, than that a blind man may, by the inſpiration of the muſes, or, to ſtrip the figure of its mythological dreſs, may, by the efforts of a cultivated genius, exhibit in poetry the moſt natural images and animated deſcriptions, even of viſible objects, without either incurring or deſerving the imputation of plagiariſm. In the ſiſter art of muſic, there are, at preſent, living and noble inſtances how far the blind may proceed. If we look into former periods, we ſhall find illuſtrious and pregnant examples, how amply nature has capacitated the blind to excel both in the ſcientific and practical departments of muſic. In the 16th century, when the progreſs of improvement both in melody and harmony was rapid and conſpicuous, Franciſcus Salinas was eminently diſtinguiſhed. He was born A. D. 1513, at Burgos in Spain; and was ſon to the treaſurer of that city. Though afflicted with incurable blindneſs, he was profoundly ſkilled both in the theory and practice of muſic. As a performer, he is celebrated by his cotemporaries with the higheſt encomiums. As a theoriſt, his book, if we may believe Sir John Hawkins, is equal in value to any now extant in any language. Though he was deprived of ſight in his earlieſt infancy, he does not content himſelf to delineate the various phenomena in muſic, but the principles from whence they reſult, the relations of ſound, the nature of arithmetic, geometrical, and harmonical ratios, which at that period were eſteemed eſſential to the theory of muſic, with a degree of intelligence which would have deſerved admiration though he had been in full poſſeſſion of every ſenſe requiſite for theſe diſquiſitions.

In the ſame period flouriſhed Caſpar Crumbhorn, blind from the third year of his age: yet he compoſed ſeveral pieces in many parts with ſo much ſucceſs, and performed both upon the flute and violin ſo exquiſitely, that he was diſtinguiſhed by Auguſtus elector of Saxony. But preferring his native Sileſia to every other country, he returned thither, and was appointed organiſt of the church of St. Peter and Paul in the city of Lignitz, where he likewiſe had often the direction of the muſical college, and died June 11th, 1621.

To theſe might be added Martini Peſenti, of Venice, a compoſer of vocal and inſtrumental muſic almoſt of all kinds, though blind from his nativity; with other examples equally worthy of the public attention. But if vulgar prejudice is capable of bluſhing at its own contemptible character, or of yielding to conviction, thoſe already quoted are more than ſufficient to ſhew the muſical jugglers of our time, who are generally as abſolute ſtrangers to learning and taſte as to virtue, that their art is no monopoly with which thoſe alone who ſee are inveſted by the irreverſible decree of heaven.

A work publiſhed at Paris, a little prior to the revolution, ſuperſedes every former attempt to promote or facilitate the improvement of the blind. The invention of a plan ſo arduous in its appearance and ſo practicable in its execution, demanded the higheſt exertions of the nobleſt genius to produce it, and the moſt ſtrenuous efforts of indefatigable humanity to render it effectual. It is intitled, "An Eſſay on the Education of the Blind." Its object is to teach them, by palpable characters impreſſed on paper, not only the liberal arts and ſciences, but likewiſe the principles of mechanical operation, in ſuch a manner, that thoſe who have no genius for literary improvement may yet become reſpectable, uſeful, and independent members of ſociety, in the capacity of common artiſans. By theſe tangible ſignatures they are taught to read, to write, and to print; they are likewiſe inſtructed in geometry, in algebra, in geography, and, in ſhort, in every branch of natural philoſophy. Nor are their efforts circumſcribed by mere utility: a taſte for the fine arts has likewiſe been cultivated among them. They have been taught to read muſic with their fingers as others do with their eyes; and though they cannot at once feel the notes and perform them upon an inſtrument, yet are they capable of acquiring any leſſon with as much exactneſs and rapidity as thoſe who enjoy all the advantages of light. But we ſhall give a more particular account of the wonderful topics contained in this eſſay. In his firſt chapter the author diſcovers the end propoſed by that delineation of culture which he offers to the blind; it is to enlarge their ſphere of knowledge, and of conſequence to increaſe their capacities and improve their powers of action, ſo that they may become happy and independent in themſelves, and uſeful and agreeable to others. The 2d chapter contains an anſwer to the objections urged againſt the general utility of this inſtitution. Theſe objections are candidly ſtated, and anſwered in the moſt ſatisfactory manner; but were we to recapitulate them in detail, it would protract this article to a length much beyond its due proportion, even upon the extended plan of the many additional

ſheets introduced in this edition of the work. The 3d chapter treats of reading as adapted to the practice of the blind. The 4th chapter conſiſts of anſwers to various objections againſt the method of reading propoſed for the blind; but theſe, for reaſons formerly given, we cannot with propriety delineate in this article. In the 5th chapter is ſhewn the art of printing as practiſed by the blind for their peculiar uſe. In the 6th chapter is deſcribed the manner of teaching the blind the art of printing for thoſe that ſee. In the 7th is repreſented the manner of teaching the blind to write. The 8th chapter explains the method of teaching the blind arithmetic; the 9th geography; the 10th muſic. The 11th, contains an account of the mechanic arts in which the blind are employed, and of the way by which they are formed for ſuch occupations. The 12th ſhews in general the proper manner of inſtructing the blind, and draws a parallel between their education and that of the deaf and dumb. Chapter 13th treats of the method of inſtructing them in languages, mathematics, hiſtory, &c. What remains of the book is taken up with notes which illuſtrate each particular chapter; a ſhort hiſtorical account of the riſe, the progreſs, and the preſent ſtate, of the academy for the formation of the blind; an ode on the cultivation of the blind, by one that laboured under that affliction; an extract from the regiſter of the royal academy of ſciences; opinion of the printers; models of the various pieces which blind children are capable of printing; and an account of the exerciſes performed by blind children in preſence of the king, queen, and royal family, during the Chriſtmas ſolemnities 1786. If this account ſhould appear incredible to any of our readers, let him be informed, that the author of this article has converſed with two gentlemen of learning and veracity, who ſaw the blind perform all the wonders here recapitulated with aſtoniſhing ſucceſs, to the univerſal ſatisfaction of numberleſs ſpectators whom curioſity and compaſſion impelled to viſit the academy, that they might behold with their own eyes a ſpectacle ſo intereſting to humanity. Let the incredulous be alſo informed, that the compoſer of the article has in his own hands a copy of this work now reviewed, which is printed and bound by the blind themſelves. They uſed before the revolution to exhibit at their own academy every Wedneſday and Saturday between one and two o'clock at noon, to crowds of charitable admirers, by whoſe liberal donations the inſtitution was chiefly ſupported.

The knowledge of aſtronomy might likewiſe be of infinite uſe, both by enlarging the blind perſon's ideas of the univerſe, and by giving him higher and more confirmed impreſſions of that energy by which the ſtars are moved, and of that deſign by which their motions are regulated. But theſe objects are too vaſt; their diſtances, their magnitudes, their periods of revolution, are too complex to be comprehended in the mind, or impreſſed in the memory, without ſenſible mediums. For this purpoſe, an orrery, or ſome machine of a ſimilar conſtruction, will be indiſpenſibly requiſite.

The ſcience of cauſes and effects might likewiſe yield him the moſt ſublime and rational entertainment of which an intelligent being, in his preſent ſtate, is ſuſceptible. By this he might enter into the laws, the viciſſitudes, the œconomy, of nature. Nor is it abſolutely neceſſary that he ſhould be an ocular witneſs of the experiments by which theſe laws are detected and explained. He may ſafely take them for granted; and if, at any time, a particular experiment ſhould prove faithleſs, he may, from general principles, be able to diſcover its fallacy, whether in the nature of the ſubject, the inaptitude of the inſtruments, or the proceſs of the execution. The laws of motion, the various ratios or proportions of forces whether ſimple or compound, he may calculate and aſcertain by the ſame means and in the ſame method ſo happily uſed by Sanderſon.

Moral and theological knowledge he may eaſily obtain, either from books, or inſtructions delivered *viva voce*. The laſt, if communicated by one that underſtands and feels the ſubject, with a proper degree of perſpicuity and ſenſibility, are infinitely the moſt eligible. By morals, we would not merely be underſtood to mean a regular and inculpable ſeries of action, but the proper exertion and habitual arrangement of the whole internal œconomy, of which external actions are no more than mere expreſſions, and from which the higheſt and moſt permanent happineſs alone can proceed. By theology, we do not mean that ſyſtematic or ſcholaſtic jargon, which too frequently uſurps its venerable name; but thoſe ſublime and liberal ideas of the nature and government of a Supreme Being, whether diſcoverable by nature or revealed in Scripture, which enforce every moral obligation, which teach us what is the ultimate good of our nature, which determine our efforts and animate our hopes in purſuing this moſt important of all objects. What Cicero ſays of the arts and ſciences may with great propriety be applied to religion: *Nam cætera neque temporum ſunt, neque ætatum omnium, neque locorum; et hæc ſtudia adoleſcentiam alunt, ſenectutem oblectant, ſecundas res ornant, adverſis perfugium ac ſolatium præbent: delectant domi, non impediunt foris; pernoctant nobiſcum, perigrinantur, ruſticantur.* Tranſlated thus: 'For other ſtudies are not ſuited to every time, to every 'age, and to every place: but theſe give ſtrength in youth, 'and joy in old age: adorn proſperity, and are the ſupport and 'conſolation of adverſity; at home they are delightful, and 'abroad they are eaſy; at night they are company to us; when 'we travel, they attend us; and in our rural retirements, they 'do not forſake us.'

To this may be added, that the joys of religion are for ever adequate to the largeſt capacity of a finite and progreſſive intelligence; and as they are boundleſs in extent, ſo they are endleſs in duration. We have already, more than once, obſerved, that the ſoul of a blind man is extremely obnoxious to melancholy and dejection. Where, therefore, can he find a more copious, intimate, permanent, and efficacious ſource of comfort than in religion? Let this then be inculcated with the utmoſt care and aſſiduity. Let the whole force of the ſoul be exerted in ſhowing him that it is reaſonable. Let all the nobleſt affections of the heart be employed in recommending it as amiable; for we will venture to aſſert, that the votary of religion alone is the man,—

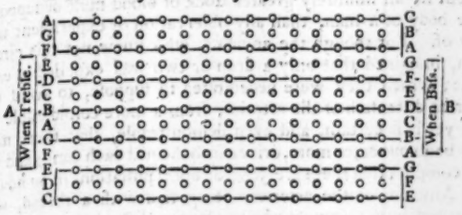
Whom, though with nature's wreck oppreſs'd,
Unmanly fears could ne'er inſeſt.

When the ſituation of the blind, and its natural effects upon their characters, are conſidered; when we reflect how exquiſite their diſtreſſes, how pungent their diſappointments, how ſenſible their regrets, how tedious and gloomy their periods of ſolitude; we muſt be wretches indeed, if we can grudge either labour or expence in procuring them every ſource of entertainment, which, when procured, remains in their own power, and yields what may be in ſome meaſure termed ſelf-derived enjoyment. Theſe amuſements are prolific of numberleſs advantages: they afford us at once entertainment and exertion; they teach us to explore a thouſand reſources for preſervation and improvement, which would otherwiſe have eſcaped our attention; they render us awake and ſenſible to a thouſand notices both of external and intellectual objects, which would otherwiſe have paſſed unobſerved.

If the blind muſt depend upon the exerciſe of their own powers for bread, we have already pointed out muſic as their eaſieſt and moſt obvious province; but let it at the ſame time be remembered, that mediocrity in this art may prove the bittereſt and moſt effectual curſe which a parent can inflict upon his offſpring, as it ſubjects them to every vicious impreſſion or habit which may be imbibed or contracted from the loweſt and moſt abandoned of mankind. If your pupil, therefore, be not endowed with natural talents exquiſitely proper both for the theory and practice of this art, ſuffer him by no means to be initiated in it. If his natural genius favours your attempts, the ſpinet, harp, or organ, are the moſt proper inſtruments for him to begin; becauſe by theſe inſtruments he may be made more eaſily acquainted with the extent of muſical ſcales, with the powers of harmony, with the relations of which it is conſtituted, and of courſe with the theory of his art. It would be not only unneceſſary, but impracticable, to carry him deep into the theory, before he has attained ſome facility in the practice. Let, therefore, his head and his hands (if we may uſe the expreſſion), be taught to go *pari paſſu*. Let the one be inſtructed in the ſimpleſt elements, and the other conducted in the eaſieſt operations, firſt: contemplation and exerciſe will produce light in the one and promptitude in the other. But as his capacity of ſpeculation and powers of action become more and more mature, diſcoveries more abſtract and retired, taſks more arduous and difficult, may be aſſigned him. He ſhould be taught the names and gradations of the diatonic ſcale, the nature and uſe of time, the diverſity of its modes whether ſimple or mixed. He ſhould be taught the quantity or value of notes, not only with reſpect to their pitch, but to their duration. Yet, let him be inſtructed not to conſider theſe durations as abſolutely fixed, but variable according to the velocity of the movements in which they are placed. Thus we reckon a ſemibreve equal to 4 vibrations of a pendulum: a minim to 2; a crotchet to 1, &c. But if the number of aliquot parts, into which a ſemibreve is divided, be great, and conſequently the value of each particular part, ſmall, the minim, crotchet, quaver, &c. will increaſe in their intrinſic durations, though they muſt always preſerve the ſame proportions relatively one to another. He ſhould never be habituated to take a piece of muſic, either from the ſound of a voice or an inſtrument. His companion ought to read the muſic by the names and values of its characters, with the ſame exactneſs as the words in any other language. When he becomes a conſiderable adept in the art, tangible ſigns may be invented, by which he may not only be enabled to read, but even to ſet, muſic for himſelf. Such exerciſes will render him infinitely more accurate, both in his principles and practice, than he would otherwiſe be. There is a hint of ſuch tangible ſigns given in Tanſure's muſical grammar, p. 93. and which, though (like the reſt of the book) obſcure and indigeſted, may be improved and applied with advantage. For the ſake of thoſe in whoſe hands it may not be, we quote the paſſage at length. "As it is the pleaſure of the Almighty, that ſome perſons are deſtitute of *eyeſight*; in like manner it is his infinite goodneſs to make them a double amends another way, by giving them a greater ſhare of memory, &c. whereby they become very dexterous in playing

playing on muſical inſtruments, mathematics, &c. as we may obſerve by Dr. Stanley, organiſt of St. Andrew's Holborn, in London, the blind profeſſor of mathematics in the univerſity of Cambridge, and many others too tedious here to mention, who were born *blind*, and never ſaw the leaſt glance of light: yet God gave them ſuch a light in *knowledge*, that they became the wonder of all ſuch as had the benefit of ſeeing, &c. And as *blind perſons*, at firſt, cannot poſſibly have ſo clear an idea of *notes* and *muſical characters* as they that ſee them, until they are taught by a maſter or tutor; I have (for the good-will I bear to ſuch unfortunate perſons) contrived the following table; that, by *feeling*, they may underſtand notes, and learn any tune that ſhall be ſet them, in their maſter's abſence.

A New Muſical Table for ſuch as are Blind.



EXPLANATION.

« Let A—B be a ſmooth board, 3 or 4 feet long, 1 inch thick, and 9 inches wide, with 5 ſquare ledges glued thereon, each being half an inch aſunder, half an inch wide, and half an inch high, which riſing ledges repreſent our 5 lines of muſic, and their ſpaces: and the two outward lines, being made a little lower, may ſerve as leger lines, on occaſion. The cyphers repreſent ſo many holes bored into every line and ſpace, half an inch aſunder; wherein pegs of different ſhapes are to be ſet, to repreſent the ſeveral ſorts of notes and characters of the tune: which pegs the blind perſon may know by feeling, as well as he does his keys of the organ or harpſichord: ſo that, by keeping his fingers on the 5 lines, he feels the ſeveral pegs as they come on, and are ſet to repreſent the ſeveral ſorts of notes, on both line and ſpace; whilſt his right hand ſtrikes the reſpective key, &c. he firſt knowing the names of all his keys, his lines, ſpaces, and the mark of every peg. Let each peg be about half an inch high, when ſet in very faſt. [N. B. The blind perſon muſt firſt be taught the names of the above lines and ſpaces in both the treble and baſs cliffs; and that he muſt feel his treble with his right hand, and his baſs with the left hand; each being contrary, as you may ſee by the letters of the above table, A and B; and muſt learn each part ſeparate.] Of pegs, he muſt have a great number of every ſort, to ſet his tune with, which he may mark as follows:

For a *Semibreve*, 4 top-notches.
Minim, 2 top-notches.
Crotchet, 1 top-notch.
Quaver, one corner cut off.
Semiquaver, 2 corners cut off.
Demiſemiquaver, all 4 corners cut off.
Reſts, a notch in the corner.
A Flat, 1 notch on the ſide.
Sharp, 2 notches on the ſide.
Point, 3 notches on the ſide.
Bar, a flat thin top.
Repeat, a ſharp pointed top, &c. &c. &c.

« But it is beſt for every performer to make and mark his own pegs; and deliver them one by one as they are called for by the perſon that ſets his *tune*."

Thus far our author. But it appears to us, that Tanſure's Muſical Notation is imperfect; and perhaps every table or inſtrument of the ſame kind may be liable to the ſame cenſure, as not being comprehenſive of all the characters in the written language of muſic, ſo that the blind reader may find no deficiency in acquiring any leſſon: the cuſhion of Mr. Cheeſe appears to have more powers than Tanſure's inſtrument; but as this alſo is attended with many powerful objections, we ſhall not deſcribe it. It may, poſſibly, however, be beſt for every blind adept in the muſical art, after being ſufficiently inſtructed in its theoretical and practical principles, to invent for himſelf a table, by which may be expreſſed all the various phenomena of muſic, in which, by varying the forms and poſitions of his pegs, he may habitually aſſociate them with ſounds, durations, reſts, intervals, chords, cadences, da capos, repeats, and all the various graces which give animation and expreſſion to muſical ſounds: for thus, being the immediate creatures of his own imagination, they will more eaſily become familiar to his memory, and be more ſtrongly and readily aſſociated with the phenomena which they are intended to ſignify, than if he had aſſumed the inventions of any other.

It is certain, that when playing concertos, or, if you pleaſe, when performing in *ſcore*, the blind muſt depend upon memory, and upon memory alone: but happily their retentive powers are remarkably ſtrong; and there are few pieces in muſic which will be found either too intricate to be acquired, or too long to be remembered, by a perſon deprived of ſight. Mr. Stanley, the gentleman formerly mentioned by Tanſure, performs what is ſtill more aſtoniſhing. If our information, which we cannot doubt, be true, he accompanies any leſſon with a thorough baſs, though he never has heard it before. We have never yet heard of any perſon, though bleſſed with the full uſe of ſight, and with all the advantages accruing from it, who could thus anticipate harmony before the chords were ſounded, and accompany it in a manner ſuitable to its nature. When he becomes a more profound theoriſt, if he has adopted the notion that muſic and geometry are congenial and inſeparable (which, however, in our judgment is frivolous), he may peruſe Malcom's Eſſay on Muſic, and Treydell's Theory and Practice of Muſic. But if he chooſes to hear the ſame principles delivered without that unneceſſary parade and oſtentation of profundity, let him be inſtructed by D'Alembert; by Rameau, in his Principles of Compoſition; and by Rouſſeau's Muſical Dictionary. It is true, that the forms and proportions of inſtruments, the thickneſs, length, and tenſion of muſical ſtrings, may be mathematically adjuſted; their relations one to another may be determined by the coincidence of their vibrations, or by the number and velocity of theſe vibrations when diſſonant; but experience and a good ear are amply ſufficient for theſe purpoſes. Yet, if the neceſſity of geometry in muſic ſhould ſtill remain an indelible article in his creed, he may peruſe Dr. Smith's Philoſophical Principles of Harmony. There has alſo lately been publiſhed, an explication of Tartini's theory, intitled, *The Principles and Power of Harmony*; which, after he has made conſiderable progreſs, may be read to him with ſenſible improvement.

It now remains to demand an anſwer from ſociety, Whether it is more humane and eligible, that ſuch unhappy perſons ſhould be ſuffered to languiſh out their lives in torpid and miſerable obſcurity, wretched in themſelves and burdenſome to others; or to cultivate and improve their powers in ſuch a manner, as that they may be qualified for internal enjoyment and public utility? Surely there is not a human being, who does not diſgrace the works of God, that can be at any loſs in anſwering this queſtion. Have we not then a right to call the world to an account? have we not a right to demand, why rational beings, ſuſceptible of felicity in themſelves, and capable of transfuſing happineſs through the ſocieties with whom they are connected, ſhould be abandoned to a ſtate of inſignificance and miſery? Is it poſſible that men who are every moment ſubjected to the ſame contingencies with which they behold their fellow-creatures afflicted, ſhould not with all their ſouls endeavour to alleviate the misfortunes of their ſuffering brethren? Is the native and hereditary portion of human woe to light and ſupportable in itſelf, that we ſhould neglect and deſpiſe thoſe to whom it is embittered by accidental circumſtances of horror and diſtreſs? You who are parents, who feel the ſtrong and powerful pleadings of nature, do not, by a brutal negligence and inſenſibility, render the exiſtence which you have given a curſe to its poſſeſſors. Do not give them reaſon to upbraid your memory; and to anſwer thoſe who aſk what patrimony you have left them, that their ſole inheritance was ignorance, incapacity, and indigence. You men of wealth and eminence, you whom Providence has rendered conſpicuous on the theatre of nature, to whom it has given the nobleſt opportunities of participating the divine beatitude by the exerciſe of univerſal benevolence and genuine patriotiſm: yours is the glorious province of bringing neglected merit from obſcurity, or healing the wounds inflicted by adverſe fortune, and of cultivating thoſe talents which may be exerted for your own advantage, and the honour of your ſpecies. Thus you ſhall riſe in the heraldry of heaven, and your names diffuſe luſtre through the extent of ſpace and the archives of eternity. Otherwiſe the temporary glare and parade of your ſituation can produce nothing elſe but a deſpicable mimicry of real and intrinſic greatneſs, and are no more than a ſplendid maſk to cover what in itſelf is infamous or deteſtable.

BLINDNESS, a privation of the ſenſe of ſight, ariſing from a total depravation of its organs, or an involuntary obſtruction of their functions. Partial blindneſs, is that wherein ſome faint glimmering is left, as is always the caſe in people who have ripe cataracts, who are never ſo blind, but they can diſcern day from night; and, for the moſt part, in a ſtrong light, diſtinguiſh black, white, and ſcarlet, though they cannot perceive the ſhape of any thing. The reaſon is, that the light by which thoſe perceptions are made, being let in obliquely through the aqueous humour, or the anterior ſurface of the cryſtalline (by which the rays cannot be brought into a focus upon the retina), they can diſcern in no other manner than a ſound eye can through a glaſs of broken jelly, where a great variety of ſurfaces ſo differently refract the light, that the ſeveral diſtinct pencils of rays cannot be collected by the eye into their proper foci; wherefore the ſhape of an object in ſuch a caſe cannot be at all diſcerned, though the colour may. Phil. Tranſ. No. 402. p. 447. The cauſes of blindneſs are either ordinary, as a decay of the optic nerve (an inſtance whereof we have in the Academy of Sciences, where, upon opening the eye of a perſon long blind, the optic nerve was found extremely ſhrunk and decayed, and having no medulla in it); or

ſome

ſome external violence, vicious conformation, growth of a cataract, gutta ſerena, ſmall-pox, or the like. Hiſt. Acad. Scienc. ann. 1713 and 1721. For the moſt approved methods of treating theſe diſeaſes, ſee the SYSTEM, Sect. 39.

BLISTER, in the Animal Oeconomy, denotes a thin bladder raiſed on the ſkin, and full of a watery or other humour.—Bliſters are ſymptoms uſually enſuing on burns, ſcalds, and cauſtic matters applied to the ſkin. It is diſputed among ſurgeons, whether bliſters, in caſes of burns, are to be opened, or not. Some adviſe it, to prevent further ulcerations underneath; others, unleſs they be large, diſſuade it, as creating the patient needleſs pain.

BLISTER, Epipaſtic, or Veſicatory, an external medicine, ſerving to raiſe a bliſter; whence alſo it is itſelf, though improperly, called a bliſter. Of bliſters there are ſome which act very gently, and others with great violence. Bliſters are unguents, cataplaſms, or plaſters made of ſharp, irritating medicaments, which have a faculty of drawing the humours from within, outwards; inflaming and ulcerating the ſkin, and raiſing veſicæ, or bladders; whence their denomination, veſicatory. We have veſicatories made of cantharides, of euphorbium, figs, ſublimate of mercury, lapis infernalis, muſtard, anacardium, ſquills, briony, vinegar, pepper, leaven, leſſer ſpurge, &c. which are incorporated and made up with honey, gums, reſins, &c. to bring them to the conſiſtence required.

Bliſtering chiefly takes place in the dropſy, delirious and feveriſh diſorders, apoplexies, pleuriſies, and the like. Some alſo preſcribe it in the hydrocephalus, ophthalmia, ſuffocative catarrhs, cephalæa, &c. Some ſay, that bliſtering is generally found hurtful in dropſies. In the Phil Tranſ. vol. I. part ii. No. 475. an. 1758, there is a paper by Dr. Whytt, containing caſes of the remarkable effects of bliſters in leſſening the quickneſs of the pulſe in coughs, attended with infarction of the lungs, and fever. See alſo ſeveral papers concerning bliſters in the Lond. Medic. Obſery. &c. vol. ii. p. 311. ibid. p. 382, and vol. iii. p. 102, where they are recommended as efficacious in curing an incontinence of urine.

The operation and effect of bliſters in curing fevers, are by ſome reſolved into the ingreſs of the particles of the cantharides into the blood; by others, into the quantity of hot, ſharp, and ſalt lymph diſcharged; by others, into the condenſation of the blood, and ſtoppage of the rarefaction, whereby the ſpirits are diſpoſed to be plentifully ſeparated. Dr. Cockburn, who refutes all theſe ſyſtems, accounts for it from the cantharides wounding the nerves or canals whereby the ſpirits are conveyed to the heart; Dr. Morgan from the ſubtile, hot, active ſalts of the flies, ſtrongly attracted by the ſerum, and carried with it through the ſeveral glands and ſecretory ducts of the body, where they act by diſſolving, attenuating, and rarefying the viſcid coheſions of the lymph and ſerum, and ſtimulating the nervous coats of the veſſels, whereby they are induced to throw off their ſtagnating viſcidities, and reſtore the free drain of the lymph from the arteries to the veins; and at the ſame time, by ſcouring and cleanſing the expurgatory glands, bring on critical ſweats and urines. Phil. Tranſ. No. 252, p. 173. Dr. Morgan endeavours to diſcard the method of dreſſing bliſters, by which nothing is gained, but the plaguing and tormenting the patient, and depriving him of the benefit of a much greater diſcharge, which would be at leaſt three to one, were the ſame plaſter left on for four or five days, or as long as it will draw off any thing; and then, when it has done running, taking it off and applying a plaſter of melilot, or rather of diachylum, once, for all, till the part is quite well and healed. Indeed, when a bliſter is firſt raiſed, if it doth not break and run of itſelf, it may be proper to raiſe the lower end of the plaſter a little, to ſnip the bladder, and let out the water; but if the ſurgeon has made the plaſter ſtrong enough, this is commonly done of itſelf, without help. It is uſually objected, that a ſtrong epiſpaſtic left on five or ſix days, muſt deeply corrode the fleſh under it, and thereby endanger a mortification. But this, according to the author laſt cited, is ſo far from being true, that, on the contrary, it prevents the worſt accidents uſually happening in bliſtering, which are what they call ſloughs, or deep ſtrong incruſtations of a ſharp ſalt and adheſive matter, covering the whole ſurface of the fleſh where the plaſter had been applied. Now, this is always occaſioned by an unſeaſonable removal of the epiſpaſtic, while the humour is in full flow, and ſtrongly feeding to the part; and the humour, thus ſuddenly checked and thrown back for want of a ſufficient drain, forms this ſlough. Morg. Mech. Pract. of Phyſ. p. 176.

BLOOD, a warm, red liquor in moſt animals, circulating, by means of arteries, and veins, through every part of the body, during their life, and the common ſource whence all the neceſſary and ſuperfluous animal liquids are derived.

Circulation of the BLOOD, denotes a natural motion of the blood in every living animal; whereby that fluid is alternately conveyed from the heart to every part of the body, by the arteries, and returned from the ſame parts to the heart by the veins. The circulation of the blood has been generally allowed to have been firſt diſcovered in England, in the year 1628, by Harvey a phyſician of our own country; though there are ſeveral authors who diſpute it with him. The circulation of the blood through the lungs by the major circuitus was undoubtedly the diſcovery of Harvey. Many of the ancients had ſome knowledge of the motion of the blood; but they were ignorant of its regular circulation.

The circulation of the blood is evinced, from the following conſiderations.

1. All the blood of a living animal, upon wounding any one of the larger arteries, is ſoon evacuated, and with conſiderable force: as in the operation of butchers, &c. Hence, it follows, that the blood has a paſſage from every part of the animal body into every artery: and if the whole maſs of blood be found to move on this occaſion, it is evident it muſt have moved before.

2. The great quantity of blood driven out of the heart into the arteries of every pulſe, makes a circulation neceſſary; ſince, without it, an infinitely greater ſtock of blood muſt be ſuppoſed in the body of a man, than any obſervation or experiment will allow of. For though the ancients, who knew not this circulation, imagined that only a drop or two was expelled at each ſyſtole; which they were neceſſitated to ſuppoſe, to avoid the too great diſtenſion of the arteries, from a more conſiderable influx: yet it is certain, and even demonſtrable, that there muſt needs be an ounce, or more, driven into them at each time; and yet ſome compute that there are 5000 or 6000 pulſations in an hour.

3. Any one of the arteries, being tied with a thread, will ſwell, and beat, between the bandage and the heart; but they grow flaccid between the bandage and the extremities of the body. If now the artery be cut between the bandage and the heart, blood ſtreams out, even to death; if it be cut between the bandage and the extremity of the body, the quantity of blood it yields is very ſmall. The vital blood, therefore, flows through the arteries; and its courſe is from the heart towards the extremes of the body: and this it does in every part of the body, internal and external; ſtill out of a wider part into a narrower; out of the trunk into the branches. And it is on this principle alone, that all the blood may be derived into any artery, and evacuated at it.

4. Any one of the largeſt veins being bound up with a thread, ſwells between the extremes of the body and the bandage, but without beating; and between the bandage and heart it becomes flaccid. If opened in the former part, it bleeds largely; if in the latter, ſcarcely at all. The blood, therefore, flows briſkly from every part of the body into this vein; and its courſe is from the extremities towards the heart; from the narrower parts of the vein towards the wider parts; from the branches to the trunk.

From the whole it is clearly evident, that all the arteries of the body are continually bringing the blood from the left part of the heart, through the trunks of the arteries, into the branches; and from thoſe to all parts of the body, internal and external; and on the contrary, that all the veins, excepting the porta, are perpetually bringing back the blood from the extreme parts into the ſmaller branches; from thoſe it paſſes into the larger, at length into the trunks, and thence into the cava; and through the ſinus venoſus, or trunk of that vein (which ends in the cavity of the right auricle) into the heart.

The blood being arrived here, its circulation is continued as follows: The auricles of the heart being large hollow muſcles, are furniſhed with a double ſeries of ſtrong fibres proceeding with a contrary direction to two oppoſite tendons, the one adhering to the right ventricle, the other to the ſinus venoſus; as alſo with innumerable veins and arteries; by the contractile force of theſe auricles, the blood will be vigorouſly expreſſed, and drove into the right ventricle; which, upon this contraction is rendered flaccid, empty, and diſpoſed to admit it.

If the right ventricle, thus full of blood, by the contraction of its fibres, preſs the blood towards the aperture again, venous blood at the ſame time pouring in, will drive it back again into the cavity, and mix it more intimately; till riſing up againſt the parietes, it raiſes the valvulæ tricuſpides, which are ſo connected to the fleſhy columns extended on the oppoſite ſide, as that when laid quite down they cannot cloſe the parietes of the right ventricle; theſe it thruſts towards the right auricle, till being there joined, they ſtop the paſſage very cloſely, and prevent any return. By the ſame means, the ſame blood riſes up into the three ſemilunar valves, placed in the extremity of the other mouth, and lying open to the pulmonary artery: theſe it ſhuts cloſe againſt the ſides of the artery, and leaves a paſſage into the artery alone. The venous blood, therefore, that is the blood of the body, continually moves out of the ſinus, or trunk of the vena cava, through the right auricle, and right ventricle, into the pulmonary artery, in a continued and forcible ſtream. The blood carried by this artery into the lungs, and diſtributed by its branches through the whole ſubſtance thereof, is firſt admitted into the extremities of the pulmonary vein, called arteria venoſa; whence paſſing into four large veſſels, which unite together, it is brought to the left ſinus venoſus, or trunk of the pulmonary vein; by the force of whoſe muſculous ſtructure it is driven into the left ventricle, which, on this occaſion, is relaxed, and by that means prepared to receive it. Hence, as before, it is driven into the left ventricle, which is relaxed by the ſame means; and the valvulæ mitrales opening, admit it into the left ventricle, and hinder its reflux into the pulmonary vein.

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From hence it is forced into the aorta; at whose orifice there are three ſemilunar valves, which alſo prevent a reflux, by cloſing the ſame. And thus is circulation effected; all the blood ſent into the lungs, and received in the *arteria venoſa*, *ſinus venoſus*, left auricle and ventricle, being here continually propelled into the aorta, whoſe ramifications are ſpread throughout all the reſt of the body, with a violent motion.

This motion, in living animals, is attended with the following phenomena:

1. Both the venous ſinuſes are filled, and grow turgid at the ſame time. 2. Both auricles grow flaccid at the ſame time, and both are filled at the ſame time with blood, impelled by the contractile force of its correſpondent muſcular venous ſinus. 3. Each ventricle contracts, and empties itſelf of blood, at the ſame time, and the two great arteries are filled and dilated at the ſame time. 4. As ſoon as the blood, by this contraction, is expelled, both ventricles being emptied, the heart grows longer and broader, and conſequently more flaccid and capacious. 5. Upon which the muſcular fibres of both venous ſinuſes contract, and expreſs the blood contained in them into the ventricles of the heart. 6. In the mean time, the venous ſinuſes are again filled, as before; and the auricles, &c. return into their former habitude. 7. And this alteration continues till the animal begins to languiſh, under the approach of death; at which time the auricles and venous ſinuſes make ſeveral palpitations, for one contraction of the ventricle. Thus is all the blood, in its return from every part of the body, internal and external, and from every part of the heart and its auricles, impelled into the right ventricle, out of that into the lungs, thence into the left ventricle, and thence through the whole extent of the body, and thence again brought back to the heart.

As to the manner of the blood's paſſing out of the arteries into the veins, in order to its being returned to the heart, there are two opinions.

In the firſt, the veins and arteries are ſuppoſed to open into each other, or to be continued from each other, by *anaſtomoſis*, or inoſculation of their extremities.

In the latter, the extreme capillary arteries are ſuppoſed to let out their blood into the pores of the ſubſtances of the parts, on whoſe nutrition part is ſpent, and the reſt is received in at the mouths of the capillary veins.

Each of theſe opinions muſt be allowed to have its reaſon: for, without the firſt, it were difficult to account for ſo quick a return of the blood to the heart, as in effect we find; beſides, that in ſome of the larger veſſels there is a confeſſed anaſtomoſis, v. g. in the ſplenic artery with the ſplenic vein, &c. whence authors conclude the ſame contrivance to hold in the leſſer veſſels, even in the ſmalleſt twigs in the extreme parts of the body, though not diſcovered by the eye; nature being ordinarily found very uniform, and conſiſtent with herſelf.

Riolanus, however, who will allow of no circulation but by anaſtomoſis, allows of none, neither, but by the larger veſſels.

The reaſon of the latter opinion is deduced hence, that if part of the arterial blood did not ooze out into the ſubſtance of the parts, they could not be nouriſhed thereby: for the blood, while contained in the veſſels, may indeed convey warmth thereto, but no nutriment; the very veſſels themſelves being not nouriſhed by the fluid running in their cavity, but by capillaries paſſing their coats.

If then the blood be driven out of the veſſels in a greater quantity than is required for nutrition, the redundancy muſt be imbibed by the capillary veins.

M. Lewenhoeck ſeemed to have put this matter out of doubt, by his microſcopes, with which he diſcovered the inoſculations, or continuations of the extremities of the veins and arteries, in fiſhes, frogs, &c. See ANASTOMOSIS. But doubts ariſing whether the veins and arteries in human bodies and quadrupeds were of ſimilar ſtructure, Mr. Cowper made experiments, which evinced the inoſculation in the omentum of a cat, and alſo in the meſentery of a dog. He found that the extremities of the veſſels are not equally leſſened, in the inoſculations, in different animals.

In the tail of the tadpole, he frequently obſerved ſeveral communications between the veins and the arteries, through each of which two globules of blood might paſs together. In young fiſh, particularly grigs, the communicant branch is ſo ſmall, that one globule of blood can ſcarcely paſs in the ſpace of three ſeconds.

The tail of a newt, or water-lizard, affords alſo a very entertaining proſpect of the circulation of the blood, through almoſt numberleſs ſmall veſſels; but no object ſhews it ſo agreeably as one of theſe animals while ſo young as not to be above an inch long; for then the whole body is ſo very tranſparent, that the circulation may be ſeen in every part of it, as well as in the tail; and, in theſe objects, nothing is more beautiful than the courſe of the blood into the toes, and back again, where it may be traced all the way with great eaſe. Near the head there are alſo found three ſmall ſins, which afford a very delightful proſpect. Theſe are all divided like the leaves of polypody, and, in every one of the branches of theſe, the blood may be very accurately traced, running to the end through the artery, and there returning back again, by a vein of the ſame ſize, and laid in the ſame direction; and as the veſſels are very numerous and large in this part, and the third or fourth magnifier may be uſed, there are ſometimes ſeen thirty or forty channels of the running blood at once; and this the more as the globules of blood in the newt are large, and are fewer in number, in proportion to the quantity of ſerum, than in any other animal, and their figure, as they are protruded through the veſſels, changes in a very ſurpriſing manner.

In a fœtus, the apparatus for the circulation is ſomewhat different from that above deſcribed. The *ſeptum*, which ſeparates the two auricles of the heart, is pierced through with an aperture, called the *foramen ovale*; and the trunk of the pulmonary artery, a little after it has left the heart, ſends out a tube in the deſcending aorta, called the *communicating canal*.

The fœtus being born, the *foramen ovale* cloſes, by degrees, and the canal of communication dries up, and becomes a ſimple ligament. Though, in ſome inſtances, it has been known to remain open.

This mechaniſm once known, it was eaſy to perceive its uſe. For while the fœtus is incloſed in the uterus, it receives no air, but that little furniſhed it by the umbilical vein. Its lungs, therefore, cannot ſwell and ſubſide, as they do after the birth, and after the free admiſſion of the air. They continue almoſt at reſt, and without any motion: their veſſels are, as it were, full of themſelves, and do not allow the blood to circulate, either in abundance or with eaſe. Nature, therefore, has excuſed the lungs from the paſſage of the greateſt part of the blood, and has contrived the *foramen ovale*, by which part of the blood of the *vena cava*, received into the right auricle, paſſes into the left auricle, at the mouth of the pulmonary veins; and by this means it is found as far in its journey as if it had paſſed the lungs. But this is not all: for the blood of the *cava*, which, miſſing the *foramen ovale*, paſſes from the right auricle into the right ventricle, being ſtill in too great quantity to paſs by the lungs, whither it is driven through the pulmonary artery, is partly intercepted in the way by the communicant canal, and poured immediately into the deſcending aorta.

This is the doctrine of Harvey, Lower, and moſt other anatomiſts; but M. Mery, of the Royal Academy, has made an innovation in it. He aſſigns another uſe for the *foramen ovale*, and maintains that the whole maſs of blood brought from the *cava* to the right ventricle, paſſes, as in adults, into the pulmonary artery; whence part of it is conveyed by the communicant canal into the aorta, and the reſt brought from the lungs by the pulmonary vein into the left auricle, where it is divided into two parts, the one paſſing through the foramen ovale, into the right ventricle, without circulating through the aorta, and the reſt of the body: the other part puſhed, as in adults, by the contraction of the left ventricle, into the aorta, and the whole body of the fœtus. The whole queſtion then turns upon this, viz. whether the blood paſſes through the foramen ovale from the right to the left ventricle, or from the left to the right?

M. du Verney aſſerts the ancient opinion, againſt M. Mery, and maintains that the foramen ovale has a valve ſo diſpoſed as to be opened by the blood driving into the right ventricle; but ſhut the more firmly by its puſhing towards the left. But M. Mery denies the exiſtence of any ſuch valve. Again, in an adult, the aorta, being to receive all the blood of the pulmonary artery, is found of the ſame bigneſs. In a fœtus, the two arteries are to receive unequal quantities, which of the two ſyſtems ſoever be followed. According to the common opinion, the aorta, receiving more blood than the pulmonary, ſhould be bigger: according to the opinion of M. Mery, the pulmonary artery ſhould be the bigger, as being eſteemed to receive a greater quantity of blood.

To judge of the two ſyſtems, therefore, it ſhould ſeem there needed nothing but to determine which of the two veſſels were largeſt in a fœtus.

M. Mery always found the pulmonary artery half as big again as the aorta: and, on the other hand, M. Tauvry, who ſeconded M. du Verney, produces caſes where the pulmonary is leſs than the aorta: the facts on both ſides being examined by the French Royal Academy.

M. Tauvry adds, that though the pulmonary artery ſhould be greater than the aorta, yet this does not prove, that more blood paſſes the firſt than the ſecond; ſince it may be accounted for from the blood's preſſing more ſlowly towards the lungs, which it finds ſome difficulty to penetrate, and accordingly ſwells, and is driven back.

M. Littre, upon diſſecting an adult, in whom the *foramen ovale* was ſtill open, and meaſuring the capacities of the veſſels on each ſide, declares for M. Mery.

As to the force of the circulation in the fœtus, anatomiſts are again divided. The popular opinion is, that, during geſtation, the arteries of the uterus convey their blood into the placenta, which is nouriſhed by it, and that the ſurplus is conveyed into the roots of the umbilical vein, which makes part of the navel-ſtring: thence it is carried to the liver of the fœtus, where it enters the *vena cava*, and is thence conveyed to the right ventricle of the heart, and diſtributed as before. Again, the blood, brought from the iliac arteries of the fœtus, enters the navel-ſtring

by the umbilical arteries; then paſſes into the placenta, where it is reſumed by the veins of the uterus, which carry it back again to the mother: and perhaps alſo by the roots of the umbilical vein, which mix it afreſh with the blood of the mother. According to this ſyſtem, therefore, it is the blood of the mother that ſupplies the child; which is here only regarded as a diſtinct member, or part, of her frame. See the Syſtem of MIDWIFERY, Part I. Sect. 1.

The beating of her heart ſends to it a portion of her blood; and ſo much of the impulſe is preſerved, as ſuffices to maintain that languid circulation which a fœtus enjoys; and in all probability, gives that feeble pulſation obſerved in the heart.

M. Mery diſſected a woman big with child, killed by a fall; in the cavity of her belly were found ſeven or eight pints of blood: all the blood-veſſels being emptied: the child too was found dead, but without the leaſt appearance of any wound or contuſion, all its blood-veſſels being empty of blood, like thoſe of the mother. The body of the placenta ſtill adhered to the whole inner ſurface of the uterus; nor was there any extravaſated blood there. Now the blood here had no other way to diſcharge itſelf, but by the veins of the uterus: whence it follows, that thoſe veins bring back to the mother the blood of the fœtus; which, alone, eſtabliſhes the whole ſyſtem. If the circulation were only from the fœtus to the placenta, and not alſo to the mother, the dead child would have had all its blood.

Upon the whole, the blood in the lungs of the fœtus has none of the advantages of air, or reſpiration; which yet being neceſſary, nature, it is ſuppoſed, takes care that it receives a portion of air, mixed together with its mother's blood, and tranſmitted to it by the umbilical veſſels, to be diffuſed through the body. This is confirmed hence; that, by conſtringing the navel-ſtring very tight the child dies like a man ſtrangled; which appears to be owing to nothing but the want of air. Add to this, that as ſoon as the mother ceaſes to reſpire, the fœtus expires.

As to the velocity of the circulating blood, and the time wherein the circulation is completed, ſeveral computations have been made. By Dr. Keill's account, the blood is driven out of the heart into the aorta, with a velocity which would carry it 50 feet in a minute; but this velocity is continually abated by the progreſs of the blood through the numerous ſections or branches of the arteries; ſo that before it arrives at the extremities of the body, its motion is infinitely diminiſhed.

Dr. Keill, upon a moderate ratio of the branches of the arteries to the trunk, ſhews, that the greateſt velocity of the blood is to the leaſt, in a greater proportion than that of 10000,00000,00000 00000,00000,00000,00000,00000,00000 to one.

The ſpace of time wherein the whole maſs of blood may ordinarily circulate, is variouſly determined. Some of the lateſt writers ſtate it thus: ſuppoſing the heart to make 2000 pulſes in an hour, and that at every pulſe there is expelled an ounce of blood, as the whole maſs is not ordinarily computed to exceed 24 pounds, it muſt be circulated ſeven or eight times over, in the ſpace of an hour. See the article PULSE.

The impetus, occaſioning the circulation, is great enough in ſome animals to raiſe the blood ſix, ſeven, or eight feet high from the orifice it ſpins out at, which, however, is far exceeded by that of the ſap of a vine in bleeding time, which will ſometimes riſe upwards of forty feet high. Phil. Tranſ. No. 398, p. 274.

The heat and motion of the blood are always greater, from a greater activity, in the day than in the night; and they are likewiſe ever greater from the food taken in the day-time; for the pulſe is always quicker after eating than before it; after a full meal, than after a ſpare one; and after a meal of drier and ſtronger food, than after a meal of food that is moiſter and weaker. See the article FOOD.

It now remains to give ſome further account of the means by which the circulation of the blood is carried on, in the living body. From the time of Harvey till very lately, this was ſuppoſed to be chiefly the muſcular power of the heart and arteries, which by ſome phyſiologiſts have been thought to be prodigiouſly great; and accordingly many calculations, requiring no ſmall degree of mathematical knowledge to underſtand them, have been made, of the forces requiſite to perform this circulation. Other phyſiologiſts, however, have thought proper to take in ſeveral auxiliary helps, as the motion of the muſcles, reſpiration, &c. and from Dr. Hale's experiment, it appears that reſpiration hath a conſiderable influence in this matter. It cannot, however, be the ſole cauſe, ſeeing the circulation is carried on in animals which do not reſpire.

New Hypotheſis by Dr. Wilſon.

In 1773, Dr. Wilſon, in his lecture ſuggeſted a new principle of motion, which, we believe, was never uſed before, to account for the circulation of animal fluids. It is briefly this: "As the fluids of the human body do all of them ſuffer a continual waſte, and conſequently require a conſtant ſupply in proportion; we muſt look upon their going out of the body to be the end of the motion, and on their entering into the body to be the beginning of it; and hence we are to look for the origin of all the motions of the fluids in that part of the ſyſtem where the new ſupplies are taken in. This is the *primæ viæ*, where the lacteals abſorb a fluid from digeſted aliment, and convey it into the blood. The power by which this is accompliſhed, is neceſſarily independent of the heart, as having not the leaſt connection with it. It has been ſaid to be the ſame with that which cauſes fluids to riſe in capillary tubes: but though very probably the powers in both caſes may be the ſame, there is this remarkable difference between them, that in the capillary tubes the fluids only riſe to a certain height; and will not riſe at all unleſs the tubes are empty. In the lacteals they riſe in veſſels already full, and continue to do ſo. Neither is the force whereby this abſorption is performed to be accounted little; ſeeing the ſupply by the chyle muſt conſtantly be equal to the waſte which is continually taking place in the fluids already contained in the veſſels. We ſee alſo with what force an abſorption of this kind ſometimes takes place in other caſes; thus ropes will abſorb water with ſuch ſtrength as to raiſe immenſe weights faſtened to them; and which no mechanical injection of water into ſmall tubes could poſſibly accompliſh. What is already ſaid of the lacteals applies alſo to the lymphatics; and from thence we are almoſt tempted to conclude, that the caſe is the ſame with the ſanguiferous veins alſo; that though there may be a continuation of ſome arteries into the veins correſponding with them, yet that for the moſt part theſe veſſels extravaſate the blood into ſmall cavities, which is then taken up by the abſorbent power of the veins, and returned to the heart. For a copious account of the lymphatic and abſorbent ſyſtem, ſee the Syſtem of ANATOMY, Part III. Sect. 11. For repreſentation, ſee Plates 6 and 7.

"If, however, the veſſels continued abſolutely full, it would be impoſſible that any motion could be carried on in them; and to continue and regulate the circulation, the heart with its cavities is provided. Let us ſuppoſe, that by the abovementioned power the veins are full, and the auricles or chambers into which the veins empty themſelves are full alſo: where is the collected ſtreams in the veins to go next? There is no room for more in the auricle. What muſt be done? The auricle contracts and empties itſelf. The conſequence is a ſudden vacuum, equal to what the auricle could contain; the turgid veins, urged by the abſorbing power abovementioned, ruſh their contents into the auricle, to fill up the vacuum again; and all behind moving in the venous direction, advances forward with ſo much force, that the veins near the heart ſuſtain a pulſation from the regurgitation of this impetuous ſtream, when the auricle ſhuts upon it to empty itſelf. In ſhort, the full auricle occupies a determinate quantity of ſpace in the breaſt: when it is emptied, there it a nonreſiſting vacuum of ſo much ſpace as was full before, and thither there is a mechanical niſus from the remoteſt filament of a vein over the whole body, which becomes conſpicuous in the torrent that ruſhes every other moment from the mouth of the vena cava into this vacuum."

This is a ſhort abſtract of Dr. Wilſon's new theory of the circulation. According to him, this abſorbing power of the veins is the principal agent, while the heart and arteries do no more than empty themſelves of the blood with which they are filled by the veins. Even this cauſe, however, he ſays, would not be ſufficient to carry on the circulation for a ſingle moment, without the preſence of another, which he calls *life*, and does not conſider as abſolutely unmechanical, though we cannot reduce it either to mechanical rules or ideas. But as we apprehend all ſpeculations concerning ſuch cauſes muſt be arbitrary, and without foundation, we forbear to give any account of the Doctor's opinions on this ſubject.

Blood contains no Air while in the Bodies of Animals.

It hath been a general opinion, that blood, as it exiſts in the bodies of animals, contains a conſiderable quantity of common air; and indeed it is certain, that blood, after it has been drawn from the veins of any animal, and afterwards placed under the receiver of an air-pump, yields a very conſiderable quantity of air upon exhauſting the receiver: but if a portion of any blood-veſſel is tied up, ſo as to prevent the eſcape of its contents, and then cut out of the body and placed under a receiver, it will not ſwell, or ſhew the leaſt ſign of its containing any quantity of air whatever.

Though there is no living creature as yet known whoſe life does not immediately depend upon the circulation of ſome kind of fluid through its veſſels, yet unleſs ſuch fluid is of a red colour, it does not obtain the name of blood; and, therefore, ſuch creatures as have a colourleſs or milky liquor circulating through their veſſels, are called *exſanguineous animals*.

Appearance of the Blood when drawn from a Vein.

The common appearance of the blood, when drawn from a vein in the human body, is well known. It firſt ſeems an homogeneous red liquor; then it conſolidates into one uniform maſs; in a little time, a yellowiſh watery liquor begins to ſeparate from it, which is more or leſs in quantity, according to the ſtate in which the blood happens to be; the red maſs, in the mean time, contracts greatly in its dimenſions, and increaſes in ſolidity. But this increaſe of ſolidity is likewiſe proportional to the ſtate of the blood at the time. In ſtrong people, if attacked with a violent

a violent inflammatory diſeaſe, the ſolid part is exceedingly tough, inſomuch that Dr. Huxham ſays he has ſometimes found it almoſt like a piece of fleſh itſelf: whereas, in other diſeaſes, the ſolid part is very ſoft and tender, breaking in pieces with the ſlighteſt touch. The ſpontaneous ſeparation of the blood into craſſamentum, ſerum, and coagulable lymph, hath been noticed in the Syſtem of ANATOMY, Part V. Sect. 5.

Dr. Lewis's Account of the Blood.

In Dr. Lewis's notes on Newman's Chymiſtry, we have the following account of the blood, and the parts into which it may be reſolved: "Recent blood is equally fluid, and in taſte ſomewhat ſaline. Viewed by a microſcope, it appears compoſed of numerous red globules, ſwimming in a tranſparent fluid. On ſtanding for a little time, it ſeparates into a thick craſſamentum and fluid ſerum. By agitation it continues fluid. A conſiſtent polypous matter adheres to the ſtirrer, which, by repeated ablution with water, becomes white. Received from the vein in warm water, it depoſits a quantity of tranſparent filamentous matter, the red portion continuing diſſolved in the water. On evaporating the fluid, a red powdery ſubſtance is left. It congeals by froſt, and becomes fluid again by warmth: after liquefaction it quickly putrifies. Fluid and florid blood, expoſed to a temperate air, putrifies ſooner than ſuch as is more denſe. Inſpiſſated to dryneſs, it leaves a dark-coloured maſs, amounting, at a medium, to about one-fourth of the weight of the blood, of a bitter, ſaline taſte, eaſily inflammable, burning with a blueiſh flame. The exſiccated blood is not ſoluble in acid or alkaline liquors; but gives ſome tincture to water and to ſpirit of wine, and is more powerfully acted upon by dulcified ſpirit of nitre. Recent blood is coagulated by the mineral acids, and by moſt of the combinations of them with earthy and metallic bodies. With vegetable acids, and with ſolutions of neutral ſalts, it mingles equally without coagulation. Alkalis, both fixed and volatile, render it more fluid, and preſerve it from coagulating.

"The ſerum of blood is more ſaline than the craſſamentum, and does not ſo ſpeedily putrify. It freezes ſomewhat more difficultly than pure water; and its aqueous part evaporates, by a gentle warmth, ſomewhat more readily, leaving about one-twelfth of the weight of the ſerum of a ſolid yellowiſh pellucid matter. Expoſed to heat a little greater than that of the human body, it coagulates into a ſolid maſs, without any conſiderable evaporation. Both this coagulum and the inſpiſſated ſerum are readily inflammable in the fire, not diſſoluble in water, or in ſpirit of wine, in acid, or in alkaline liquors.

Colour of Blood.

Dr. Cullen, in his phyſiological part of the Inſtitutions of Medicine, acknowledges that we know but little of the formation of any of the animal fluids; and concerning the microſcopical obſervations, &c. on the blood, gives his opinion in the following words: "The red globules have been conſidered as an oily matter, and from thence their diſtinct and globular appearance has been accounted for; but there is no direct proof of their oily nature; and their ready union with, and diſſuſibility in water, renders it very improbable. As being microſcopical objects only, they have been repreſented by different perſons very differently. Some have thought them ſpherical bodies, but diviſible into ſix parts, each of which, in its ſeparate ſtate, was alſo ſpherical; but other perſons have not obſerved them to be thus diviſible. To many obſervers they have appeared as perfectly ſpherical; while many judge them to be oblate ſpheroids, or lenticular. To ſome they have appeared as annular, and to others as containing a hollow veſicle. All this, with ſeveral other circumſtances relating to them, very variouſly repreſented, ſhew ſome uncertainty in microſcopical obſervations; and it leaves me, who am not converſant in ſuch obſervations, altogether uncertain with reſpect to the preciſe nature of this part of the blood. The chymical hiſtory of it is equally precarious; and therefore what has been hitherto ſaid of the production and changes happening to theſe red globules, we chooſe to leave untouched.—We ſuppoſe that the red globules, when viewed ſingly, have very little colour; and that it is only when a certain number of them are laid upon one another, that the colour appears of a bright red: but this alſo hath its limits; ſo that when a number of globules, laid one on another, is conſiderable, the colour becomes of a darker red. Upon this ſuppoſition, the colour of the maſs of blood will be brighter or darker, as the colouring part is more or leſs diffuſed among the other parts of the maſs; and we think this appears to be truly the caſe, from every circumſtance that attends the changes which have been at any time obſerved in the colour of the blood."

Colour of the Blood accounted for from the Action of the Air.

Concerning the uncertainty of microſcopical as well as chymical experiments, we ſhall not diſpute; though the concluſion againſt them ſeems carried too far. But with regard to the colour of the blood, we apprehend it hath been known almoſt, if not altogether, ſince the diſcovery of the circulation, that the florid or dark colour depends on the preſence or abſence of air, and not on any number of globules. Thus the blood, returning from the veins, is of a dark colour. Though diluted with the freſh chyle from the ſubclavian vein, it continues of the ſame dark colour till it paſſes through the lungs, upon which it inſtantly aſſumes a very florid red: but it can never be proved that the globules in the pulmonary vein are at all leſs numerous than in the pulmonary artery. That this change of colour may be effected by the air, through membranes much thicker than we can ſuppoſe the veſſels of the lungs to be, hath been demonſtrated by Dr. Prieſtley's experiments, mentioned under the article DEPHLOGISTICATED AIR, and in the Syſtem of AEROLOGY, Sect. 3: but whether the change is occaſioned by the mere ſeparation of phlogiſton from the blood, or by the abſorption of ſome other principle in its ſtead, is not yet determined, though the latter is indeed acknowledged by Dr. Prieſtley himſelf to be the more probable opinion. He even ſuppoſes the redneſs to be owing to a portion of dephlogiſticated air, abſorbed in the lungs; but, in the Syſtem and Section laſt referred to, it is ſhewn that this fluid cannot be abſorbed by any liquid without decompoſition. It muſt therefore be the elaſtic principle of this air which is abſorbed, while the other, combined with part of the phlogiſton, emitted by the blood, is converted into fixed air.

Uſes of the Blood in Animals.

This leads us to conſider the uſes to which the blood is ſubſervient in the animal economy, and the changes that happen to it in reſpiration. The uſes of this fluid are ſo various, and of ſuch an important nature, that ſome have not ſcrupled to affirm the blood to be actually poſſeſſed of a living principle, and that the life of the whole body is derived from it. This opinion was firſt broached by the celebrated Harvey, the diſcoverer of the circulation; but in this he was never much followed; and the hypotheſis itſelf, indeed, has been much laid aſide, till of late it was revived by the late Mr. J. Hunter, profeſſor of anatomy. He ſupports his opinion by the following arguments:

Mr. Hunter's Arguments in Favour of this Opinion.

1. The blood unites living parts, in ſome circumſtances, as certainly as the yet recent juices of the branch of one tree unite it with that of another. Were either of theſe fluids to be conſidered as extraneous, or dead matters, he thinks, they would act as ſtimuli, and no union would take place in the animal or vegetable kingdom. This argument Mr. Hunter imagines is ſtill farther eſtabliſhed by the following experiment: Having taken off the teſticle from a living cock, he introduced it into the belly of a living hen. Many weeks afterwards, upon injecting the liver of the hen, he injected the teſticle of the cock, which had come in contact with the liver, and adhered to it. He alleges, that, in the nature of things, there is not a more intimate connection between life and a ſolid, than between life and a fluid. For, although we are more accuſtomed to connect it with the one than the other, yet the only real difference which can be ſhewn between a ſolid and a fluid is, that the particles of the one are leſs moveable among themſelves than thoſe of the other. Beſides, we often ſee the ſame body fluid in one caſe, and ſolid in another.

2. The blood becomes vaſcular, like other living parts. Mr. Hunter affirms, that, after amputations, the coagula in the extremities of arteries may be injected, by injecting theſe arteries; and he has a preparation in which he thinks he can demonſtrate veſſels riſing from the centre of what had been a coagulum of blood, and opening into the ſtream of the circulating blood.

3. Blood taken from the arm in the moſt intenſe cold which the human body can bear, raiſes the thermometer to the ſame height as blood taken in the moſt ſultry heat. This he conſiders as a ſtrong proof of the blood's being alive; as living bodies alone have the power of reſiſting great degrees both of heat and cold, and of maintaining, in almoſt every ſituation, while in health, that temperature which we diſtinguiſh by the name of *animal heat*.

4. Blood is capable of being acted upon by a ſtimulus. In proof of this he obſerves, that it coagulates from expoſure, as certainly as the cavities of the abdomen and thorax inflame from the ſame cauſe. The more it is alive, that is, the more the animal is in health, it coagulates the ſooner on expoſure; and the more it has loſt of its living principle, as in the caſe of violent inflammations, the leſs it is ſenſible to the ſtimulus produced from its being expoſed, and it coagulates the later.

5. The blood preſerves life in different parts of the body. When the nerves going to a part are tied or cut, the part becomes paralytic, and loſes all power of motion; but it does not mortify. If the artery be cut, the part dies, and mortification enſues. What keeps it alive in the firſt caſe? Mr. Hunter believes it is the living principle which alone can keep it alive; and he thinks that this phenomenon is inexplicable on any other ſuppoſition than that life is ſupported by the blood.

6. Another argument he draws from a caſe of a fractured *os humeri* he had occaſion to obſerve. A man was brought into St. George's hoſpital for a ſimple fracture of the *os humeri*, and died about a month after the accident. As the bones had not united, Mr. Hunter injected the arm after death. He found that the cavity between the extremities of the bones was filled up with blood which had coagulated. This blood was become vaſcular. In ſome places it was very much ſo. He does not maintain that all coagulated blood becomes vaſcular: and indeed the reaſon is obvious; for it is often thrown out, and coagulated in parts where its

its becoming vascular can answer no end in the system; as, for example, in the cavities of aneurismal sacs. If it be supposed, that, in such cases as that just now mentioned, the vessels are not formed in the coagulum, but come from the neighbouring arteries, he thinks it equally an argument that the blood is alive; for the substance into which vessels shoot must be so. The very idea that such a quantity of dead matter as the whole mass of blood, circulates in a living body, appears to him absurd.

Nervous System alone thought by some to contain the vital principle.

The system which at present stands opposed to that of Mr. Hunter, considers the brain and nervous system as the fountain of life, and that, so far from receiving its life from the blood, the nervous system is capable of instantaneously changing the crasis of the blood, or any other animal fluid; and though the nervous system cannot continue its action for any length of time, if the action of the blood-vessels is suspended, yet the heart and blood-vessels cannot act for a single moment without the influence of the nervous fluid. Hence, say they, it is plain we must suppose the nervous system, and not the blood, to contain properly the life of the animal, and consequently to be the principal vital organ. The secretion of the vital fluid from the blood, by means of the brain, is, by the supporters of this hypothesis, denied. They say, that any fluid secreted from the blood must be aqueous, inelastic, and inactive; whereas the nervous fluid is full of vigour, elastic, and volatile to the highest degree. The great necessity for the circulation of the blood through all parts of the body, notwithstanding the presence of the nervous fluid in the same parts, they say, is because some degree of tension is necessary to be given to the fibres, in order to fit them for the influx of the nervous fluid; and this tension they receive from the repletion of the blood-vessels, which are every where dispersed along with the nerves.

To follow this dispute through every argument that hath been, or that may be, used by both parties, would prove tedious, and to us appears, in a great measure, unnecessary, as the following short considerations seem to decide the matter absolutely against the patrons of the nervous system:

Decisive Arguments in Favour of Mr. Hunter's Opinion.

In the first place, then, if we can prove the life of the human body to have existed in, or to have been communicated from a fluid to the nervous system, the analogical argument will be very strongly in favour of the supposition that the case is so still. Now, that the case once was so, is most evident; for the human body, as well as the body of every other living creature, in its first state, is well known to be a gelatinous mass, without muscles, nerves, or blood-vessels. Nevertheless, this gelatinous matter, even at that time, contained the nervous fluid. Of this there can be no doubt, because the nerves were formed out of it, and had their power originally from it; and, what is remarkable, the brain is observed to be that part of the animal which is first formed. Of this gelatinous fluid we can give no other account, than that it was the nutritious matter from which the whole body appeared to be formed. At the original formation of man, and other animals, therefore, the nutritious matter was the substratum of the whole body, consisting of muscles, nerves, blood-vessels, &c.: nay more, it was the immediate efficient cause of the nervous power itself. Why should it not be so now, as well as then?

Again, in the formation of the embryo, we see a vital principle existing, as it were, at large, and forming to itself a kind of regulator to its own motions, or a habitation in which it chooses to reside, rather than to act at random in the fluid. This habitation, or regulator, was undoubtedly the nervous system, and continues so to this moment. But, at the same time, it is no less evident that a nutritious fluid was the immediate origin of these same nerves, and of that very nervous fluid. Now, we know, that the fluid which in the womb nourishes the bodies of all embryo animals, is necessarily equivalent to the blood which nourishes the bodies of adult ones; and, consequently, as soon as the blood became the only nutritious juice of the body, at that same time the vital or nervous fluid took up its residence there, and from the blood diffused itself along the nerves, where it was regulated exactly according to the model originally formed in the embryo. Perhaps it may be said, that the vital power, when once it hath taken possession of the human or any other body, requires no addition or supply; but continues there, in the same quantity, from first to last. If we suppose the nervous power to be immaterial, this will indeed be the case, and there is an end of reasoning upon the subject: but if we call this power a volatile and elastic fluid, it is plain that there will be more occasion for recruits to such a power than to any other fluid of the body, as its volatility and elasticity will promote its escape in great quantities through every part of the body.

It may also be objected, that it is absurd to suppose any fluid or mechanical cause capable of putting matter in such a form as to direct its own motions in a particular way: but even of this we have a positive proof, in the case of the electric fluid. For if any quantity of this matter has a tendency to go from one place to another, where it meets with difficulty, through the air, for instance, it will throw small conducting substances before it, in order to facilitate its progress. Also, if a number of small and light conducting substances are laid between two metallic bodies, so as to form a circle, for example, a shock of electricity will destroy that circle, and place the small conducting substances nearer to a straight line between the two metals; as if the fluid knew there was a shorter passage, and resolved to take that, if it should have occasion to return. Lastly, it is universally allowed that the brain is a secretory organ, made up of an infinite number of small glands, which have no other excretories than the medullary fibres and nerves. As a considerable quantity of blood is carried to the brain, and the minute arteries end in these small glands, it follows that the fluid, whatever it is, must come from the blood. Now there is no gland whatever in the human or any other body, but will discharge the fluid it is appointed to secrete, in very considerable quantity, if its excretory be cut. Upon the cutting of a nerve, therefore, the fluid secreted by the brain ought to be discharged; but no such discharge is visible. A small quantity of glairy matter is indeed discharged from the large nerves; but this can be no other than the nutritious juice necessary for their support. This makes it plain, even to demonstration, that the fluid secreted in the brain is *invisible* in its nature; and as we know the nervous fluid hath its residence in the brain, it is very probable, to use no stronger expression, that it is the peculiar province of the brain to secrete this fluid from the blood, and consequently that the blood originally contains this vital principle.

After it is allowed that the blood contains the vital principle, it becomes another question, not very easily solved, Whence is the vital principle derived?

Vivifying Spirit supposed to be derived from the Air.

For this we can only discover two sources; namely, the chyle, or aliment from which the blood is prepared, and respiration.—The latter hath been commonly held as the principal source of the vital principle; and, for a long time it was generally thought that there was a kind of vivifying spirit in the air, which being absorbed by the blood at each inspiration, communicated to that fluid the quality necessary for preserving animal life. As a proof of this, it was urged, that life cannot be supported without respiration; and that air which hath been often breathed ceases to be capable of supporting life; because when once it has been totally deprived of its vivifying spirit, it can communicate none to the blood in any subsequent respirations. This doctrine, however, hath been denied, and generally thought to be exploded by modern discoveries. Dr. Hales brings several experiments against it; of which the following may serve for a specimen, and which we shall give in his own words:

Dr. Hales's Experiment against a vivifying Spirit.

"I tied a middle-sized dog alive on a table, and having laid bare his wind-pipe, I cut it asunder just below the larynx, and fixed fast to it the small end of a common fosset: the other end of the fosset had a large bladder tied to it, which contained 162 cubic inches; and to the other end of the bladder was tied the great end of another fosset, whose orifice was covered with a valve, which opened inwards, so as to admit any air that was blown into the bladder, but none could return that way; yet, for further security, that passage was also stopped by a spigot.

"As soon as the first fosset was tied fast to the wind-pipe, the bladder was blown full of air, through the other fosset; when the dog had breathed the air in the bladder to and fro for a minute or two, he then breathed very fast, and shewed great uneasiness, as being almost suffocated.

"Then with my hand I pressed the bladder hard, so as to drive the air into his lungs with some force; and thereby make his abdomen rise by the pressure of the diaphragm, as in natural breathings; then taking alternately my hand off the bladder, the lungs with the abdomen subsided: I continued in this manner to make the dog breathe for an hour; during which time, I was obliged to blow fresh air into the bladder every five minutes, three parts out of four of that air being either absorbed by the vapours in the lungs, or escaping through the ligatures, upon my pressing hard on the bladder.

"During this hour, the dog was frequently near expiring, whenever I pressed the air but weakly into his lungs; as I found by his pulse, which was very plainly to be felt in the great crural artery near the groin, which place an assistant held his finger on most part of the time; but the languid pulse was accelerated so as to beat fast, soon after I dilated the lungs much, by pressing hard upon the bladder: especially when the motion of the lungs was promoted by pressing alternately the abdomen and the bladder, whereby both the contraction and dilatation of the lungs was increased.

"And I could by this means rouse the languid pulse whenever I pleased, not only at the end of every five minutes, when most air was blown into the bladder from a man's lungs, but also towards the end of the five minutes, when the air was fullest of fumes.

"At the end of the hour, I intended to try whether I could have by the same means kept the dog alive some time longer when the bladder was filled with the fumes of burning brimstone; but being obliged to cease for a while from pressing the air into his lungs, while matters were preparing for this additional experiment

riment, in the mean time the dog died, which might otherwiſe have lived longer, if I had continued to force the air into the lungs.

"Now, though this experiment was ſo frequently diſturbed, by being obliged to blow more air into the bladder twelve times during the hour; yet ſince he was almoſt ſuffocated in leſs than two minutes, by breathing of himſelf to and fro the firſt air in the bladder, he would have died in leſs than two minutes, when one-fourth of the old air remained in the bladder, immediately to taint the new air admitted from a man's lungs; ſo that his continuing to live through the whole hour muſt be owing to the forcible dilatation of the lungs, by compreſſing the bladder, and not to the vivifying ſpirit of the air."

Dr. Hales's Experiment inconcluſive.

Theſe theories were oppoſed in the former edition of this Work. With regard to Dr. Hales's opinion, that the want of elaſticity, or preſſure, is the reaſon why phlogiſticated air cannot ſupport animal life, we apprehend it to be totally inconcluſive, becauſe it doth not at all appear that phlogiſticated air wants elaſticity; on the contrary, from Dr. Prieſtley's experiments, it appears to be more elaſtic than common air. Beſides, we know that the elaſticity of every fluid muſt always be in proportion to the preſſure upon it, as re-action is always equal to action. Suppoſing, therefore, the elaſticity of any portion of air to be deſtroyed, the preſſure of the ſuperincumbent atmoſphere will reduce it into a proportionably leſs bulk, and then it is equally elaſtic with the reſt; for if it was not, it would behove it ſtill to yield under the preſſure. Hence we may ſee, that as the bladder made uſe of in Dr. Hales's experiment was by no means ſufficient to keep off the preſſure of the external atmoſphere, the death of the dog could not be fairly aſcribed to want of elaſticity in the tainted air. When he applied more force than the natural elaſticity of the air, he kept the dog *alive*, as he calls it, for an hour; but we can by no means allow a mechanical circulation of the blood to be life, any more than we can allow a dead body to be alive on account of the motion of its arm, or any other member, by mechanical means. The experiment, however, is valuable, becauſe it ſhews that reſpiration is one of the immediate mechanical agents by which the circulation of the blood is carried on; but in order to prove that the dog was really kept alive by this means, he ought to have recovered from the effects of the experiment. Had Dr. Hales tried a ſimilar experiment on himſelf, by taking the ſoſſet in his mouth, cloſing his noſtrils, and cauſing another perſon to compreſs the bladder, we have not the leaſt doubt but he would then have felt ſuch a method of breathing not to be a way of preſerving life, but of deſtroying it.

Dr. Prieſtley's Opinion.

Dr. Prieſtley at firſt concluded from his own obſervations, and no doubt very juſtly, that air which hath been often breathed becomes pernicious by its accumulated phlogiſton, ſtimulating the lungs, and making the animal fall into convulſions. Reſpiration, therefore, he ſuppoſed to be a phlogiſtic proceſs, in which the blood parts with its ſuperfluous phlogiſton. He did not ſay, that the blood receives nothing in exchange; but rather, that it may receive ſome nitrous principle, which gives it the red colour: but as to a vivifying ſpirit, he doth not appear to have the leaſt idea of any ſuch thing being received at that time. Nay, in his firſt volume, p. 277, he expreſsly adopts the other hypotheſis, namely, that the vital principle is received from the chyle. "My conjecture (ſays he) is, that animals have a power of converting phlogiſton, from the ſtate in which they receive it in their nutriment, into that ſtate in which it is called the *electrical fluid;* that the brain, beſides its other proper uſes, is the great laboratory, and repoſitory for this purpoſe; that, by means of the nerves, this great principle, thus exalted, is directed into the muſcles, and forces them to act in the ſame manner as they are forced into action when the electric fluid is thrown into them *ab extra*."

Proof of a Reception of the vivifying Principle from the Air.

"Now, to apply this reaſoning to the point in queſtion: The blood is found to emit phlogiſton from the lungs at every expiration; therefore we affirm that it hath received a proportional quantity of elaſtic vapour, which it had not before. Again, The air expelled from the lungs is found to contain much of the fixable part floating looſe, and capable of being attracted by lime-water, &c.; therefore we ſay, this elaſtic principle hath come from that part of the atmoſphere. But, to put the matter beyond doubt, the very inſpection of arterial and venous blood will ſhew, that the firſt hath a quantity of elaſtic matter in it, which the laſt wants: and as the brain, as well as all other parts of the body, are ſupplied with arterial blood, we think it abundantly evident, that this elaſtic principle is abſolutely and eſſentially neceſſary to life; that it is continually expended thereon; and that it may be ſaid, with the utmoſt propriety, that every time we draw the air into our lungs, we receive a portion of vivifying or vital ſpirit from it into our blood. Add to all this, that many ſubſtances, which are commonly obſerved to phlogiſticate air, appear to receive an elaſtic ſpirit by ſo doing. Putrifying bodies ſwell: they would not do ſo *in vacuo;* and therefore we muſt conclude, that they receive this elaſtic principle which ſwells them from the external air, and experience ſhews that it is communicated by this fixable part of the atmoſphere.

"The foregoing reaſoning, which to us appeared ſufficiently concluſive, leads to a very important diſcovery in natural philoſophy, *viz.* That it is to the atmoſphere, and to that particular part of it which goes by the name of *fixed air*, that we are every moment indebted for that vital ſpirit which animates our bodies, and is the immediate bond of union betwixt our immaterial ſpirit and this viſible world. It may be aſked, indeed, If fixed air is capable of ſupplying this ſpirit in ſuch plenty, how comes it to be ſo inſtantaneouſly fatal, when breathed? The reply to this, however, is obvious; it communicates too great a degree of elaſticity to the blood, whence the circulation is ſtopped, and inſtant death enſues. That this is really the caſe, appears from the following account of the ſymptoms obſerved on the diſſection of perſons who have been ſuffocated by this kind of air.

Appearances on the Diſſection of thoſe ſuffocated by Fixed Air.

"1. The veſſels of the brain are gorged with blood, and the ventricles of that viſcus are filled ſometimes with a frothy, ſometimes with a bloody, ſeroſity. 2. The trunk of the pulmonary artery is much diſtended, and the lungs appear nearly in a natural ſtate. 3. The right ventricle and auricle of the heart, the venæ cavæ, and jugular veins, are full of frothy blood. 4. Bloody ſeroſity is often found in the bronchiæ. 5. The trunk of the pulmonary veins, and the left auricle, are either empty, or almoſt empty, of blood. 6. The blood found in the places that have been mentioned, is generally fluid, and, as it were, in a diſſolved ſtate. It is eaſily extravaſated into the cellular texture, of the head particularly, becauſe it is in this part that it abounds moſt. 7. The epiglottis in ſuffocated perſons is raiſed, and the glottis open and free. 8. The tongue is much ſwelled, and can hardly be contained within the mouth. 9. The eyes protrude, and preſerve their luſtre to the ſecond or third day; they are often even brighter than natural. 10. The body preſerves its heat for a long time; nay, the heat is ſometimes greater than it is during life, or, at leaſt, conſiſtently with health. 11. The limbs are flexible for a long time after death. 12. The face is more ſwelled, and often more red, than uſual. 13. The neck, and upper extremities, are ſometimes ſo much ſwelled, that they appear to be inflamed. Theſe ſwellings, however, do not, like œdematous ones, preſerve the impreſſions of the finger.

Fixed Air ſuppoſed the Cauſe of Animal Heat.

"This account ſeemed ſo much in favour of what we had really advanced concerning the action of fixed air, that no obſervation was made upon it, farther than that this elaſtic principle would ſeem alſo to be the cauſe of animal heat; for, as the blood evidently received a vaſt quantity of elaſtic fluid, it alſo received a much greater proportion of heat than uſual."

Such was the mode of reaſoning adopted at that time, derived from the diſcoveries which had been made in *Aërology*. Succeeding diſcoveries, however, have made it evident, that fixed air is not one of the natural component parts of our atmoſphere, but that it conſiſts of two different fluids; one of which is commonly called *phlogiſticated*, the other *dephlogiſticated*, air. It is the latter which ſupplies the vital principle; and the above reaſoning ſtill holds good, only ſubſtituting the words *dephlogiſticated air* for *fixed air*. See each, with their reſpective properties, in the Syſtem of AEROLOGY, Sect. 3 and 5. The poiſonous quality of the latter ſeems alſo ſtill to depend on its too eaſy decompoſition; by which means the elaſtic principle is diſcharged into the blood in ſuch quantity as to burſt the ſmall veſſels, as has already been obſerved. This is ſhewn, indeed, by the remedies moſt proper for the recovery of thoſe who have ſuffered from the noxious qualities of fixed air: theſe conſiſt in evacuation, and eſpecially ſprinkling the body with cold water, in order to take off the ſuperfluous heat, and produce an univerſal contraction of the veſſels.

As to the *heat* of the blood, authors are exceedingly divided about the cauſe thereof. The ancients aſcribe it to a vital flame, or innate heat, lodged in the heart, and thence communicated to the blood. Dr. Willis imagines a kind of acceniion in the blood; and thinks its heat reſults from its being, as it were, ſet on fire, and perſevering in that ſtate. Dr. Henſhaw ſolves it from an ebullition, conſequent on the mixture of two fluids, ſo diſſimilar as the chyle and blood. Others have recourſe to the chymical principles of alkali and acid; others to the mutual action of the principles, or component parts of the blood, by means whereof an inteſtine motion, and by that means an inteſtine heat, or incaleſcence, is effected.

Dr. Boerhaave accounts for the heat of the blood from the action of the heart, and the re-action of the aorta: for, the blood driven by the heart obliquely againſt the ſides of the aorta, preſſes them, and ſpends almoſt its whole momentum againſt the curvity thereof, and is, by the figure and elaſticity of this veſſel, preſſed back again. Every moment of time, therefore, each particle of blood acquires a new motion, a new niſus, and rotation. Hence follows a perpetual attrition, attenuation, rubbing off of angles, and a ſimilitude and homogeneity of all the parts; and hence the maſs derives its fluidity, heat, diviſion into particles accommodated to all veſſels, preſſure into the lateral tubes, &c.

Quantity of Blood.

The Quantity of BLOOD in a human body has been variouſly eſtimated by various authors. Dr. Lower computes it, in an ordinary

ordinary man, at about twenty pounds. Dr. Moulin, by obſerving the proportion of the weight of ſeveral animals to their blood, eſtimates it at about one-twentieth of the weight of the whole man, which may amount to eight or ten pounds. Dr. Keill, from a calculation founded on a proportion of the coats to the diameters of the veſſels, ſhews, that in a body weighing 160 pounds, 100 pounds thereof are blood; but then, under blood, he includes the juices of the lymphe-ducts, nerves, and other veſſels, which are ſecreted from it.

In reality, it is very difficult to determine the quantity of blood in the body. Bleeding to death, the method uſed by Dr. Moulin and others, can never give the eſtimate of its true quantity; becauſe no animal can bleed longer than while the great artery is full, the continuance of which will be longer or ſhorter, as the wounded artery is ſmaller or greater; and the aorta muſt always be the firſt veſſel that empties. The moſt certain way, in Dr. Keill's opinion, is, by finding what proportion the cavities of the veſſels, of which the whole body is compoſed, bear to the thickneſs of the coat. This, in the veins and arteries, may be exactly found; but, in other veſſels, we only know the quantity of fluid they contain, by carefully evaporating as much as poſſible.

Some think it probable, that at leaſt two-thirds of the quantity of blood contained in an animal body is continually paſſing the capillaries and ſmall veſſels in the glandular and muſcular parts, which can never be taken off by any thick diſcharge, from cutting the large veſſels; ſince, in that caſe, the larger veſſels, being emptied much faſter than they can be ſupplied again from the capillaries, a defect of blood will ſoon enſue at the heart, upon which the animal falls into convulſions, and the circulation ſtops, while far the greater part of the blood muſt be ſuppoſed ſtagnating in the ſmaller and remoter veſſels.

Changes and Diſorders of the Blood.

From the principles, or conſtituent parts, of the blood, above recited, variouſly combined and diſtributed by the circulatory motion impreſſed by the heart, and by the oſcillatory expanſive motion of the interſperſed air, and the re-action of the contractile veſſels, flow all the properties and operations of the blood. From this mixture of elements, and their lax compoſition, it becomes ſuſceptible of various alterations and impreſſions; the principal whereof are, *coagulation*, which uſually attends it out of the body, ſometimes in it, and ſcarce ever without an artificial procurement, but always mortal; and *diſſolution*, which is juſt oppoſite to the former, and conſiſts in ſuch a comminution of the fibrous parts of the blood, as indiſpoſes it for a ſeparation of the cruor from the ſerum. This is frequently the conſequence of malignant and peſtilential fevers, &c. and is likewiſe occaſioned by ſome kinds of poiſons. See the Syſtem of MEDICINE, Genus VI.

Theſe two contrary affections of the blood Dr. Drake aſcribes to the oppoſite kinds of ſalts, acids, and volatile alkalis. For though, adds he, in a human body no pure acid is found, nor could it, indeed, be conſiſtent with life; yet it may, and does often, enter the blood, ſo compounded as to bridle the volatile alkalious ſalt of the blood, and ſo hinder the due attenuation and mixture of the ſeveral parts; as is the caſe in a diabetes, and perhaps in a chloroſis, where the blood is thick and torpid: on the other hand, where the alkalious ſalts are too redundant, the blood is rendered too thin and fluid, ſo that the difference of its conſtituent parts is loſt.

Another affection frequent in the blood is, a too great abundance of gelatinous ſubſtance, by means whereof the active parts of the blood are too much clogged, and thoſe parts which ſhould be ſecreted, for peculiar uſes in the body, are detained; and perhaps the ſolids, through which it paſſes, too much lubricated, their tone vitiated, ſhrunk, relaxed, &c. whence the ſluggiſhneſs and inactivity of very fat people. See CORPULENCY.

The contrary affection to this is, the defect of this gelatinous conſiſtence in the blood; which being, as it were, its balſam, lines and preſerves the parts from being fretted and corroded by the ſalts, whoſe ſpicula, or edges, are, as it were, ſheathed into this ſoft balſamic matter, and their attrition againſt the ſolid parts prevented. This ſtate of the blood is uſually attended with a general atrophy, and a fretting and corroſion of ſome particular parts; whence ſerous defluctions, apoſthumations, and ulcers, eſpecially in the lungs, whoſe tender veſiculous ſubſtance is more eaſily annoyed than any other, by the acrimony of the ſaline ſerum. See Syſtem of MEDICINE, Genus LI.

There are other affections of the blood, reſulting from its inordinate temperature and mixture, with regard to the earthy parts; the conſequences of which are, the ſtone, &c.; and others that do not originally ſpring from any dyſcraſy, or undue mixture of the elements, but from an alteration in its motion; ſuch as an augmentation or diminution of its progreſſive motion, or the like changes in its inteſtine motion; whence ſupernatural fermentations are induced. The occaſions here may be various; ſometimes fevers, and other diſorders, occaſioned by ſurfeits, debauches, catching cold, violent exerciſe, &c. whence atonias; at other times, ſome latent malignity of the air, whence epidemical diſeaſes. To which may be added divers other morbific conſtitutions, depending on the different ſtates and diſpoſitions of the blood, in reſpect of quantity, velocity, fluidity, denſity, ſeroſity, &c. An exceſs in the quantity of blood conſtitutes what we call a *plenitude*, or *plethora*; a defect, or want of a competent quantity, *leiphæmia*.

The ſymptoms of exceſs or defect, of an over repletion or depletion, in the blood-veſſels, are obvious; but caution muſt be uſed not to miſtake every occaſional flushing or tide of the blood to the head, for a general plethora of the blood-veſſels, ſuch tides and flushings being very common in caſes where there is yet no blood to ſpare.

The equilibrium of the BLOOD, is an uniform and proportional diffuſion of it through all the parts of the body. Any conſiderable ſtimulus, it is known, will drive the blood in large quantities to the ſtimulated part, which muſt neceſſarily break the equilibrium and uniformity of its circulation; whence congeſtions, ſtagnations, concretions, &c. of the blood; and hence it is, that a great part of regular practice conſiſts in driving, revulſing, diſcuſſing, and variouſly directing and determining the blood, in order to recover its equilibrium. The equilibrium of the blood againſt any occaſional affluxes and refluxes of this fluid, is preſerved or reſtored, either by raiſing and diffuſing it when too weak and languid, by cardiacs; as ſaffron, opium, Virginia ſnake-root, &c. or by depreſſing and repelling it, when too much raiſed and diffuſed; which is done by the abſorbents, coolers, purgatives, acids of all ſorts, eſpecially apples.

The morbific exceſs or defect of the blood's velocity is as remarkable as that of its quantity; but this cannot be judged from the natural ſtate of the pulſe in health, which is different in different conſtitutions. The ordinary number of pulſations in a minute is from 70 to 80 under a ſtate of waking and moderate heat, and from 80 to 90 during the time of ſleep. See the article PULSE.

The too great *heat* and *viſcidity* of the blood, are ſome of its moſt generally prevailing morbific conſtitutions, eſpecially in a country like our's, abounding, with all the temptations to, and proviſions for, eaſe and luxury. This ſtate of the blood is brought on generally by drinking too freely, hot, ſpirituous, inflammable liquors, and feeding plentifully on things which contain a large proportion of volatile oily ſalts; as fleſh meats, half boiled or roaſted, eaten in their bloody gravy, and all hot, ſpicy, and high-ſeaſoned broths, ſauces, and the like. The blood being by theſe overheated and rarefied, the ſerum is, in conſequence, thickened into a kind of jelly, by which means it is rendered unfit for motion, coheres too ſtrongly with the craſſamentum, and paſſes but ſlowly through the lymphatics and ſecretory glands. In this ſtate, the thicker and more viſcid parts of the ſerum, lodging on the lymphatics and receptacles of the glands, gradually obſtruct or fill them up. From which obſtruction and diminiſhed or intercepted circulation of the animal fluids, the heat and viſcidity of the blood ſtill increaſe, till a vital flame, raiſed too high, produces a fever. See the article FEVER, and Syſtem of MEDICINE, Genus VIII. This ſtate of the blood, and its ſymptoms, are aggravated by a ſedentary life, or the want of due motion or exerciſe; for while the natural motion of the muſcular *fibrillæ* is either not all, or but little, promoted by voluntary action, the glands, and their receptacles, muſt be the ſooner ſtuffed up, and the circulation of the lymph, that powerful means by which nature continually cools and dilutes the blood, ſooner be ſuſpended.

The blood is cooled, diluted, and attenuated, by temperance, exerciſe, the uſe of water as beverage, or otherwiſe, and by deobſtruents, eſpecially mercury, in the gentler preparations of it; as *æthiops*, or cinnabar, given in moderate doſes, ſo as not ſenſibly to affect the ſtomach; nor excite ſalivation for a long time.

As to the greater or leſs degree of fluidity and viſcidity of the blood, it is manifeſt, that this humour may either have its parts too intimately divided and attenuated, or, on the contrary, there may be too cloſe a coheſion between its parts, ſo as to render the maſs too thick and viſcous. The firſt of theſe ſtates diſpoſes the blood to a too quick, eaſy, and rapid motion; and ſometimes diſſolves and fuſes it to ſuch a degree, that the globules or craſſamentum paſs, together with the ſerum, through the glandular ſtrainers, and occaſion bloody ſecretions; as in malignant and peſtilential fevers, bloody ſweats, and other preternatural hæmorrhages. The latter or viſcid ſtate renders the blood unapt for motion, and diſpoſes it to ſtick and lodge in the capillaries and lymphatics.

The ſpecific gravity of the BLOOD, or the various degrees of its rarefaction and condenſation, depend on the degrees of heat: as the natural heat either riſes too high, or ſinks too low, the blood will of conſequence be either too much rarefied, or too much condenſed. In the former caſe, where the blood is overheated and rarefied, the expanſive force of the elementary fire and air contained in the maſs prevails over the corpuſcular attraction: and then, by the coagulating power of heat upon the ſerum, and its too intimate mixture and coheſion with the craſſamentum, the lymph which ſhould form the ſecretions, cannot be ſeparated, but the ſerum is, as it were, abſorbed in the craſſamentum; in conſequence of which, the ſecretions muſt be diminiſhed, or quite ſuſpended, and a fever enſue, more or leſs inflammatory, according

ing to the degrees of heat in the blood, and the conſequent ſuſpenſion or interruption of the lymphatic ſecretions.

On the other hand, when the blood is immoderately cooled and condenſed, the corpuſcular attraction prevailing over the expanſive force, the ſerum will be over thinned and diluted, and conſequently ſeparated too faſt, and thrown off too plentifully on the glands and lymphatics, ſo that if the urinary drains happen to be obſtructed, a ſurcharge of ſerum muſt enſue, and in conſequence of this a dropſy; and in caſe the fluid parts of the urine paſs freely enough, and only the groſſer recrements, ſalts, and ſabula, or fine ſands, be kept back, theſe being thrown on the ſeveral organs, will produce the ſymptoms of the ſcurvy.

There are frequent inſtances of the tawney colour of the ſerum, the reſolution of the craſſamentum, and even of the offenſive ſmell of blood recently drawn. And, indeed, if we reflect how putreſcent blood is in a heat equal to that of the human body, we may be convinced that no ſooner is the reſpiration of the lungs impeded, than a corruption begins in the whole maſs; which, if not timely prevented, brings on ſome putrid diſeaſe. If the acrimony is great and ſudden, a fever or flux will enſue; but if the accumulation is ſo flow that the body grows habituated to the putrefaction, a ſcurvy prevails. This is the caſe in long voyages, on board unventilated ſhips; in marſhy countries; and, in a leſſer degree, in all northerly climates, in moiſt ſituations.

Thickneſs of the BLOOD, is alſo a preternatural concretion, following on a plethora, or diminution of its motion, from which ſtagnations and other diſorders draw their riſe. This is either general throughout the whole body; or ſpecial, confined to ſome particular part; as in hypochondriac and hyſteric caſes, where the blood, by reaſon of the ſlowneſs of its progreſſion, acquires a lentor in the region of the abdomen. To the ſame cauſe are alſo owing polypuſes, apoplexies, pleuriſies, infractions of the viſcera, palpitations of the heart, ſuppreſſions of the menſes, &c. See the Syſtem of MEDICINE, under the reſpective genera.

Excretions or evacuations of the BLOOD, are either ſpontaneous, as in the hæmorrhoids, hæmoptoe, hæmorrhages at the noſe, the lochia, and menſtrual flux: or artificially produced by medicines, emmenagogues, venæſections, ſcarifications, leeches, &c. The want of due evacuations of the blood produces plethoras. In hypochondriacal caſes, the natural excretions by the anus, menſtrual flux, &c. are by all means to be promoted, as the ſureſt means of cure. See the Syſtem of MEDICINE, under the reſpective genera.

Spitting of BLOOD. Spirit of plaintain-juice, comfrey-roots, and fine ſugar, are recommended by Mr. Boyle as an approved remedy againſt ſpitting and vomitting of blood. Tar-water is ſaid to be a very good remedy in this caſe.

Orgaſm of the BLOOD, denotes an extraordinary efflatus or ebullition obſerved in fevers, frenſies, hæmoptoes, palpitations of the heart, and even by ſome ſuppoſed in cephalagias, ſcurvies, arthritic pains, &c. It is to be compoſed or allayed by calmers, nitrous preparations, &c. rather than by opiates.

Flux of BLOOD, is called an *Hæmorrhage*. The periodical ones of women, *Menſes*. Thoſe after child-birth, *Lochia*. That ordinarily happening on the firſt coition is by ſome called and conſidered as the teſt of virginity. In the Philoſophical Tranſactions we have ſeveral very uncommon inſtances of ſpontaneous hæmorrhages, or effuſions of blood; particularly of a child that bled at the noſe, ears, and hind part of the head, for three days; from that to the ſixth, ſhe ſweat blood from the head; on the ſixth, bled at the head, ſhoulders, and waiſt; and for three days more continued to bleed at the toes, bend of the arms, joints of the fingers of each hand, and at the fingers' end, till ſhe died: after death were found, in the places where the blood iſſued, little holes, like the prickings of a needle.

Nutritious Principles of the Blood.

About the matter of nutrition, or the ſource whence the nouriſhment is derived, great conteſts have ariſen among phyſicians and anatomiſts; ſome contending for a nutritious juice conveyed through the lungs, ſome ſetting up the lymph, others the chyle, ſome the ſerum of the blood, ſome the cruor, as the univerſal ſuccus alibilis, &c. However, all theſe, except they who bring the nutriment through the nerves, make the blood the vehicle that conveys the alimentary parts through the body, whatever they be, and whenceſoever derived. See NUTRITION, and the Syſtem of ANATOMY, Part V. Sect. 3.

Uſes of Blood.

The principal uſe of blood in the arts is, for making Pruſſian blue, or ſometimes for clarifying certain liquors; it is alſo recommended in agriculture, as an excellent manure for fruit-trees. A mixture of blood with lime makes an exceedingly ſtrong cement; and hence it is of uſe in the preparation of ſome chymical lutes, the making of floors, &c. See Syſtem of ARCHITECTURE, Part II. Sect. 2, Article 7. As a food, it hath been diſputed whether blood really affords any nouriſhment or not. The beſt judges now, however, are generally agreed that it is very nutritious; and though out of the body, like the white of an egg, it is very inſoluble, yet, like that too, in the body it is commonly of eaſy digeſtion. It is, however, highly alcaleſcent in hot climates: on which account the prohibition of it to the Iſraelites was very proper. Even in this country, when blood was uſed as food in great quantity, the ſcurvy was more frequent than at other times; but to a moderate uſe of it here no ſuch objection takes place.

Religious Uſes of Blood.

Among the ancients, blood was uſed for the ſealing and ratifying covenants and alliances, which was done by the contracting parties drinking a little of each other's blood; and for appeaſing the manes of the dead, in order to which the blood was offered on their tombs as part of the funeral ceremony. Thus we read that twelve youths were ſacrificed at the funeral of Patroculus; and eight at that of Paris. Homer, Il. Φ. ver. 27. Virgil, Æn. lib. x. ver. 518.

The blood of victims was anciently the portion of the gods; and accordingly was poured or ſprinkled on the altars in oblation to them. The prieſts made another uſe of blood, *viz.* for divination: the ſtreaming of blood from the earth, fire, and the like, was held a prodigy or omen of evil.

The Roman prieſts were not unacquainted with the uſe of blood in miracles; they had their fluxes of blood from images, ready to ſerve a turn; witneſs that ſaid to have ſtreamed from the ſtatue of Minerva at Modena, before the battle at that place. But we know not whether in this their ſucceſſors have not gone beyond them. How many relations in eccleſiaſtical writers of Madonas, crucifixes, and wafers, bleeding! At leaſt, the liquefaction of the blood of St. Januarius at Naples, repeated annually for ſo many ages, ſeems to tranſcend by far all the frauds of the Grecian or Roman prieſthood. But the chymiſts at laſt got into the ſecret; and we find M. Neumann at Berlin to have performed the miracle of the liquefaction of dried blood, with all the circumſtances of the Neapolitan experiment.

Among the ſchoolmen we find a famous diſpute, under Pope Pius II. whether the blood of Chriſt, which fell from him in the three days' paſſion, retained or loſt the hypoſtatic union; and conſequently whether it was the proper object of adoration. The Dominicans maintained the former, the Franciſcans the latter. It ſeems the Dominican doctrine gained the aſcendant, as being fitted to favour the profits of the monks; who becoming poſſeſſed, ſome way or other, of a few drops of this precious liquor, were ſecured of ample offerings from the deluded laity, who flocked to pay their homage to the ſacred relic. Joſeph of Arimathea is ſaid to have firſt brought into Britain two ſilver veſſels filled with the blood of Chriſt, which, by his orders, were buried in his tomb. King Henry III. had a cryſtal, containing a portion of the ſame blood, ſent him by the maſter of the temple at Jeruſalem, atteſted with the ſeals of the patriarch; which treaſure the king committed to the church of St. Peter's, Weſtminſter, and obtained from the biſhops an indulgence of 6 years and 116 days to all that ſhould viſit it. Matt. Paris, even aſſures us, that the king ſummoning his nobles and prelates to celebrate the feaſt of St. Edward in St. Peter's church, was chiefly, *pro veneratione ſanctæ ſanguinis Chriſti, nuper adepti*, "in veneration of the holy blood of Chriſt, lately acquired." Divers others of our monaſteries were poſſeſſed of this profitable relic; as the college of Bons Hommes at Aſhbridge, and the abbey of Hales, to whom it was given by Henry, ſon of Richard duke of Cornwall, and king of the Romans. To it reſorted a great concourſe of people for devotion and adoration; till, in 1538, as the reformation took place, it was perceived to be only honey clarified and coloured with ſaffron, as was ſhewn at St Paul's croſs by the biſhop of Rocheſter. The like diſcovery was made of the blood of Chriſt, found among the relics in the abbey of Feſcamp, in Normandy, pretended to have been preſerved by Nicodemus, when he took the body from the croſs, and given to that abbey by William duke of Normandy; it was buried by his ſon Richard, and again diſcovered in 1171, and attended with different miracles; but the cheat, which had been long winked at, was at length expoſed, the relation of which is given by Speed.

BLOOD, in the *Romiſh Church*, is uſed in ſpeaking of the wine in the euchariſt; which they ſuppoſe miraculouſly converted, by the prieſt's conſecration, into the real blood of Chriſt. See TRANSUBSTANTIATION, &c.

BLOOD-*letting*. See BLEEDING.

BLOOD-*veſſels*, in anatomy, includes the veins and arteries. For a copious deſcription of the Vaſcular Syſtem, including the veins and arteries, and denominated by profeſſors, Angiology, ſee the Syſtem, Part V. throughout, and Plates 8 and 9.

BLOODY-*flux*. For the cauſes and methods of treating this diſorder, ſee the Syſtem of MEDICINE, Genus 44. For a very copious account, ſee the article DYSENTERY.

BLOODY *urine*, a diſorder wherein the urine comes away mixed with blood, in greater or leſs quantity.

The blood here voided uſually comes from the kidneys, though ſometimes from the bladder or ureters. It is ſometimes occaſioned by violent motion, or a fall on the back, cauſing a rupture of ſome of the blood-veſſels of the urinary parts: ſometimes it ſucceeds ſudden ſuppreſſions of the hæmorrhoids or menſes. The ſtone, eſpecially in the kidneys, will alſo occaſion frequent paroxyſms

roxyfins of this diſeaſe: and *cantharides* taken internally, or even applied externally, without acids, will ſometimes have the ſame effect. Bloody urine is a terrible ſymptom in the ſmall-pox, and malignant fevers; though on ſome occaſions it has proved critical, and carried off the diſtemper.

BLOOD-HOUND, the *canis ſagax* of Linnæus, *le chien courant* of Buffon, the *ſleuthounde* of the Scots. The hound or dog, with long, ſmooth, and pendulous ears. It was a dog of great uſe, and in high eſteem of our anceſtors. Its employ was was to recover any game that had eſcaped wounded from the hunter, or been killed and ſtolen out of the foreſt. It was remarkable for the acuteneſs of its ſmell, tracing the loſt beaſt by the blood it had ſpilt; from whence the name is derived. This ſpecies could, with the utmoſt certainty, diſcover the thief, by following his footſteps, let the diſtance of his flight be ever ſo great, and through the moſt ſecret and thickeſt coverts: nor would it ceaſe its purſuit till it had taken the felon. They were likewiſe uſed by Wallace and Bruce during the civil wars. The poetical hiſtorians of the two heroes frequently relate very curious paſſages on this ſubject; of the ſervice theſe dogs were of to their maſters, and the eſcapes they had from thoſe of the enemy. The blood-hound was in great requeſt on the confines of England and Scotland; where the borders were continually preying on the herds and flocks of their neighbours. The true blood-hound was large, ſtrong, muſcular, broad-breaſted, of a ſtern countenance, of a deep tan-colour, and generally marked with a black ſpot above each eye.

BLOSSOM, in a general ſenſe, denotes the *flower* of any plant. In a more proper ſenſe, the word is reſtrained to the flowers of trees, which they put forth in the ſpring, as the forerunners of their fruit, otherwiſe called their bloom. The office of the bloſſom is partly to protect, and partly to draw nouriſhment to, the embryo fruit, or ſeed. Phil. Tranſ. No. 399, p. 329. As eſſential as bloſſom may ſeem to be to fruits, being, according to Malpighi, both the uterus and the eggs, or fœtus of the plant, yet we are told of trees bearing fruit without bloſſoms, as was done by the maple-tree, in New England, mentioned by Mr. Dudley, and is always done by the polonic-tree, in China, which, according to Kircher's relation, produces its fruit immediately from the ſtock, without the intervention of any bloſſoms. Phil. Tranſ. No. 117, No. 385, p. 199. No. 26, p. 486.

In ſome plants the male and female parts of generation are remote from each other, e. gr. in the *gourd*, *pumpkin*, *melon*, *cucumber*, and all that race; to which may be added, the nut-bearing, and perhaps moſt bearing trees, which have all bloſſoms diſtinctly, male and female, on the ſame plant. The *male bloſſoms*, called alſo *catkins*, may be diſtinguiſhed from the others, in that they have not any piſtil or rudiment of fruit about them, but have only a large thrum, covered with duſt, in the middle.

The *female bloſſom* has a piſtil within the petala, or flower-leaves, and the rudiment of their fruit is always apparent at the bottom of the flower before it opens. See further particulars on this ſubject in the Syſtem of BOTANY, Sect. III.

BLOW-PIPE, among jewellers and other artificers, is a glaſs tube, of a length and thickneſs at diſcretion, wherewith they quicken the flame of their lamp, by blowing through it with their mouth. It is uſed in works of quicker diſpatch, which do not need the bellows, for concentrating flame, and various uſes. It may be made to melt ſilver, or even copper itſelf, which yet may be kept for many hours unmelted in a red-hot crucible, or the flame of the lamp or candle unaſſiſted by the blaſt. The enamellers have alſo tubes, of divers ſizes, wherewith to blow their enamel, anſwering to the ſame purpoſe as the *ponteglio*, or *blow-pipe* of glaſſmen.

The power of this inſtrument is ſo great, that by the blaſt of the breath directed upon the flame of a lamp or candle, it vitrifies any ſmall portion of mineral ſubſtance; and thus the proceſs of aſſaying in the dry way may be performed in a very ſhort time, where either want of inſtruments or opportunity prevent other methods from being uſed. M. Bergman obſerves that this inſtrument is extremely uſeful to chymiſts, as many experiments are daily neglected, either becauſe they require furnaces and a large apparatus of veſſels; from the want of time to examine them in the ordinary way; or from the quantity required in the common way for examination, when the matter may be too ſcarce or too dear. In all theſe caſes the blow-pipe may be advantageouſly uſed. For the uſes of the blow-pipe in making experiments on metallic ſubſtances, ſee the Syſtem of CHEMISTRY, Part III. Introduction.

BLOWING *of glaſs*. One of the methods of forming the divers kinds of works in the glaſs manufacture. It is performed by dipping the end of an iron ponteglio, or blowing-pipe, in the melted glaſs, and blowing through it with the mouth, according to the circumſtances of the glaſs to be blown. See a copious account of this operation, under the article GLASS.

BLOWING, in medicine. One method of adminiſtring medicines is by inflation, or blowing them into the part by a tube: thus it is, they ſometimes convey powders into the eye, and ſometimes up the noſe, for the cure of a polypus.

BLUBBER, the fat which inveſts the bodies of all large cetacious fiſh, ſerving to furniſh an oil. The *blubber* is properly the *adeps* of the animal: it lies immediately under the ſkin, and over the muſcular fleſh. In the porpoiſe, it is firm and full of fibres, and inveſts the body about an inch thick. In the whale, its thickneſs is ordinarily ſix inches; but about the under lip, it is found two or three feet thick. The whole quantity yielded by one of theſe animals ordinarily amounts to forty or fifty, ſometimes to eighty or more, hundred weight. Phil. Tranſ. No. 77, p. 8275.

The uſe of the blubber to the animal ſeems to be partly to poiſe the body, and render it equiponderant to the water; partly to keep off the water at ſome diſtance from the blood, the immediate contact whereof would be apt to chill it; and partly alſo for the ſame uſe that clothes ſerve us, to keep the fiſh warm, by reflecting or reverberating the hot ſteams of the body, and ſo redoubling the heat; ſince all fat bodies are, by experience, found leſs ſenſible of the impreſſion of cold than lean ones.

BLUE, one of the ſeven colours into which the rays of light divide themſelves when refracted through a glaſs priſm. For an account of the particular ſtructure of bodies by which they appear of a blue colour, ſee the Syſtem of OPTICS, Part I. Sect. 3. Problem 8 to 12. See alſo the Syſtem of CHYMISTRY, Part IV. Chap. 1. Sect. 10.

Dyers' BLUE, is one of their ſimple or mother colours, uſed in the compoſition of others; it is given chiefly with woad and indigo. See the Treatiſe on DYEING, Sect. 2.

Pruſſian, or *Berlin* BLUE, is a modern invention, conſiderably in uſe among painters, though inferior to ultramarine blue. It was diſcovered, by accident, about the beginning of this century. A chymiſt of Berlin, having ſucceſſively thrown upon the ground ſeveral liquors from his laboratory, was ſurpriſed to ſee it ſuddenly ſtained with a moſt beautiful colour. Recollecting the liquors he had thrown on each other, he made a ſimilar mixture in a veſſel, and produced the ſame colour. He did not publiſh his proceſs, but prepared and ſold his blue, which was ſubſtituted for ultramarine. The account of it was firſt publiſhed in the Berlin Memoirs, 1710; but without the deſcription of its proceſs.

The method of making this Pruſſian blue, in perfection, has been purchaſed as a very valuable ſecret. Its proceſs is very extraordinary, and could ſcarcely be derived *à priori* from any reaſoning about the nature of colours. It is allowed to be an excellent blue pigment, and is by ſome preferred to ultramarine, though its durability might have been ſuſpected, from the vegetable and animal matters uſed in its preparation, if the colour did not ſeem extraordinarily fixed by the operation. The goodneſs of Pruſſian blue muſt be diſtinguiſhed by its brightneſs, deepneſs, and coolneſs.

There are four different proceſſes given for making the fineſt ſort of Pruſſian blue, with quick-lime, given in the Hiſt. of the Acad. of Scienc. at Paris, for the year 1756.

Proceſs I. Take 3lb. of ox's blood, dried and reduced into a kind of ſmall ſcales: an equal quantity of quick-lime, newly baked; 2lb. of red tartar, and 1lb. 8oz. of ſaltpetre: pulveriſe the whole groſsly, and put it into a crucible, placed in the midſt of a great furnace, and give it a gradual fire. After four hours, when the matter is reduced into a kind of paſte, which emits no more ſmoke, and is equally red, throw it by ſpoonfuls into two pails of boiling water; and, having filtrated the lixivium, mix it with a ſolution of 6lb. of alum, and 1lb. 8oz. of green vitriol. This operation will yield but 7 oz. of *fecula*; but its beauty will make ſufficient amends for the ſmall quantity, as it will ſurpaſs, in this reſpect, all the blues of Pruſſia which are prepared by other methods.

It has alſo as good an effect as the fineſt ultramarine; and has beſides the advantage of reſiſting the impreſſion of the air.

Proceſs II. Take 3lb. of dried ox's blood, an equal quantity of quick-lime, 2lb. of red tartar, and 2lb. of nitre: let them be calcined and lixiviated, as in the former proceſs; pour the ſolution into a lixivium of 4lb. of alum, and 1lb. of green vitriol. This operation will yield more of the *blue fecula* than the other, but the colour will be leſs beautiful.

Proceſs III. Take 3lb. of dried ox's blood, 4lb. 8oz. of quick-lime, 2lb. of red tartar, 1lb. 8oz. of ſalt-petre. Proceed as before. This operation will produce the moſt beautiful blue, but the quantity will be only about 8 oz. and 4 drachms.

Proceſs IV. Take 3lb. of dried ox's blood, 6lb. of quick-lime, 2lb. of red tartar, and 1lb. 8oz. of nitre. Calcine and lixiviate as before; pour the warm lixivium into a ſolution of 4lb. of of allum, and 1lb. of green vitriol; the *fecula* precipitated in this way will be as beautiful as thoſe of the firſt proceſs, and the quantity 26 ounces.

SAXON-BLUE. This dye has been known for ſome time, and is made by diſſolving indigo in oil of vitriol, by which the indigo becomes of a much more lively colour, and is extended to ſuch a degree that it will go very far in dyeing. For the moſt approved method of making this colour, ſee the Treatiſe on DYEING, Sect. 2.

Stone or Powder BLUE, uſed in waſhing of linen, is the ſame with

with *smalt*, either in the lump, or powdered. When the smalt is taken from the pot, it is thrown into a large vessel of cold water: this makes it more tractable, and easily powdered. Afterwards, when examined, after cooling, it is found to be mixed with a greyish matter, resembling ashes, which they call *eschel*. This grey matter is separated by washing, and then the blue substance is powdered, and sifted through fine sieves, to bring it to what we call *powder-blue*. Phil. Trans. No. 396.

Ultramarine BLUE, a beautiful blue colour, used by the painters, prepared from *lapis lazuli*. Some derive its name *ultramarine*, q. d. *beyond sea*, from its being first brought into Europe out of India and Persia. Others say, it is because its colour is deeper than that of the sea. This blue is one of the richest and most valuable colours used in painting. The preparation consists in first calcining the stone, in an iron pot or crucible, then grinding it very fine on a porphyry, then mixing it up with a paste made of wax, pitch, mastich, turpentine, and oil; and at last washing the paste well in clear water, to separate the colouring part from the rest, which precipitates to the bottom, in form of a subtle, beautiful, blue powder. The water is then poured off, and the powder at bottom is dried in the sun, and it is the true ultramarine. The common opinion concerning its origin is, that the method of making it was first discovered in England, and that a member of the East-India Company, having a quarrel with his associates, to be revenged of them, made the secret public.

Ultramarine must be chosen of a high colour, and well ground, which is known by putting it between the teeth; where, if it feel gritty, it is a sign the triture is not sufficient. To know whether it be pure and unmixed, put a little of it in a crucible, and heating it red-hot, if the powder has not changed its colour, after this trial, it is certainly pure: on the contrary, if you perceive any change, or any black specks in it, it is falsified. Besides this, there is another kind, called *common* or *Dutch ultramarine*, which is only the crude *lapis armenus* and smalt well ground, and pulverised, the colour whereof, when used by the painters, is something like that of the true ultramarine, though much less valued.

Ultramarine, on account of its high price, is frequently adulterated, either by a precipitation or magistery of copper, made by alkaline salt, or by fine smalt. The adulteration in the former way may be discovered by pouring some diluted spirit of nitre on a small quantity of the ultramarine; which, if there be any copper, will soon dissolve, and form a greenish blue solution. The other kind of adulteration may be detected by washing the substance in water; the particles of the smalt being much grosser than those of the ultramarine. Besides, smalt will not mix so readily with oil, and in enamel-painting they may be easily distinguished, because smalt will flux without any addition, whereas the other requires the addition of some vitreous body.

BLUE-BOTTLE, in botany, is the English name of the *Cyanus*. It is a small plant, with beautiful blue flowers, common in our corn-fields, and of which many beautiful species are kept in gardens. The common wild blue-bottle of our corn-fields, is esteemed a cardiac and alexipharmic. Conserves and syrups are prepared from it in some places, and serve very properly for the making of other more efficacious medicines, of the same intention, into form. Schroder and some others have greatly extolled the distilled water of the flowers in inflammations, and many other disorders, of the eyes; but this seems a less warranted matter. The flowers of the large garden kind are said to be particularly good in disorders of the womb, and the leaves of either in infusion in dropsies. There are several species of this plant, commonly cultivated in gardens, for the beauty of their flowers. They are almost all annuals, perishing as soon as they have ripened their seed. In order to have them flower early, their seed should be sown in July, or the beginning of August, and when the plants have once got strength, they should be transplanted into warm borders, and will endure the cold very well, and will flower very early the next summer.

BLUENESS, that quality which denominates a body blue: or such a size and texture of the parts that compose the surface of a body, as dispose them to reflect the blue or azure rays of light, and those only to the eye. For a full disquisition of this subject, see the System of OPTICS, Part I. Sect. 3, throughout.

BLUSHING, a suffusion or redness of the cheeks, excited by a sense of shame, on account of consciousness of some failing or imperfection. Blushing is supposed to be produced from a kind of consent, or sympathy, between several parts of the body, occasioned by the same nerve being extended to them all. Thus the fifth pair of nerves being branched from the brain to the eye, ear, muscles of the lips, cheeks, palate, tongue, and nose; a thing seen or heard that is shameful affects the cheeks with blushes, driving the blood into the minute vessels thereof; at the same time that it affects the eye and ear. For the same reason it is that Dr. Derham observes, that a savoury thing seen or smelt affects the glands and parts of the mouth. If a thing heard be pleasing, it affects the muscles of the face with laughter; if melancholy, it exerts itself on the glands of the eyes, and occasions weeping, &c. And to the same cause Dr. Willis ascribes the pleasure of kissing.

BOA, in amphibiology, a genus of serpents, belonging to the order of amphibia. The characters of this genus are, that the belly and tail are both furnished with scuta. The species are ten, the most remarkable is the constrictor, which has 240 scuta on the belly, and 60 on the tail. This is an immense animal: it often exceeds 36 feet in length; the body is very thick, of a dusky white colour, and its back is interspersed with 24 large pale irregular spots, the tail is of a dark colour, and the sides are beautifully variegated with paler spots. The head is covered with small scales, and has no broad laminæ betwixt the eyes, but has a black belt behind the eyes. It wants the large dog-fangs, and of course its bite is not poisonous. The tongue is fleshy, and very little forked.—Above the eyes, on each side, the head rises high. The scales of this serpent are all very small, roundish, and smooth. The tail does not exceed one-eighth of the whole length of the animal. The Indians, who adore this monstrous animal, use the skin for clothes, on account of its smoothness and beauty. There are several of these skins of the above dimensions preserved, and to be seen in the different museums of Europe, particularly in the library and botanic garden of Upsal, in Sweden, which has of late been greatly enriched by Count Grillinborg. The flesh of this serpent is eaten by the Indians and the negroes of Africa. Piso, Margraave, and Kempfer, give the following account of its method of living and catching its prey. It frequents caves and thick forests, where it conceals itself and suddenly darts out upon strangers, wild beasts, &c. When it chooses a tree for its watching-place, it supports itself by twisting its tail round the trunk, or a branch, and darts down upon sheep, goats, or any animal that comes within its reach. When it lays hold of animals, especially any of the larger kinds, it twists itself several times round their body, and, by the vast force of its circular muscles, destroys them.

BOAR, *sus agrestis*, the *wild-boar*, a species of the genus *Sus*, in the system of mammalia. For a description of the genus, see the art. SUS. For representation, see Plate 10, Genus 35, Species 1. Variety 2. This creature differs from the common domestic *hog*, in that the grown animal is not different in colour in the different individuals of the same species; but is always of a rusty iron-grey. His snout is much longer also than that of the other; his ears shorter and rounder; and both these, and his tail and feet are always black. It differs also, in that it is covered with two sorts of hairs, the one kind long, the other short; these last serve the creature to the same purposes as the downy fur which the beaver and otter have under their long hair. It is very commonly wild in Italy, and its flesh frequently brought to market.

The WILD-BOAR, among the huntsmen, has several names, according to its different ages: the first year it is called *a pig of the saunder*; the second it is called *a hog*; the third *a hog-steer*; and the fourth, *boar*; when leaving the saunder, he is called *a singler*, or *sanglier*.

The boar generally lives to twenty-five or thirty years, if he escapes accidents. The time of going to rut is in December, and lasts about three weeks. They feed on all sorts of fruits, and on the roots of many plants: the root of fern, in particular, seems a great favourite with them: and when they frequent places near the sea-coasts, they will descend to the shores, and demolish the tenderer shell-fish in very great numbers. Their general places of rest are among the thickest bushes that can be found, and they are not easily put out of them, but will stand the bay a long time. In April and May they sleep more sound than at any other time of the year; and this is, therefore, the successful time for taking them in the toils. When a boar is roused out of the thicket, he always goes from it, if possible, the same way by which he came to it; and when he is once well up, he will never stop, till he comes to some place of greater security. If it happens that a *saunder* of them are found together, when any one breaks away, the rest all follow the same way. When the boar is hunted in the wood where he was bred, he will scarcely ever be brought to quit it; he will sometimes make towards the sides, to listen to the noise of the dogs, but retires into the middle again, and usually dies or escapes there. When it happens that a boar runs ahead, he will not be stopped, or put out of his way, by man or beast, so long as he has any strength left. He makes no doubles, or crossings, when chased; and when killed makes no noise, if an old boar, but the sows and pigs will squeak, when wounded.

The season for hunting the wild-boar begins in September, and ends in December, when they go to rut. If it be a large boar, and one that has lain long at rest, he must be hunted with a great number of dogs, and those such as will keep close to him; and the huntsman, with his spear, should always be riding in among them, and charging the boar as often as he can, to discourage him; such a boar as this, with five or six couple of dogs, will run to the first convenient place of shelter, and there stand at bay, and make at them as they attempt to come up with him. There ought always to be relays also set for the best and staunchest hounds in the kennel; for if they are of young eager dogs, they will be apt to seize him, and be killed, or spoiled, before the rest

The BINDER *is desired to observe, that the Sheet* 5 P—2 *is to be placed after* 5 P—1; *it being a* duplicate Signature, *introduced in the* NEW EDITION *of this Work, to enlarge on the Articles* BLOOD, BOG, BONES, BOOK, *&c.*

come up. The putting of collars with bells about the dogs' necks is a great ſecurity for them, for the boar will not ſo ſoon ſtrike at them when they have theſe, but will rather run before them. The huntſmen generally kill the boar with their ſwords or ſpears; but great caution is neceſſary in making the blows, for he is very apt to catch them upon his ſnout or tuſks, and if wounded and not killed, he will attack the huntſman in the moſt furious manner. The places in which the wound is to be given with the ſpear, are either between the eyes, in the middle of the forehead, or in the ſhoulders; both theſe places make the wound mortal.

When this creature makes at the hunter, his ſafety conſiſts merely in courage and addreſs; if he flies for it, he is ſurely overtaken and killed: if the boar comes ſtraight up, he is to be received at the point of the ſpear; but if he makes doubles and windings, he is to be watched very cautiouſly, for he will attempt getting hold of the ſpear in his mouth, and if he does ſo, nothing can ſave the huntſman, but another perſon's attacking him behind; he will on this attack the ſecond perſon, and the firſt muſt attack him again; two people will thus have enough to do with him, and were it not for the forks of the ſpears, that make it impoſſible to preſs forward upon them, the huntſman who gives the creature his death-wound would ſeldom eſcape falling a ſacrifice to his revenge for it.

The modern way of boar-hunting is generally to diſpatch the creature, by all the huntſmen ſtriking at him at once: but the ancient Roman way was, for a perſon on foot, armed with a ſpear, to keep the creature at bay, and in this caſe the boar will run of himſelf upon the ſpear, to come at the huntſman, and puſh forward till the ſpear pierced him through.

The wild-boar was formerly a native of Britain, as appears from the Laws of Hoel Dda, Leges Wallicæ, 41. William the Conqueror puniſhed with the loſs of their eyes any that were convicted of killing him. Charles I. turned out wild-boars in the New Foreſt; but they were deſtroyed in the civil wars.

The hinder claws of a boar are called *guards*. In the corn he is ſaid to *feed;* in the meadows or fallow-fields to *rout, worm*, or *fern;* in a cloſe, to *graze*. The boar is farrowed with as many teeth as he will ever have, his teeth increaſing only in bigneſs, not in number; among theſe are four called *tuſhes*, or *tuſks*, the two biggeſt of which do not hurt when he ſtrikes. but only ſerve to whet the other two loweſt, with which the beaſt defends himſelf, and frequently kills, as being greater and longer than the reſt.

It is very remarkable, that theſe creatures, in the Weſt-Indies, are ſubject to the ſtone; few of them are abſolutely free from it, yet ſcarce any have the ſtones of any conſiderable ſize. It is common to find a great number in the ſame bladder, and they are moſtly about a ſcruple weight, and are angular, and that with great regularity, each having five angles. Phil. Tranſ. No. 36. Among the ancient Romans, boar's fleſh was a delicacy; a boar ſerved up whole was a diſh of ſtate.

BOARDING, in a naval engagement, a deſperate and furious aſſault made by one ſhip on another, after having found every other method to reduce her ineffectual. For a copious account of this part of naval operations, ſee the Treatiſe on NAVAL AFFAIRS, Sect. III.

BODY, in phyſics, a ſolid, extended, palpable ſubſtance; of itſelf merely paſſive, and indifferent either to motion or reſt; but capable of any ſort of motion, and of all figures and forms. Body is compoſed, according to the Peripatetics, of *matter, form*, and *privation;* according to the Epicureans and Corpuſcularians, of an aſſemblage of hooked, heavy *atoms;* according to the Carteſians, of a certain quantity of *extenſion;* according to the Newtonians, of a ſyſtem or aſſociation of ſolid, maſſy, hard, impenetrable, moveable *particles*, ranged or diſpoſed in this or that manner; whence reſult bodies of this or that form; diſtinguiſhed by this or that name.

Theſe elementary or component particles of bodies muſt be infinitely hard, vaſtly harder than the bodies compounded of them, nay, ſo hard as never to wear, or break in pieces.—"This (Sir Iſaac Newton obſerves) is neceſſary, in order to the world's perſiſting in the ſame ſtate, and bodies continuing of the ſame nature and texture in ſeveral ages."

Body generally ſtands contradiſtinguiſhed from *ſpirit;* though in Spinola's and the Chineſe ſyſtem this difference is ſet aſide, and body and ſpirit ſuppoſed to be the ſame ſubſtance, under different modifications. Mr. Hobbes likewiſe affirms ſpirits to be bodies, the exiſtence of any ſubſtance not corporeal being rejected by him. See alſo Dr. Prieſtley on Matter and Spirit.

The true notion of body is hard to frame, and philoſophers are not yet agreed on it; the rather as the purſuit leads to the perplexing controverſy *di compoſitione continui*. Some place the eſſence of body in ſolidity, or impenetrability; others in weight or gravity; others in extenſion; others in mobility. According to the firſt of theſe, body is defined as ſomewhat that perfectly fills a determinate quantity of ſpace or extenſion, ſo as neceſſarily to exclude all other bodies from being comprehended within the ſame dimenſions. According to the ſecond, body is defined as a thing which is receptive and communicative of motion or progreſſion. Sir W. Petty repreſents body as matter under ſome figure. The Carteſians define it, any thing extended every way, or towards all ſides. According to Wolfius, the eſſence of body conſiſts in its compoſition, or mechaniſm of parts, from which all its other properties reſult, even extenſion itſelf; ſince we cannot conceive a compound body otherwiſe than as extended, or conſiſting of parts, at leaſt poſſible, if not actual ones.

The firſt, or internal, principles of bodies, which are not reſolvable into others, are called *elements*. *Light*, or *fire*, is found an ingredient in all bodies; which ſome, indeed, eſpecially among the chymiſts, make to be the ſame with the principle *ſulphur*. The Peripatetics maintain, that, beſides the common matter of all bodies, there is ſomething in every thing which diſcriminates it from every other, and makes it what it is: this they call *form*, [ſee the article FORM] which, becauſe all the qualities, and other accidents of the body, muſt depend on it, they alſo imagine to be a ſubſtance, and, indeed, a kind of ſoul, that, united to the groſs matter, with it compoſes a natural body.

As to the *colours* of bodies, Sir Iſaac Newton ſhews, that bodies appear of this or that colour, as they are diſpoſed to reflect moſt copiouſly the rays of light originally endued with ſuch colours. But the particular conſtitutions, whereby they reflect ſome rays more copiouſly than others, remain yet to be diſcovered. However, ſome of the laws and circumſtances thereof he delivers in the following propoſitions:

1. Thoſe ſurfaces of tranſparent bodies reflect the greateſt quantity of light, which have the greateſt refracting power; i.e. which intercede mediums, that differ moſt in their refractive denſities: and in the confines of equally refracting mediums, there is no reflection. 2. The leaſt parts of almoſt all natural bodies are, in ſome meaſure, tranſparent: and the opacity of thoſe bodies ariſes from the multitude of reflections cauſed in their internal parts. 3. Between the parts of opake and coloured bodies are many ſpaces, either empty, or replete with mediums of different denſities; as water between the tinging corpuſcles wherewith a liquor is impregnated, air between the aqueous globules that conſtitute clouds or miſts; and even ſpaces void both of air and water, between the parts of hard bodies, are not wholly void of all ſubſtance. 4. The parts of the bodies, and their interſtices, muſt be leſs than of ſome definite bigneſs, to render them opake and coloured. 5. The tranſparent parts of bodies, according to their ſeveral ſizes, reflect rays of one colour, and tranſmit thoſe of another, for the ſame reaſon that thin plates or bubbles do reflect or tranſmit thoſe rays; and this appears to be the ground of all their colour. 6. The parts of bodies, on which their colours depend, are denſer than the medium which pervades their interſtices. 7. The bigneſs of the component parts of natural bodies may be conjectured from their colours, on this principle, that tranſparent corpuſcles, of the ſame thickneſs and denſity with a plate, do exhibit the ſame colour. 8. The cauſe of reflection is not the impinging of light on the ſolid or impervious parts of bodies, as commonly believed. 9. Bodies reflect and refract light by one and the ſame power, variouſly exerciſed, in various circumſtances. For the two laſt articles, ſee the Syſtem of OPTICS, Part I. Sect. I.

BODIES are divided into *animate* and *inanimate;* i. e. into thoſe informed by a ſoul, and thoſe which are not; or thoſe that have life, and thoſe that have none. Some conſider bodies, either as *natural* and *ſenſible*, viz. as formed by phyſical cauſes, and clothed by phyſical qualities (in which ſenſe body makes the object of phyſics); or as *intellectual* or *quantitative*, in the general or abſtract, and according to three dimenſions; in which ſenſe body makes the ſubject of geometry.

BODY, with regard to animals, is uſed in oppoſition to *ſoul*, viz. for that part of an animal compoſed of bones, muſcles, canals, juices, nerves, &c.; in which ſenſe body makes the ſubject of Comparative Anatomy. See the Syſtem, throughout.

The Human BODY, conſidered with regard to the various voluntary motions it is capable of performing, is an aſſemblage of an infinite number of levers, drawn by cords: if conſidered with regard to the motions of the fluids it contains, it is another aſſemblage of an infinity of tubes and hydraulic machines: laſtly, if conſidered with regard to the generation of thoſe ſame fluids, it is another infinite aſſemblage of chymical inſtruments and veſſels; as philtres, alembics, recipients, ſerpentines, &c.; and the whole is a compound which we can only admire, and whereof the greateſt part eſcapes our admiration itſelf. The principal chymical apparatus in the whole body, is that wonderful laboratory the brain. It is in this that precious extract called animal ſpirits, the only material mover of the whole fabric, is ſecreted from the blood. In the machine of the animal body, the retainers to the doctrine of trituration maintain the brain to do the office of the beam of a preſs; the heart, of a piſton; the lungs, of a bellows; the mouth, of a mill-ſtone; the teeth, of peſtles; the ſtomach, of a preſs; the inteſtines of a reſervoir; the veſſels, of ſieves, or ſtrainers; and the air, of a pondus, or ſpring, that ſets the machine a-going.

Phyſicians divide the body into ſolids and fluids. Alſo into venters, or cavities, the head, thorax, and lower venter. The body

body ceaſes to grow in height when the bones are arrived at a degree of firmneſs and rigidity, which will not allow of farther extenſion by the effort of the heart and motion of the blood.—Phil. Tranſ. abr. vol. vii. No. 383.

Faculties of the BODY. See FACULTY.

BODY is alſo applied by anatomiſts to ſeveral particular parts of the animal fabric: as, the callous body of the brain, the cavernous or ſpongeous bodies of the penis, &c.

BOG, a moiſt, rotten ſpot of earth, which ſinks and gives way to the weight of the body, formed of graſs and plants, putrified by ſome ſpring: frequent, eſpecially in Ireland. In this ſenſe, *bog* amounts to much the ſame with what in other places are called *moſſes*, *marſhes*, *fens*, &c.

In Ireland they diſtinguiſh between a *turf-bog*, called alſo a *red-bog*, out of which turf or peat is dug, and a *quaking-bog*, which will ſink under a man, in the place where he ſtands, to a conſiderable depth, and riſe before and behind proportionably; underneath is frequently clear water, into which a perſon often ſlips to the middle, upon breaking the ſurface. Quaking-bogs frequently turn into turf-bogs. Every red-bog is encompaſſed with a deep marſhy, ſloughy ground, called the *bounds of the bog*. Horns and ſkeletons of mooſe-deer are ſometimes found in bogs, fourteen feet deep.

The inconveniences of bogs are, that a conſiderable part of the kingdom is rendered uſeleſs by them: they alſo keep people at a diſtance from each other, and thus hinder buſineſs from going forward. They occaſion the roads to be crooked and circuitous to avoid them. They are a great deſtruction to cattle, the chief riches of Ireland, which are encouraged, by the graſs growing on the edges of the bogs, to venture in, where they are loſt. The ſmell and vapour ariſing from them is accounted unwholeſome, and the fogs putrid and ſtinking. Add, that they corrupt the water, both as to its colour and taſte.

Bogs have alſo their uſes: moſt of the people in Ireland have their firing from them, the wood being impoliticly deſtroyed, and little pit-coal yet diſcovered. The Iriſh could hardly do without ſome bogs. The natives had anciently another advantage from bogs, viz. that by means of them they were preſerved from the conqueſt of the Engliſh; and it ſeems to be from the remembrance of this that they ſtill chooſe to build near bogs.

As to the origin and formation of bogs, it is to be obſerved, that there are few places in the northern world which have not formerly been as famous for them as Ireland now is. Every wild ill-inhabited country has them, The *loca paluſtria*, or *paludes*, to which the ancient Gauls, Germans, and Britons retired when beaten, appear to be no other than what we now call bogs. The like may even ſtill be found in the barren parts of Italy, as Liguria. Boggy lands upon levels are generally called *fens* with us; and what our farmers particularly underſtand by the term *bog-land*, is that ſort of bog which lies among hills, or between two eminences, and has deſcent enough to drain it, if the water could get off.

The true cauſe of bogs, then, ſeems to be the want of induſtry; at leaſt, it is certain, induſtry may remove, and much more prevent them. There are many bogs of late ſtanding in Ireland, formed through the miſeries of the times, and the deſolation of civil war. It is no wonder, if a country remarkable for lazineſs ſhould abound with them.

To ſhew how want of induſtry cauſes bogs, it muſt be remembered that Ireland abounds with ſprings; that theſe ſprings are dry, or nearly ſo, in the ſummer time, and that the graſs and weeds grow thick about the places where they burſt out: in the winter the ſame ſprings ſwell again, and run, and ſoften, and looſen the earth about them; and the ſward, or ſcurf of the earth, which conſiſts of the roots of graſs, being lifted up, and made ſuzzy by the water, becomes dried againſt the ſpring; and does not fall together, but withers in a tuft, and new graſs ſprings through it; which, the next winter is again lifted up: thus the ſpring is more and more ſtopped, and the ſcurf grows thicker and thicker, till it firſt makes what we call a quaking-bog: and as it grows higher and drier, and the graſs-roots, and other vegetables, become more putrid, together with the mud and ſlime of the water, it acquires a blackneſs, and grows into what we call a turf-bog. What confirms this account is, that bogs are generally found higher than the land about them, and the higheſt in the middle: the chief ſprings which cauſe them being commonly about the middle; from whence they dilate themſelves by degrees, as one would blow a bladder; but not always equally, becauſe they ſometimes meet with greater obſtacles on one ſide, than on the other. Add, that if a deep trench be cut through a bog, you will find the original ſpring, and vaſt quantities of water will run from it, and the bog will ſubſide; ſometimes a dozen or fifteen, ſome even ſay thirty feet. Laſtly, thoſe hills which have no ſprings have no bogs; and thoſe which have ſprings, and want culture, are never without them. In brief, wherever bogs are, there are great ſprings; the turf generally diſcovers a vegetable ſubſtance; it is light, and impervious to water, while the ground under it is very pervious.

It is true there are ſome quaking-bogs cauſed otherwiſe: as when a ſtream or ſpring runs through a flat; if the paſſage be not tended, it is filled with weeds in ſummer, trees fall acroſs it, and dam it up; then, in winter, the water ſtagnates farther and farther every year, till the whole flat be covered; next, there riſes a coarſe kind of graſs, peculiar to theſe bogs; it grows in tufts, and the roots conſolidate together, and yearly grow higher, inſomuch as ſometimes to reach the height of a man.—This graſs rots in winter, and falls on the tufts, and the ſeed with it, which ſprings up next year, and thus makes a new addition. Sometimes the tops of flags and graſs are interwoven on the ſurface of the water, and become, by degrees, thicker, till they lie like a cover on the water; other herbs take root in it, and, by a plexus of thoſe roots, it becomes ſtrong enough to bear the weight of a man.

Another cauſe of bogs is moſs, with which Ireland abounds extremely. That which grows in bogs is remarkable; the light ſpongy turf above-mentioned being nothing but a congeries of the threads of this moſs, which is ſometimes in ſuch quantities, and ſo tough, that the turf-ſpades cannot cut it. In the north of Ireland they call it old-wives' tow; not being much unlike flax. The turf-holes, in time, grow up with it again, and all the little gutters in bogs are generally filled with it. In reality, to this the red or turf-bogs ſeem to be chiefly owing.

For the draining of bogs, to render them fit for paſture or arable, it is not impoſſible; the ſame having been performed in England, France, Germany, &c. People commonly diſtinguiſh between bogs which have no fall to carry away the water from them, and thoſe which have. The laſt are reputed drainable, the former not. But Mr. King aſſures us, he never obſerved one bog without a fall ſufficient to drain it, nor does he believe there is any. In reality, the great object againſt draining is the charge; which, it is commonly reckoned, will amount to much more than would purchaſe an equal quantity of good ground: for an acre of this kind, in moſt parts of Ireland, is not worth above 4s. per annum, and fourteen or fifteen years purchaſe; ſo that three pounds will buy an acre of good land; and it is very doubtful with moſt whether that ſum will reduce a bog. This reaſoning paſſes current, and is the great impediment to this work. To this it is anſwered, that quaking bogs, though land be ever ſo cheap, never fail to be worth draining: one trench will drain many acres; and, when dry, it is generally meadow, or the beſt grazing ground. Again, the bounds of a red-bog never fail to be worth the draining, being done by one deep trench drawn round the bog. By this, cattle are kept out of the bog, and the bounds turned into meadow. Add, that even red bogs might be made fit for grazing at a much cheaper rate than has hitherto been done, by a proper conduct in the digging of trenches, particularly deſcribed by Mr. King, Phil. Tranſ. No. 170, p. 948. See alſo No. 330, p. 305; and No. 314, p. 59. Plott's Hiſt. Oxf. chap. ix. § 81, &c.

In ruſhy grounds, the ſprings are commonly found to lie within a foot or two of the ſurface, when any thing of ſtonineſs or ſmall gravel is to be found, and ſometimes conſiderably lower in a hungry gravel; but it is always lower in boggy ground than in ruſhy, and is deep according to the weight of earth that pens it in. The beſt way is to begin the drain at the loweſt place, and ſo carry it in towards the ſpring-head, where there muſt lie made ſuch trenches, either round or croſs the bog, as ſhall be found neceſſary to the draining of it thoroughly.

If it be neceſſary to make ſuch large and deep drains, that there is danger of the cattle's falling into them, they may be filled up with ſtones or brick-batts, and theſe covered with boards, and the turf laid over them. The cavities among the ſtones will give paſſage to the water, and the turf will grow at top, as if nothing had been done.

It is a common practice to make a bank with the earth dug out of the trench, laying it on the ſide; but this is extremely wrong. If the trench be ſmall, the earth dug out of it ſhould be carried away in wheel-barrows; and if large, it ſhould be ſpread upon the loweſt places of the bog, where there is room for it.

Another excellent method is to make the trenches about a yard deep, and two feet wide, laying at the bottom of them black-thorn-buſhes, and over theſe a ſtratum of large and round ſtones, or at leaſt, of fuel as cannot lie cloſe; over theſe lay another ſtratum of thorn-buſhes, and then place a quantity of ſtraw, to keep the earth from falling in, and filling them up. By this means the trench will be kept open, which otherwiſe will naturally ſwell and fill up of itſelf.

The lands occupied by bogs are always of a good and rich quality, when properly drained; and the expence of ſuch draining, when judiciouſly managed, is inconſiderable, compared with the advantages which conſequently reſult. Moraſſy ground thus improved, and planted with wood, intermixed with timber-trees, would, in the courſe of fifteen or twenty years, yield a produce of uſeful poles and fire-wood, equal to twenty times the expence of the improvement and planting: the adjacent air would be ſalubrious and healthful, induſtry would be promoted, and every public and private benefit accrue, which the moſt zealous friend to his country could effect or deſire.

BOHEA. See TEA.

BOIL, or FURUNCLE, in ſurgery, is a ſmall reſiſting tumor, with inflammation, redneſs, and great pain ariſing in the *membrana adipoſa* under the ſkin. As there is no part of the body free from being the ſubject of this tumour, ſo the whole body is ſometimes ſo miſerably infeſted with them, that the patient knows not how to ſtir, or on what part to lie. Young infants and adults are equally liable to this diſorder; and though in adults there is ſeldom any great danger in it, yet it ſometimes happens when they are very numerous in tender infants, that they not only excite violent pains, reſtleſſneſs, and toſſings, with great weakneſs, convulſions, and epilepſies, but death itſelf ſometimes follows them.

The principal cauſe of boils is a too glutinous and inſpiſſated ſtate of the blood, and the cure of them principally depends upon the reſtoring the blood to its due conſiſtence and proper circulation. People who are very ſubject to theſe tumours ſhould bleed and take purging medicines at proper intervals, and drink plentifully of warm and weak liquors, abſtaining from wine, ſtrong ſpirituous liquors, and from the uſe of tobacco. When the diſorder is recent, or not habitual, external remedies alone are ſufficient for the cure: honey, mixed to a proper ſharpneſs with ſpirit of vitriol, is a very good external application. The touching the boils with ſpirit of vitriol alone, is often alſo of great ſervice; and ſometimes the diſcutient plaſters are to be applied, as the diachylon, ſpermaceti, and ſoap-plaſter. If theſe applications, however, do not prove ſucceſsful in the diſperſing a boil, the only method to be taken is that of bringing it to ſuppuration. This, however, in ſome caſes, is no eaſy talk, but the tumour remains ſometimes very hard and troubleſome, even after a proper treatment of ſeveral weeks; and ſometimes the humour that occaſions it becomes ſo acrimonious, by its long tenſion, and great inſpiſſation, that it produces ulcers, which grow gradually worſe and worſe, till at length they end in ulcerated *fiſtulæ*. To promote and quicken the ſuppuration, it is generally found of great ſervice to apply plaſters of diachylon with the gums, and of honey and flour mixed, and made to a proper conſiſtence; and where theſe prove inſufficient, maturating cataplaſms are to be applied, and very frequently repeated. When the boil is ſufficiently maturated by one or other means, which will be known from the ſoftneſs and yellowneſs of its head, it muſt be opened by inciſion, and when the matter it contained is diſcharged, the ulcer muſt be daily cleanſed, till perfectly freed from all malignity, and then healed with the vulnerary balſams.

When infants which ſuck are afflicted with boils, the proper method is to give cooling medicines and purges to the nurſe, and enjoin her a due regimen in diet; and the infant ſhould at the ſame time be got to take ſome gentle laxative, and the abſorbent powders, as thoſe of crabs-eyes, and the like, to allay the acrimony of its juices.

BOILING, or EBULLITION, the bubbling up of any fluid. The term is moſt commonly applied to that bubbling which happens by the application of fire, though that which enſues in the mixture of an acid and an alkali is ſometimes alſo diſtinguiſhed by the ſame.

The phenomenon of boiling may be thus accounted for. By the application of fire to any veſſel, it occaſions, at firſt, a ſmall inteſtine motion in the water, and from the continued action of the firſt cauſe, the effect is increaſed, and the motion of the water continually accelerated: ſo that the water, by degrees, becomes ſenſibly agitated. But now the particles of the fire ſtriking on thoſe on the loweſt ſurface of the water, will not only give them an impulſe upwards, contrary to the laws of equilibrium, but will likewiſe render them ſpecifically lighter than before, ſo as to determine them to aſcend, according to the laws of equilibrium; and this, either by inflating them into little veſicles, by the attraction of the particles of water around them, or by breaking and ſeparating the little ſpherules of water, and ſo increaſing the ratio of their ſurface to their ſolid content.—There will therefore be a conſtant flux of water from the bottom of the veſſel to the top, and conſequently a reciprocal flux from the top to the bottom: i. e. the upper and under water will change places; and hence we have the reaſon of that phenomenon, of the water's being hot at top ſooner than at bottom.

Again, an intenſe heat will diminiſh the ſpecific gravity of water, ſo as not only to make it mount in water, but alſo in air; whence ariſe the phenomena of vapour and ſmoke; though the air incloſed in the interſtices of the water muſt be allowed a good ſhare in this appearance: for that air being dilated, and its ſpring ſtrengthened by the action of the fire, breaks its priſon, and aſcends through the water into the air; carrying with it ſome of the contiguous ſpherules of water, ſo many as ſhall hang in its villi, or can adhere immediately to it.

The particles of air in the ſeveral interſtices of the fluid maſs thus expanded, and moving upwards, will meet and coaleſce in their paſſage; by which means a great quantity of the water will be heaved up, and let fall again, alternately, as the air riſes up, and again paſſes from the water: for the air, after coalition, though it may buoy up a great heap of water, by its elaſticity, while in the water, yet cannot carry it up, together with itſelf, into the atmoſphere; ſince, when once got free from the upper ſurface of the water in the veſſel, it will unbend itſelf in the atmoſphere, and ſo its ſpring and force will become juſt equal to that of the common unheated air. Add to this, that were the ſpring and motion of the air ſufficient to carry up the water with it, yet it would not have that effect; but the water would run off at the extremities of the air; all except ſo much as ſhould be either entangled in its villi, or immediately adhere to its ſurface by attraction; and hence we ſee the reaſon of the principal phenomenon of boiling, viz. the fluctuating of the ſurface of the water. Boiling water diſpoſes it to freeze more readily.

We generally annex the idea of a certain very great degree of heat to the boiling of liquids; but this does not ſeem to be a connexion of nature's making, but of our own. It is reported by many, that a veſſel of tar being ſet over the fire till it boils, a perſon may, while it is boiling, put his hand into it without injury; and that the artificers who prepare and uſe this commodity, know this property of it ſo well, that they uſually take the ſkum from their pots of it, while boiling, with their naked hands.

Water, in the receiver of an air-pump, when exhauſted, will boil without any great heat. The receiver ſhould, for this experiment, be one part full of water, and three empty: in this caſe, the flame of a candle being placed under the veſſel, the water will boil violently, while the water itſelf is ſcarcely warm; and when the water has been thus kept boiling a quarter of an hour, the glaſs will ſcarcely be any thing the hotter for it. When the candle is taken away, the water will ſtill continue a great while boiling, and when it ceaſes firſt, will renew itſelf again from time to time to a very great ebullition. All the bubbles that riſe out of the water on this occaſion, do not raiſe the mercury in a gage to any ſenſible height.

Different fluids require different degrees of heat to make them boil. Dr. Friend gives a table of the different times required to make ſeveral fluids boil by the ſame heat. Water, when once brought to boil, is not ſuſceptible of any further degree of heat, however the fire be increaſed: but this differs according to the weight of the atmoſphere, and the purity of the water.

BOILING is alſo a method of trying or aſſaying the goodneſs or falſeneſs of a colour or a dye, by boiling the ſtuff in water with certain drugs, different according to the kind or quality of the colour, to try whether or no it will diſcharge, and give a tincture to the water. With this intention red crimſon, ſilks are boiled with alum, and ſcarlets with ſoap, in quantity equal to the weight of the ſilk.

BOILING-WATERS, in natural hiſtory. See BURNING SPRING.

BOLES, are viſcid earths, leſs coherent, and more friable than clay; more readily uniting with water, and more freely ſubſiding from it. They are ſoft and unctuous to the touch; adhere to the tongue; and by degrees melt in the mouth, impreſſing a light ſenſe of aſtringency. There are a great variety of theſe earths; the principal of which are the following: Armenian Bole, French Bole, Bole of Blois, Bohemian Bole, Lemnian and Sileſian Bole. Theſe and other earths, made into little maſſes, and ſtamped with certain impreſſions, are called *terræ ſigillatæ*. They have been recommended as aſtringent, ſudorific, and alexipharmic; but theſe, and many other virtues that have been aſcribed to them, appear to have no foundation.

They are ſtill, however, preſcribed in fluxes and complaints of the primæ viæ. See the Syſtem of CHYMISTRY, Part II. Chap. 4.

BOLUS, in medicine, an extemporaneous form of remedy, of a ſoft conſiſtence, ſomewhat more ſo than that of an electuary, and of the quantity of one doſe, or morſel, to be ſwallowed down; contrived principally for the ſake of ſuch as have an averſion to potable medicines; as alſo for the better conveyance of certain preparations of mercury, antimony, &c. which, by their weight, would ſink to the bottom of the glaſs, were they given in draughts. There are boluſes of various kinds, made with electuaries, confections, conſerves, pulps, powders, ſalts, oils, eſſences, extracts, ſyrups, &c. ſome of which ingredients muſt always have ſolidity or dryneſs enough to give a conſiſtence to thoſe that are liquid. Boluſes are chiefly denominated from their intentions; as emetic boluſes, purgative boluſes, aſtringent, anodyne, antifebrile, alexipharmic, &c. boluſes.

The choice of the proper ingredients for a bolus is regulated by the following conſiderations: a due coheſion, ſoftneſs, and equable mixture, are eſſentially neceſſary to a bolus; for this reaſon, dry ſubſtances muſt be put to liquid ones, and liquid ones to dry, to produce the proper conſiſtence; but the thicker electuaries, conſerves, and robs, are themſelves naturally in form of a bolus.

Acrid ſubſtances, and ſuch as are offenſive either to the ſmell or taſte, or are of a very viſcid nature, are much more properly exhibited in form of boluſes than of powders; ſince their offenſive qualities are by this means concealed. The draſtic purges, and mercurial preparations, are therefore very properly given in boluſes.

Balſams, and other ſuch liquid ſubſtances, are beſt mixed into a bolus with ſugar, becauſe it is not only the means of their going

going down eaſily, but it aſſiſts their diſſolution in the ſtomach. The alkaline, fixed, and volatile ſalts, and all other ſubſtances which ſoon become liquid, are very improperly made ingredients in boluſes which are to ſtand any time; ſince they ſpoil the form of the medicine, and loſe their own virtues; and, for the ſame reaſon, ſuch ſubſtances as will ferment when brought together, are very improper for boluſes, unleſs they are to be ſwallowed as ſoon as made up. To this it may be added, that the number of ingredients in a bolus ſhould never exceed three, or at the moſt four.

The number of boluſes made up at once ought only to be one, or at the utmoſt two: but the apothecaries have got an almoſt univerſal cuſtom at preſent of ſending in four at a time; by which means, the laſt which are taken are uſually too hard to be ſwallowed, and often have loſt all their virtues. It is the common cuſtom to wrap up boluſes in leaf-gold, or in a wafer; but ſome chooſe neither of theſe, but will diſſolve them in ſome liquor before they are taken. The ſignature on each bolus is to expreſs its nature and deſign, the liquor to be taken with or after it, and the regimen to be uſed; and it is highly neceſſary to give a convenient liquor after ſome of them, if we ſuſpect they are made of ingredients which will not eaſily diſſolve in the ſtomach: and this caution is to be regarded principally in thoſe of the terebinthinous and other balſamic kinds.

Boluſes are a form of medicines almoſt univerſally uſeful. All we have to conſider in regard to the taking them is whether the patient is in a condition to ſwallow a ſolid morſel, or not; and from hence it is eaſily inferred, that they are not to be given in quinſies, or in ulcers of the fauces; apoplexies, epilepſies, and ſyncopes, alſo render them very improper.

BOMB, in military affairs, a large ſhell of caſt-iron, having a great vent to receive the fuſee, which is made of wood. The ſhell being filled with gunpowder, the fuſee is driven into the vent or aperture, within an inch of the head, and faſtened with a cement made of quick-lime, aſhes, brick-duſt, and ſteel-filings, worked together in a glutinous water; or of four parts of pitch, two of colophony, one of turpentine, and one of wax. This tube is filled with a combuſtible matter, made of two ounces of nitre, one of ſulphur, and three of gunpowder-duſt, well rammed. To preſerve the fuſee, they pitch it over, but uncaſe it when they put the bomb into the mortar, and cover it with gun-powder-duſt; which having taken fire by the flaſh of the powder in the chamber of the mortar, burns all the time the bomb is in the air; and the compoſition in the fuſee being ſpent, it fires the powder in the bomb, which burſts with great force, blowing up whatever is about it. The great height a bomb goes in the air, and the force with which it falls, makes it go deep into the earth.

Bombs may be uſed without mortar-pieces, as was done by the Venetians at Candia, when the Turks had poſſeſſed themſelves of the ditch, rolling down bombs, upon them along a plank ſet ſloping towards their works, with ledges on the ſides, to keep the bomb right forward. They are ſometimes alſo buried under ground, to blow up. Bombs came not into common uſe before the year 1634, and then only in the Dutch and Spaniſh armies. One Malthus, an Engliſh engineer, is ſaid to have firſt carried them into France, where they were put in uſe at the ſiege of Colliouſe. The French have lately invented a new ſort of bombs of vaſt weight, called *comminges*. The art of throwing bombs makes a branch of gunnery, founded on the theory of projectiles, and the laws and qualities of gunpowder. See the Treatiſe on PROJECTILES, Part II. Art. 10.

BOMBAST, in compoſition, is a ſerious endeavour, by ſtrained deſcription, to raiſe a low or familiar ſubject beyond its rank; which, inſtead of being ſublime, never fails to be ridiculous. The mind in ſome animating paſſions is indeed apt to magnify its objects beyond natural bounds: but ſuch hyperbolical deſcription has its limits; and, when carried beyond theſe, degenerates into burleſque, as in the following example:

> *Sejanus.* —— Great and high,
> The world knows only two, that's Rome and I.
> My roof receives me not; 'tis air I tread,
> And at each ſtep I feel my advanc'd head
> Knock out a ſtar in heaven.
>
> SEJAN. of *Ben. Johnſon*, Act 5.

A writer who has no natural elevation of genius is extremely apt to deviate into bombaſt. He ſtrains above his genius, and the violent effort he makes carries him generally beyond the bounds of propriety.

BOMBAX, or SILK-COTTON TREE: a genus of the polyandria order, belonging to the monodelphia claſs of plants. The moſt remarkable ſpecies are, the ceiba, with a prickly ſtalk, and the pentandrum, with a ſmooth ſtalk. They grow naturally in both the Indies, where they arrive at a great magnitude, being ſome of the largeſt trees in theſe parts.

Uſes. The dark ſhort cotton of theſe two ſpecies is uſed by the poorer inhabitants of thoſe places, where ſuch trees grow, to ſtuff pillows or chairs, but is generally deemed unwholeſome to lie upon. Large pirogues, or canoes fit to carry a ſail, are made both at Senegal, and in America, of the trunk of the ſilk-cotton tree, the wood of which is very light, and found unfit for any other purpoſe. In Columbus's firſt voyage, ſays Miller, it was reported that a canoe was ſeen at Cuba, made of the hollowed trunk of one of theſe trees, which was 95 palms long, of a proportional width, and capable of containing 150 men.

BONES, for their origin, formation, compoſition, texture, variety, offices, &c. ſee the Syſtem of ANATOMY, Part I. throughout. For repreſentation, ſee Plate 1.

On viewing the bones, with the aſſiſtance of good glaſſes, their ſuperficial part is found to conſiſt of a great many ſmall veſſels, and ſome few of a larger ſize; which laſt, when they come to the ſurface of the bone, appear inveſted with either a membrane or a bony ſubſtance, perfectly tranſparent. The inſide of the bone is a ſpungy or cellular ſubſtance, conſiſting of long particles, cloſely united; and theſe are compoſed of numberleſs ſmall veſſels, cloſely united, and ſome running lengthways, others taking their courſe towards the ſide of the bony fibres; which, notwithſtnding their great number of apertures, are extremely hard, and lie ſome parallel, and others perpendicular to the length of the bone. Mr. Leewenhoeck diſcovered once, in a ſmall bit of a ſhin-bone, four or five veſſels, with apertures large enough for a ſilk thread to paſs through, each whereof ſeemed furniſhed with a valve, diſpoſed in ſuch a manner as to let out what was contained in the veſſel, but ſuffer nothing to return into it.

The way to examine the bones, is to ſhave off, with a very ſharp pen-knife, extremely thin pieces, lengthwiſe, croſſwiſe, and obliquely, and theſe from the outſide, inſide, and middle of the bone, and apply theſe, ſome dry, others moiſtened with water, to the focus of the double microſcope; and thus the veſſels will be ſeen in all directions: but the beſt way of ſeeing the bony ſtructure, is by the putting the bones in a very clear fire till they are red-hot, and then taking them out carefully, you will find the bony cells, though tender, perfect and entire: and being now quite empty, they may be viewed with eaſe and pleaſure.

The marrow in the cavity of the bones is inveſted with a membrane, wherein are included little bags or globules; and in theſe bags are veſiculæ, or glandulous bladders, ſerving both for the ſecretion of the medullary oil from the blood, and the reception and conſervation of the ſame. They ſeem to have paſſages into each other, as have alſo the bags; whereby the oil has a freer courſe to the joints and ſubſtance of the bone. The uſe of the marrow is to oil the ſubſtance of the bone, and to prevent its being too dry and brittle; it alſo lubricates the articulation of the bones, and hinders their ends from being worn or over-heated with motion, and it moiſtens the ligaments by which they are tied to each other: in which it is aſſiſted by the mucilaginous glands, found in all the articulations of the bones.

The bones are generally bigger at their extremeties than in the middle, that the articulations might be firm, and the bones not ſo eaſily diſlocated: but to render the middle of the bones ſtrong withal, ſo as to ſuſtain its allotted weight, and reſiſt accidents, the fibres are there more cloſely compacted together, and ſupport each other; to which it may be added, that the bone, being hollow, is not ſo eaſily broken, as if it had been ſolid and ſmaller; for of two bones of equal length, and of equal numbers of fibres, the ſtrength of the one to the ſtrength of the other will be as their diameters.

The bodes are joined and connected together, various ways, according to the various purpoſes they are to ſerve; ſome being intended for motion, others for reſt, and the ſupport of the incumbent parts only. That jointure intended for motion, is called *Diarthroſis*, or articulation ſeparated; that for reſt, *Synarthroſis*, or articulation conjoined; and each of theſe again is ſubdivided into ſeveral others. See ARTICULATION.

The bones of the human ſkeleton, enumerated by Winſlow, are 54 in the head, without reckoning os hyoides, and bones of the ear: 54 in the trunk, taking the coccyx for one bone, and the ſternum for two; 124 in the extremities, leaving out all the ſeſamoidal bones; ſo that the whole number is 232, to which adding the eight bones of the ear, and the five principal pieces of the os hyoides, we ſhall have in all 245, the ſeſamoidal bones being ſtill omitted. Winſlow's Anat. vol. 1. p. 4. For a particular deſcription, ſee the Syſtem, Part I. For repreſentation, ſee Plate I.

The general uſe of the BONES, is to ſupport and ſtrengthen the body, like beams and pillars in a building; to defend ſome of the more eſſential parts, as the brain, &c.; to give ſhape to the body, and to aſſiſt in motion. It is demonſtrable, that of whatever figure bones are, and in whatever manner their fibres are diſpoſed, their ſtrength muſt always be in a ratio compounded of their quantity of bony matter, and of the diſtance of their centre of gravity from their centre of motion. Hence, on a double account, the parts of a bone, formerly fractured, muſt be ſtronger than any other part of the ſame bone, becauſe the diameter is enlarged, and the quantity of matter is increaſed. The human bones have been ſometimes known to grow ſoft and flexible, ſo as to bend any way with leſs difficulty than the muſcular parts of a healthy perſon's leg. Phil. Tranſ. No. 470, Sect. 3. Bartholin

tholin gives an inſtance of an anoſteus, or boneleſs child, ſhewn at Briſtol, whoſe arms and legs were flexible, like a glove.

The origin and formation of BONES is generally traced from cartilages, which all bones are ſuppoſed once to have been; or, according to others, membranous tendons. Some deduce theſe further from gellies; and others, from mere fluids; which ſucceſſively arriving at greater and greater conſiſtency, become firſt gelatinous, then tendinous, then cartilaginous, and laſtly bony. Hence the different ſtates of the bones, in different ages, ſexes, and the like; which, in children, are found ſoft, moiſt, and cartilaginous; in aged people, hard, dry, and inflexible; the very cartilages in theſe frequently becoming bony.

Animals without bones are ſaid to be *anoſtei*; ſuch are all the ſpecies of reptiles, inſects, &c.

The diſeaſes and injuries to which the bones are ſubject, are fractures, luxations, fiſſures, caries, cancers, nodes, rickets, tophi, exoſtoſes, or excreſcences, &c. To which may be added, other leſs uſual diſorders, as preternatural hardneſſes, almoſt to a degree of petrefaction, and ſtiffneſſes to the condition of wax, unions or coalitions of all the bones of the body into one, cracking of the bones, in ſcorbutic caſes, worms in the cavities of the bones, &c. Mr. Petit gives an inſtance of the carnification of the bones; wherein, by a change contrary to that of their firſt formation, they were reconverted from bones to fleſh, or cartilages. Phil. Tranſ. No. 251, No. 379. Mem. Acad. Scienc. an. 1720.

BONE-SETTING, the art or act of replacing diſlocated bones, and the parts of fractured ones. The Spaniards call their bone-ſetters *algebriſts*. Bone-ſetting includes the four operations of extenſion, coaptation, deligation, and reduction or repoſition.

M. Petit has contrived an engine for bone-ſetting, which not only ſeems more handy and portable, but more powerful, as well as leſs painful to the patient. By means of it, the operator is fully maſter of the powers that pull it, and may proportion them to the ſtrength and weakneſs of the ſubject, and that of the muſcles or tendons which are to be replaced. Add, that as it is neceſſary the power which retains the body be equal to that which pulls the diſlocated member, in this machine the ſame rope which pulls the limb repels the body; and that the machines hitherto contrived have only ſerved for luxations of the ſhoulder, and that of the hip, which are made upwards, and where the members are ſhortened; whereas this ſerves for fractures as well as luxations, and not only where the members are ſhortened, but where they are longer. Mem. Acad. Scienc. ann. 1716, p. 330, &c.

Colouring and ſtaining of BONES.—The bones of living animals are capable of acquiring colour by the circulation of the blood and juices from their aliment: many inſtances of this kind, in which they have been changed into a deep red, by madder-root, are recorded both in the Philoſophical Tranſactions, and in the Memoirs of the French Academy. Bones and horns may be likewiſe artificially ſtained, with a variety of colours, by ſteeping or boiling them in decoctions of the vegetable or animal ſubſtances which are uſed for dyeing. They may be ſtained alſo without heat, by metallic ſolutions, and in this way may be ſpotted or variegated at pleaſure. The ſolution of ſilver in aqua-fortis, gives a brown or a black, according to its quantity; ſolution of gold, in aqua-regia, or in ſpirit of ſalt, a fine purple; ſolution of copper in the acetous acid, a fine green; and ſolutions of the ſame metal in volatile alkalies, a blue; which is, at firſt, deep and beautiful, but changes on being expoſed to the air, into a green, or bluiſh-green. If the bone or horn is only touched with the two firſt ſolutions, and expoſed to the air, it does not fail to acquire the colour in a few hours: in the two latter, it requires to be ſteeped for a day, or longer, in order to its imbibing the colour. In theſe and other caſes, where immerſion is neceſſary, the bone may be variegated, by covering ſuch parts as are intended to remain white, with wax, or any other matter, which the liquor will not penetrate and diſſolve. Phil. Tranſ. ab. vol. ix. p. 104, &c. Neumann's Works, by Dr. Lewis, p. 519. Lewis's Com. Phil. Techn. p. 97, 435. See DYEING and IVORY.

BONES *whitened for Skeletons*. Two proceſſes are deſcribed in the *Acta Hoffmienſia* for whitening bones. Profeſſor Rau had a method of giving them a great degree of whiteneſs. By bare expoſure to the air, ſun, and rain, for a length of time, they become remarkably white: but the whiteſt bones, kept in rooms tainted with ſmoke or fuliginous vapours, grow in a little time yelloviſh, browniſh, and unſightly. It is cuſtomary, for the purification of bones, to boil them in alkaline liquors; which, by diſſolving and extracting their ſuperfluous fat, improve their whiteneſs.

Economical uſes of BONES. Bones are a very uſeful article, not only for making different kinds of toys, but likewiſe in ſeveral of the chemical arts; as, for making caſt-iron malleable, for abſorbing the ſulphur of ſulphureous ores; for forming teſts and cupels, or veſſels for refining gold and ſilver with lead (burnt bones compoſing a maſs of a porous texture, which abſorbs the vitrified lead and other matters, while the unvitreſcible gold and ſilver remain entire behind); for the preparation of milky glaſſes and porcelains; for the rectification of volatile ſalts and empyreumatic oils; and for making glue. The bones of different animals are not equally fit for theſe uſes: even the glue, or gelatinous part of the bones of one animal is notably different, both in quantity and coheſiveneſs, from that of another.

The bones of the cuttle-fiſh are uſed by the goldſmiths for making moulds; thoſe of the bullock for painters' black; alſo in lieu of ivory for toys and cutlers' work, where if they be leſs white than ivory at firſt, they do not ſo ſoon turn yellow.

The human ſkull-bone, or cranium, the natural defence of the ſeat of ſenſation and perception, in the nobleſt animal, has been recommended medicinally as a cure for epilepſies, deliria, and all diſorders of the ſenſes, from the ſame philoſophy which aſcribed anti-aſthmatic virtues to the lungs of the long-winded fox; and expected, becauſe fowls are ſaid to digeſt even ſmall ſtones, that the ſkin of the gizard, dried and powdered, would produce a ſimilar effect in the human ſtomach. To ſuch lengths of extravagance have the ſons of phyſic been carried by the blind ſuperſtition of former ages!

Foſſil or *Petrified* BONES, are thoſe found in the earth, frequently at great depths, in all the ſtrata, even in the bodies of ſtones and rocks; ſome of them of a huge ſize, uſually ſuppoſed to be the bones of elephants or hippopotami. It is ſuppoſed they were repoſited in thoſe ſtrata when all things were in in a ſtate of ſolution; and that they incorporated and petrified with the bodies where they happened to be lodged.

In the muſeum of the Ruſſian Academy of Sciences, there is a vaſt collection of foſil bones, teeth, and horns, of the elephant, rhinoceros, and buffalo, which have been found in different parts of this empire, but more particularly in the ſouthern regions of Siberia. Naturaliſts have been puzzled to account for ſo great variety being found in a country where the animals of which they formerly made a part were never known to exiſt. It was the opinion of Peter, who, though he deſerves to be eſteemed a great monarch, was ccertainly no great naturaliſt, that the teeth found near Voronetz were the remains of elephants belonging to the army of Alexander the Great, who, according to ſome hiſtorians, croſſed the Don, and advanced as far of Koſtinka. The celebrated Bayer, whoſe authority carries greater weight in the literary world, conjectures, that the bones and teeth found in Siberia belonged to elephants common in that country during the wars which the Mongul monarchs carried on with the Perſians and Indians; and this plauſible ſuppoſition ſeems in ſome meaſure to be corroborated by the diſcovery of the entire ſkeleton of an elephant in one of the Siberian tombs. But this opinion, as Mr. Pallas very juſtly obſerves, is ſufficiently refuted by the conſideration, that the elephants employed in the armies of all India, could never have afforded the vaſt quantities of teeth which have been diſcovered, not to mention thoſe which it is juſtly to be preſumed may ſtill be buried. They have been already dug up in ſuch plenty as to make a conſiderable article of trade. See the article FOSSIL.

The ingenious naturaliſt Mr. Pallas, has given an ample deſcription of theſe foſſil bones, and has endeavoured to account for their origin. Upon examining thoſe in the muſeum, he was led to conclude, that as theſe bones were equally diſperſed in all the northern regions of Europe, the climate probably was in the earlier ages leſs ſevere than at preſent, and then poſſibly ſufficiently warm to be the native countries of the elephant, rhinoceros, and other quadrupeds, now found only in the ſouthern climates. But when he viſited, during his travels, the ſpots where the foſſil bodies were dug up, and could form a judgment from his own obſervations, and not from the accounts of others, he renounced his former hypotheſis; and, in conformity with the opinions of many modern philoſophers, aſſerted, that they muſt have been brought by the waters; and that nothing but a ſudden and general inundation, ſuch as the deluge, could have tranſported them from their native countries in the ſouth, to the regions of the north. In proof of this aſſertion, he adds, that the bones are generally found ſeparate, as if they had been ſcattered by the waves, covered with a ſtratum of mud, evidently formed by the waters, and commonly intermixed with the remains of marine plants and ſimilar ſubſtances; inſtances of which he himſelf obſerved during his progreſs through Siberia, and which ſufficiently prove that theſe regions of Aſia were once overwhelmed with the ſea.

We often find in the earth petrified bones, the greateſt part of their gelatinous matter being extracted by the moiſture, and a ſtony one introduced in its room. In ſome parts of France petrified bones are met with, which have an impregnation of copper. Hence, on being calcined in an open fire, a volatile ſalt is produced from the remains of their gelatinous principle, and the bone is tinged throughout of a fine greeniſh-blue colour, copper always ſtriking a blue with volatile alkalis. The French turcoiſe ſtones are no other than theſe bones prepared by calcination: they are very durable, and bear to be worked and po-

liſhed

liſhed nearly in the ſame manner as glaſs; without the imperfection, inſeparable from glaſſy bodies, of being brittle.

There have been lately diſcovered ſeveral enormous ſkeletons, five or ſix feet beneath the ſurface, on the banks of the Ohio, not far from the river Miume, in America, 790 miles from the ſea-coaſt. Some of the tuſks are near ſeven feet long; one foot nine inches at the baſe, and one foot near the point; the cavity at the root or baſe, nineteen inches deep. Beſides their ſize, there are ſeveral other differences which will not allow the ſuppoſition of their having been elephants': the tuſks of the true elephant having ſometimes a very ſlight lateral bend; theſe have a larger twiſt, or ſpiral curve, towards the ſmaller end: but the great and ſpecific difference conſiſts in the ſhape of the grinding teeth; which, in theſe newly found, are faſhioned like the teeth of a carnivorous animal; not flat and ribbed, tranſverſely on their ſurface, like thoſe of the modern elephant, but furniſhed with a double row of high and conic proceſſes, as if intended to maſticate, not to grind, their food. A third difference is in the thigh-bone, which is of great diſproportionable thickneſs to that of the elephant; and has alſo ſome other anatomical variations. Theſe foſſil bones have been alſo found in Peru and the Brazils; and when cut and poliſhed by the workers in ivory, appear in every reſpect ſimilar. It is the opinion of Dr. Hunter, that they muſt have belonged to a larger animal than the elephant; and differing from it in being carnivorous. But as yet this formidable creature has evaded our ſearch; and if, indeed, ſuch an animal exiſts, it is happy for man that it keeps at a diſtance; ſince what ravage might not be expected from a creature, endowed with more than the ſtrength of the elephant, and all the rapacity of the tiger! For a further account of this enormous animal, ſee MAMMOTH. For an account of the human ſkeleton, ſee SKELETON, and the Syſtem of ANATOM Part I.

BONZES, Indian prieſts. The Tonquineſe have a pagod or temple in each town; and each pagod has at leaſt two bonzes belonging to it: ſome have thirty or forty. Theſe bonzes, in order to diſtinguiſh themſelves from the laity, wear a chaplet about their necks, conſiſting of a hundred beads; and carry a ſtaff, at the end of which is a wooden bird. They live upon the alms of the people, yet are very charitably diſpoſed, and maintain ſeveral orphans and widows out of their own collections.

The bonzes of China are the prieſts of the Fohiſts, or ſect of Fohi. It is one of their eſtabliſhed tenets, that there are rewards allotted for the righteous, and puniſhments for the wicked, in the next world; and that there are various manſions in which the ſouls of men will reſide, according to their different degrees of merit. But, in order to deſerve the favour of heaven, the bonzes inſtruct the people to treat the prieſts with reſpect and reverence, to ſupport and maintain them, and alſo to erect temples and monaſteries for them. They tell them, that unleſs they comply with theſe injunctions, they will be cruelly tormented after death, and paſs through a diſagreeable variety of tranſmigrations: in ſhort, that they will be changed into mules, aſſes, rats, and mice.

The Chineſe bonzes, according to F. le Comte, are no better than a gang of diſſolute idle fellows. All their aim is to incite people to commiſerate their abject condition. To which end, they have recourſe to ſeveral tricks and impoſtures. When the common arts of addreſs fail them, they try what public acts of penance will do. Some of them drag heavy chains, thirty feet long, after them: ſome ſit in the highway, knocking their heads againſt flint-ſtones, others ſet particular drugs on fire upon their heads: all theſe are ſeveral ways of drawing the attention, and exciting the compaſſion, of the people, and they ſeldom fail of ſucceſs.

F. Navarette tells us, that the bonzes are obliged to chaſtity; and that, on the 2d of April, 1667, a petty king of Canton had condemned eleven of them to be burnt alive, for incontinence. He adds, that it was reported of an empreſs of the laſt reigning family, who had a particular kindneſs for the bonzes, that ſhe granted them a diſpenſation for the uſe of women during three days. The bonzes of China, according to the ſame author, are computed at 50,000.

BOOK, the general name of almoſt every literary compoſition, but, in a more limited ſenſe, is applied to ſuch compoſitions as are large enough to make a volume.

Origin of BOOKS.—The books of Moſes are, doubtleſs, the oldeſt of all that are extant; but there were books before them, for Moſes cited ſeveral.

A book of Enoch is cited in the Epiſtle of Jude, ver. 14 and 15, from which ſome endeavour to prove the reality of antediluvian writings; but the book cited by that apoſtle is generally allowed, both by ancient and modern writers, to be ſpurious.

Of profane books, the oldeſt extant are Homer's poems, which were even ſo in the time of Sextus Empiricus; though we find mention in Greek writers of about ſeventy others, prior to Homer; as Hermes, Orpheus, Daphne, Horus, Linus, Muſæus, Palamedes, Zoroaſter, &c. but of the greater part of theſe, there is not the leaſt fragment remaining; and of the others, the pieces which go under their name are generally held by the learned ſuppoſititious. F. Hardouin goes farther; charging all the ancient books, both Greek and Latin, except Cicero, Pliny, Virgil's Georgics, Horace's Satires and Epiſtles, Herodotus, and Homer, as ſpurious, and forged in the thirteenth century, by a club of perſons, under the direction of one Severus Arcontius. Fabr. Bib. Græc. lib. 1. cap. 1. § 1. § 6. tom. 1. Hardouin, de Num. Herod. in Proluſ. Act. Erud. Lipſ. an. 1710. p. 70.

Among the Greeks, it is to be obſerved, the oldeſt books were in verſe, which was prior to proſe: Herodotus's hiſtory is the oldeſt book extant of the proſaic kind. Strabo. Georg. lib. 1. Heuman. Via ad Hiſt. Liter. § 20. p. 50. § 21. p. 52.

Several ſorts of materials were uſed formerly in making books. Plates of lead and copper, the barks of trees, bricks, ſtone, and wood, were the firſt materials employed to engrave ſuch things upon as men were willing to have tranſmitted to poſterity. Joſephus ſpeaks of two columns, the one of ſtone, the other of brick, on which the children of Seth wrote their inventions and aſtronomical diſcoveries: Porphyry makes mention of ſome pillars preſerved in Crete, on which the ceremonies obſerved by the Corybantes in their ſacrifices were recorded. Heſiod's works were originally written upon tables of lead, and depoſited in the temple of the Muſes, in Bœotia: the ten commandments delivered to Moſes were written upon ſtone: and Solon's laws upon wooden planks. Tables of wood, box, and ivory, were common among the ancients: when of wood they were frequently covered with wax, that people might write upon them with more eaſe, or blot out what they had written. The leaves of the palm-tree were afterwards uſed, inſtead of wooden planks, and the fineſt and thinneſt part of the bark of ſuch trees, as the lime, the aſh, the maple, and the elm; from hence comes the word *liber*, which ſignifies the inner bark of the trees; and as theſe barks are rolled up, in order to be removed with greater eaſe, theſe rolls were called *volumen*, a volume, a name afterwards given to the like rolls of paper or parchment.

Thus, we find books were firſt written on ſtones, witneſs the Decalogue given to Moſes; then on the parts of plants, as leaves, chiefly of the palm-tree, the rind and barks, eſpecially of the tillia, or phillyrea, and the Egyptian papytus: by degrees wax, then leather, were introduced, eſpecially the ſkins of goats and ſheep, of which, at length, parchment was prepared; then lead came into uſe, alſo linen, ſilk, horn, and, laſtly, paper itſelf.

The firſt books were in the form of blocks and tables; but, as flexible matter came to be wrote on, they found it more convenient to make their books in the form of rolls: theſe were compoſed of ſeveral ſheets, faſtened to each other, and rolled upon a ſtick, or *umbilicus*; the whole making a kind of column, or cylinder, which was to be managed by the umbilicus, as a handle, it being reputed a crime to take hold of the roll itſelf.

Scarcity of BOOKS. Of the ſcarcity and value of books during the ſeventh, and many ſubſequent centuries, the following curious account is given by the late Mr. Warton, in his Hiſtory of Engliſh Poetry, Vol. I.

"Towards the cloſe of the ſeventh century (ſays he) even in the papal library at Rome, the number of books was ſo inconſiderable, that Pope Stf Martin requeſted Sanctamand, Biſhop of Maeſtricht, if poſſible, to ſupply this defect from the remoteſt parts of Germany. In the year 855, Lupus, Abbot of Ferrieres, in France, ſent two of his monks to Pope Benedict III. to beg a copy of *Cicero de Oratore*, and Quintilian's Inſtitutes, and ſome other books; 'for (ſays the Abbot) although we have part of theſe books, yet there is no whole or complete copy of them in all France.' Albert, Abbot of Gemblours, who, with incredible labour, and immenſe expence, had collected a hundred volumes on theological, and fifty on profane, ſubjects, imagined he had formed a ſplendid library.

"At the beginning of the tenth century, books were ſo ſcarce in Spain, that one and the ſame copy of the Bible, St. Jerom's Epiſtles, and ſome volumes of Eccleſiaſtical Offices and Martyrologies, often ſerved ſeveral different monaſteries.

"In an inventory of the goods of John de Pontiſſara, Biſhop of Wincheſter, contained in his capital palace of Wulveſey, all the books which appear are nothing more than *Septendecems pecte librorum de diverſis ſcientiis*. This was in the year 1294. The ſame prelate, in the year 1299, borrows of his cathedral convent of St. Swithin at Wincheſter, *Bibliam bene gloſſatam*: that is, the Bible, with marginal annotations, in two large folio volumes; but gives a bond for due return of the loan, drawn up with great ſolemnity. This Bible had been bequeathed to the convent the ſame year by Pontiſſara's predeceſſor, Biſhop Nicholas de Ely: and, in conſideration of ſo important a bequeſt, that is, *pro bona Biblia dicti epiſcopi bene gloſſata*, and one hundred marks in money, the monks founded a daily maſs for the ſoul of the donor. When a ſingle book was bequeathed to a friend or relation, it was ſeldom without many reſtrictions and ſtipulations. If any perſon gave a book to a religious houſe, he believed

believed that ſo valuable a donation merited eternal ſalvation; and he offered it on the altar with great ceremony. The moſt formidable anathemas were peremptorily denounced againſt thoſe who ſhould dare to alienate a book preſented to the cloiſter or library of a religious houſe. The prior and convent of Rocheſter declare, that they will every year pronounce the irrevocable ſentence of damnation on him who ſhall purloin or conceal a Latin tranſlation of Ariſtotle's Phyſics, or even obliterate the title. Sometimes a book was given to a monaſtery, on condition that the donor ſhould have the uſe of it during his life; and ſometimes to a private perſon, with the reſervation that he who receives it ſhould pray for the ſoul of his benefactor.

"When a book was bought, the affair was of ſo much importance, that it was cuſtomary to aſſemble perſons of conſequence and character, and to make a formal record that they were preſent on this occaſion. The diſputed property of a book often occaſioned the moſt violent altercations.

"About the year 1225, Roger de Inſula, Dean of York, gave ſeveral Latin Bibles to the Univerſity of Oxford, with a condition that the ſtudents who peruſed them ſhould depoſite a cautionary pledge. The library of that Univerſity, before the year 1300, conſiſted only of a few tracts, chained, or kept in cheſts, in the choir of St. Mary's church. And although the invention of paper, at the cloſe of the eleventh century, contributed to multiply manuſcripts, and conſequently to facilitate knowledge, yet, even ſo late as the reign of our Henry VI. I have diſcovered the following remarkable inſtance of the inconveniences and impediments to ſtudy which muſt have been produced by a ſcarcity of books: it is in the ſtatutes of St. Mary's college, at Oxford, founded as a ſeminary to Oſeney abbey, in the year 1446, 'Let no ſcholar occupy a book in the library above one hour, or two hours, at moſt, ſo that others ſhall be hindered from the uſe of the ſame.'

'The famous library eſtabliſhed in the univerſity of Oxford, by that munificent patron of literature, Humphrey, Duke of Glouceſter, contained only 600 volumes. About the commencement of the fourteenth century there were only four claſſics in the royal library at Paris. Theſe were, one copy of Cicero, Ovid, Lucan, and Bothius. The reſt were chiefly books of devotion, which included but few of the fathers; many treatiſes of aſtrology, geomancy, chiromancy, and medicine, originally written in Arabic, and tranſlated into Latin and French; pandects, chronicles, and romances.

"This collection was principally made by Charles V. who began his reign in 1365. This monarch was paſſionately fond of reading, and it was the faſhion to ſend him preſents of books, from every part of the kingdom of France. Theſe he ordered to be elegantly tranſcribed, and richly embelliſhed; and he placed them in a tower of the Louvre, from thence called *La Tour de la Libraire*. The whole conſiſted of 900 volumes. They were depoſited in three chambers, which, on this occaſion, were wainſcotted with Iriſh oak, and cieled with cypreſs, curiouſly carved. The windows were of painted glaſs, fenced with iron bars, and copper wire. The Engliſh became maſters of Paris in the year 1425: on which event, the Duke of Bedford, regent of France, ſent the whole library, then conſiſting of only 853 volumes, and valued at 2223 livres, into England; where, perhaps, they became the groundwork of Duke Humphrey's library, juſt mentioned.

"So late even as the year 1471, when Louis XI. of France, borrowed the works of the Arabian phyſician Raſis, from the faculty of medicine at Paris, he not only depoſited, by way of pledge, a quantity of valuable plate, but was obliged to procure a nobleman to join with him as ſurety in a deed, by which he bound himſelf to return it, under a conſiderable forfeiture."

Multitude of Books. As knowledge is naturally advantageous, and as every man ought to be in the way of information, a ſuperfluity of books is the only ſecurity againſt the total loſs, or deſtruction, of books; it is this that has preſerved them againſt the injuries of time, the rages of tyrants, the zeal of perſecutors, and the ravages of barbarians; and handed them down, through long intervals of darkneſs and ignorance, ſafe to our days. *Solaque non norunt hæc monumenta mori.* Bac. de Augm. Sc. lib. i. Auguſt. de Trin. lib. i. cap. 3. Barthol. lib. cit. Diſſ. i. p. 8, &c.

To judge of a Book, thoſe who have treated of the ſubject direct us to obſerve the title, the author's or editor's name, the number of the edition, the place where, and year when, it is printed (which in old books is frequently marked at the end) and the name: proceed then to the preface, and look for the author's deſign, and the occaſion of his writing: conſider alſo his country (each nation having its peculiar genius) which may ſometimes be learned from the dedication: if his life be annexed, run it over, and note his profeſſion, what rank he was of, and any thing remarkable that attended his education, ſtudies, converſation or correſpondences with learned men: not forgetting the elegies which have been given the author, which often occur at the beginning, or even any critique or cenſure, eſpecially if made by a man of judgment. If the preface does not give an account of the method of the work, run briefly over the order and diſpoſition of it, and note what points the author has treated of, obſerve whether his opinions are learned, judicious, and true. Note whether he introduces any new principle or innovation.

It is an indication that a book is good, if the author is known to excel in that talent more immediately neceſſary for ſuch a ſubject; or have already publiſhed any thing on the ſame that is eſteemed. Thus we may conclude that Julius Cæſar will teach us the art of war better than Peter Ramus; Cato, Palladius, and Columella agriculture better than Ariſtotle; and Cicero oratory better than M. Varro. Add, that it is not enough the author be ſkilled in the faculty, but that he be ſo in the particular branches of it he treats of; ſome, for inſtance, excel in the law yet not in the public law: Salmaſius proved himſelf an excellent critic in his Exercitat. Plinian. but was much inferior to Milton in his Defenſio Regia.

The conditions required in a Book, are, according to Selden, "ſolidity, perſpicuity, and brevity:" the *firſt* will be beſt attained, by keeping the piece long by us, often reviewing and correcting it by the advice of friends: the *ſecond*, by diſpoſing the ſentiments in a due order, and delivering them under proper and uſual expreſſions: the *third*, by throwing every thing aſide that does not immediately concern the ſubject.

The cuſtom is much altered ſince the times of the ancients, who carried their ſcrupulouſneſs to ſuch great exceſs, that nothing would ſuffice leſs than its being a treaſure: *theſauros oportet eſſe non libros:* no labour, no aſſiduity and exactneſs were thought enough to complete a work for the public view: every ſentiment and expreſſion were to be maturely weighed, and turned on all ſides; and not ſuffered to paſs, unleſs every word were a pearl, and every page beſet with gems. So that they put the reader in poſſeſſion, in a ſingle hour, of what had coſt them perhaps ten years intenſe thought and application. Such were thoſe books, which were reputed *cedro digni*, fit to be anointed with cedar-juice, and thus rendered incorruptible, for the inſtruction of all future ages.

The uſes of Books, are numerous: they make one of the chief inſtruments or means of acquiring knowledge: they are the repoſitories of laws, and the vehicles of learning: they trace the origin of things diſcovered: they fix and eſtabliſh truth; they remove prejudice, they fix more accurate and preciſe ideas of things: they improve our knowledge of facts and events, and ſhew the order and ways of Providence: our religion itſelf is founded on books: "Without them," ſays Bartholin, "God is ſilent, "juſtice dormant, phyſic at a ſtand, philoſophy lame, letters "dumb, and all things involved in Cimmerian darkneſs." De "Libr. Legend. Diſſ. i. p. 5.

The eulogiums which have been beſtowed on books are infinite: they are repreſented, "as the refuge of truth, which is baniſhed out of converſation; as ſtanding counſellors, as preachers, always at hand, and always diſintereſted; having this advantage over oral inſtructors, that they are ready to repeat their leſſon, as oft as we pleaſe." Books ſupply the want of maſters, and, in ſome meaſure, the want of genius and invention: and can raiſe the dulleſt perſons who have memory, above the level of the brighteſt without them.

Book-binding. The art of gathering together and ſewing the ſheets of a book, and covering it with a back, &c. It is performed thus: the leaves are firſt folded with a folding-ſtick, and laid over each other in the order of the ſignature; then beaten on a ſtone with a hammer, to make them ſmooth and open well; and afterwards preſſed. They are ſewed upon bands, which are pieces of cord or packthread; ſix bands to a folio book; five to a quarto, octavo, &c. which is done by drawing a thread through the middle of each ſheet, and giving it a turn round each band, beginning with the firſt, and proceeding to the laſt. After this the books are glued, and the bands opened and ſcraped, for the better fixing the paſteboards; the back is turned with a hammer, and the book fixed in a preſs between two boards, in order to make a groove for fixing the paſteboards; theſe being applied, holes are made for fixing them to the book, which is preſſed a third time. Then the book is at laſt put to the cutting preſs, betwixt two boards; the one lying even with the preſs, for the knife to run upon; the other above it, for the knife to run againſt; after which the paſteboards are ſquared.

Then remains the covers, which are either of calf-ſkin, or of ſheep-ſkin: theſe being moiſtened in water, are cut out to the ſize of the book; then ſmeared over with paſte made of wheat flour; and afterwards ſtretched over the paſteboard on the outſide, and doubled over the edges withinſide; after having firſt taken off the four angles, and indented and platted the cover at the head-band; which done, the book is covered, and bound firmly between two bands, and then ſet to dry. Afterwards it is waſhed over with a little paſte and water, and then ſprinkled with a fine bruſh, unleſs it ſhould be marbled; when the ſpots are to be made larger by mixing the ink with vitriol. After this the book is glazed twice with the white of an egg beaten, and at laſt poliſhed with a poliſhing-iron paſſed hot over the glazed cover.

BOOK-KEEPING.

THERE are, according to this Treatiſe, two ways of keeping accounts, but both are on the principles of *Double Entry*. The technical names uſed by other Authors in keeping accounts are avoided, from a belief that ſuch as we object againſt are vague and nugatory. Nor can we conceive that reaſon will admit of more than two plain names to compriſe the whole, (namely, REAL and PERSONAL) and bear real ſignification to all ſuch perſons as are not over-fond of winding compoſitions.

REAL ACCOUNTS, are real property, either inactual poſſeſſion or out of it, intruſted to others.

PERSONAL ACCOUNTS, are the mutual tranſactions ariſing between *two or more perſons*; and are to be expreſſed in ſuch order, as occaſionally to ſhew the real and fair ſtate of our dealings.

The SIX PLAIN EXAMPLES we mean to conſtruct this Syſtem upon are briefly theſe.

1ſt. An *Inventory* or exact Account of my whole Stock to begin Trade with, and *another* of what I owe; 2d. *Buying*; 3d. *Selling*; 4th. *Receiving*; 5th. *Paying*; and 7th. *Balancing*.

In which all tranſactions are and muſt be included, though ſo many other names are given to accounts. We therefore do not to confuſe the ſubject with ideal titles, to impede the *learner* in obtaining the plain ſenſe of the buſineſs.

SECT. I.

SUPPOSE I write to Mr. Lemaitre at Paris, deſiring he would purchaſe for me a pipe of Burgundy; which I order to be ſhipped from thence to Dublin, to be delivered according to my appointment to Mr. O'Kelly, Factor, who receives it and exchanges it for Iriſh linens, which he ſhips for London conſigned to me. What are theſe expences of purchaſing, commiſſions, freight, &c. but actually buying and ſelling? Yet the variety of it would occaſion ſad apprehenſions in a Learner, how to give technical terms to the ſeveral negociations, agreeable to the ſpirit of the preſent taught art of Book-keeping; and how to ſtate and balance this ſeemingly awkward chain of account, though in reality, the tranſaction is far from being myſterious or intricate.

FOR INSTANCE.

Admitting the pipe of Burgundy coſt at Paris	–	£. 33
Commiſſion, freightage, and every other charge attending the whole, for which I am accountable is	–	21
The Wine coſt me	–	£. 74
Having ſold the Linens in London for		£. 93
My gain is juſt	— —	£. 19

Partnerſhip is another degree of *imaginary accounts*; and the perſon capable of conducting it, is conceived to be no inconſiderable adept in Book-keeping; becauſe people do not reflect, that when *two* or *more* are jointly concerned in Trade, the tranſactions ought to be ſtated in the ſame manner as when a perſon carries on buſineſs *ſingly*; and the only difference is, the *diviſion* of the *Profits*, and *accounting* for the *Loſs*, when *accounts* are balanced in proportion to the reſpective *Shares* which the Partners had in the *joint Stock*.

The method firſt conſidered is founded on the Italian principle of *Double Entry*, and calculated for the uſe of the Merchant and extenſive branches of Trade; but ſo ſimplified, that perſons in different ſpheres of life may manage their inferior tranſactions on the ſame plan, and be ſatisfied of the ſtate of their domeſtic or trading concerns daily on immediate inſpection.

For the regular order of keeping accounts, in *mercantile* or other extended tranſactions, it is abſolutely neceſſary to have the following three Books.

Waſte Book, Journal, and Ledger.

Theſe *books* are kept in the ſame manner, in effect, in moſt trading cities in Europe; but not as to coin: each being regulated by that ſort of coin which has currency in the ſtate where they are.

SECT. II.
WASTE BOOK.

THE Waſte Book contains the original ſtate and progreſſive occurrences of all our tranſactions, recorded in a familiar manner; and as this firſt Book is the very foundation and authority of the other two, it ought particularly to be attended to, notwithſtanding it is ſo eaſy to conduct it, that any perſon capable of writing a legible hand, and adding a few ſums of money together, may make all the occaſional Entries in it, as correct, and as much to the purpoſe, as thoſe who have written elaborately on the ſubject.

Waſte Book is the firſt, and moſt eſſential: in this, all kinds of matters are mixed together; no order but that of time being preſerved; it being a daily regiſter of occurrences in buſineſs, to be afterwards ſeparated and transferred into the others; ſo that this may be ſaid to contain the elements of all the reſt.

In reality it conſtitutes a Journal or Day-book; but that name being applied to another, the name Waſte-book is given to this by way of diſtinction: though what relation the word Waſte bears to the nature of this Book, is not very obvious. Some with more propriety call it the Memorial-book, or Memorandum-book.

The Waſte-book begins with the inventory of a perſon's effects and debts; the difference between theſe is what the merchant calls his neat ſtock; and contains a complete record of every tranſaction of his affairs, with all the circumſtances, in a plain narration of matter of fact, every tranſaction following another in the order of the dates.

WASTE BOOK.

		£.	s.	d.
LONDON, JANUARY 1, 1794.				
	Inventory of the whole amount of my property with which I begin trade; as follows:			
—	Caſh in the hands of Meſſrs. WALLIS, PERCIVAL, & Co. Lombard-ſtreet, as per banker's book - - - - - - - - - £. 500			
—	Money and notes in my own poſſeſſion - 250			
—	Six puncheons of rum in my warehouſe a £.50 per puncheon - - - - 300			
—	Mr. Richard White owes me, per his note on demand, dated 17 November laſt - - - - - - - - 450			
	Amount of Stock - - - - - - -	1500		
—	Borrowed of Mr. Richard Davis, and gave him my note on demand, dated December 26, 1793 - - - - - 375			
	My real property ——	1125		
	——10.——			
—	Bought of Mr. Richard White, 2 pipes of Madeira, a £.36 per pipe - -	72		
	——20.——			
—	Sold by Mr. Richard Davis, 4 puncheons of rum, part of my original ſtock, a £.72 per puncheon - - - -	288		
	——28.——			
—	Received of Mr. Richard White, on account - - - - - - - - - - - -	150		
	——29.——			
—	Paid Mr. Richard Davis, on account - - - - - - - - - - - -	30		
	——31.——			
—	Paid houſekeeping expences, including horſe-hire, this month, as per bills on the file - -	12		

OBSERVATIONS ON THE WASTE BOOK.

The firſt four entries which follow the title and date make the whole of the ſtock or property with which I commence buſineſs; the next item or article acknowledges my being indebted to Mr. Richard Davis in a ſpecified ſum.

Theſe accounts of what I have and what I owe, diſcover the preſent ſtate of my affairs, and anſwers to the firſt of the ſix examples propoſed, as the balance remaining, after diſcharging Mr. Davis's debt, is my real property; although the inventory, and the ſum for which I am indebted, makes five entries in the Waſte Book.

The Sixth Entry is buying, being the *Second Example*.
The Seventh is ſelling —— *Third Example*.
The Eighth receiving —— *Fourth Example*.
The Ninth paying —— *Fifth Example*.

And the ſixth of theſe eſſential examples ariſes when I balance my debtors and creditors accounts in the Ledger, as will be hereafter ſhewn, and is accordingly termed Balance.

The ninth entry in the Waſte Book is paying, and is analogous too and comprized in the Fifth Example; and had I one thouſand entries to make, they muſt belong to or come under one of the heads alluded to in the fore-mentioned examples, and in no reſpect vary ſo as to require any more examples.

N. B. The ſtrokes in the left hand margin oppoſite each article or entry denotes their being transferred into the Journal, and the date directs where.

SECT. III.
JOURNAL.

THE Journal is the next book uſed in this method of keeping accounts. It is to be a copy of the ſubſtance of all the Entries written in the Waſte-book, with their reſpective dates; the language to be more conciſe, yet deſcriptive; that the minute narrations given in the Waſte-book, may become more brief and reduced to form, to prepare it for the Ledger.

The Journal is that wherein the affairs of each day are entered, as they happen, from the Waſte-book: ſo far as it differs from the Waſte-book, is only a book of aid to the Ledger, being a complete tranſcript of the Waſte-book, in the ſame order of time, but in a different ſtyle; becauſe the Waſte-book expreſſes every tranſaction in a ſimple detail of what is done; whereas the Journal diſtinguiſhes the debtors and creditors, as a preparation for the Ledger; thus when any tranſaction is to be transferred from the Waſte-book into the Journal, they examine it by the rules of the Ledger, as if it were to be entered immediately there; and, finding the debtors and creditors to which it belongs, theſe are diſtinctly marked by their denominations of Debtor and Creditor, in the ſtyle of Journal; at leaſt, the accounts that are debtors are expreſſly ſo named; and by their being directly connected debtor to ſome other accounts, theſe are ſufficiently determined to be the creditors though the word Creditor be not written.

BOOK-KEEPING.

Every entry in the Journal is to be made Debtor to ſome *perſon* or *thing*; the proper rule for which, deſcriptive and by example, will be hereafter given.

JOURNAL.

	LONDON, JANUARY 1, 1794.	£.	s.	d.
	Sundries Dr. to Stock, for the amount of my whole property	1500		
	Meſſrs. WALLIS, PERCIVAL, and Co.			
1	Caſh in their hands £.500			
1	Caſh in my own poſſeſſion 250			
2	Rum 6 puncheons, at £.50 per puncheon 300			
3	Mr. Richard White, debt due by him 450			
	£.1500			
4	Stock Dr. to Mr. Richard Davis			
	Money borrowed on my note 375			
	My real property ——	1125		
	——10.——			
7	Madeira Dr. to Richard White, 2 pipes bought of him at £.36 per pipe	72		
	——20.——			
3	Richard Davis Dr. to rum, 4 puncheons at £.72 per puncheon	228		
	——28.——			
1	Caſh Dr. to Richard White			
	Received on account	150		
	——29.——			
5	Richard Davis Dr. to caſh			
	Paid him on account	30		
	——31.——			
6	Houſehold expences and horſe hire			
	Dr. to caſh as per bills and receipts	12		

N. B. The figures placed in the left hand column of the Journal, refer to the folio or page in the Ledger where the accounts are opened or poſted to.

OBSERVATIONS ON THE JOURNAL.

The manner and utility of the Journal being previouſly defined; the terms uſed and the reaſon for uſing them next require explanation.

The firſt entry made in the Journal is——
"*Sundries Debtor to Stock.*"

Theſe ſundries are the four ſundry things which conſtitute the ſtock with which I begin trade, namely, Caſh at my Banker's—Caſh in my own poſſeſſion—Rum—and a debt due by Mr. R. White.

The fifth entry in the Journal is "*Stock Dr. to Richard Davis,*" having borrowed and holding myſelf accountable to Mr. Davis; I debt my ſtock for the ſum due.

The ſixth entry is a tranſaction with Mr. Richard White; having bought Madeira of him it adds to my ſtock of that commodity, and is conſequently indebted to Mr. White for that article; for that reaſon Madeira is made Dr. to Mr. White, though it may ſeem, on a ſlight conſideration, that Stock, or myſelf, ſhould be debtor in this inſtance; in fact, I am the actual debtor, but this mode of entry diſcovers more plainly how much I have gained or loſt when I balance account. For this reaſon, the ſame diſtinction muſt be obſerved in every thing bought or ſold, principally to preſerve a methodical and clear arrangement; the moſt important conſideration in accounts.

The ſeventh entry is ſelling to Mr. R. Davis, 4 *puncheons of Rum*, and is made Dr. to Rum for the value, and not to Stock, as that particular article had been diminiſhed by him.

The eight entry is Caſh received of Mr. White, and is of courſe made Dr. to him who paid it.

The ninth entry is Caſh paid Richard Davis on account; Mr. D. being the receiver, is made Dr. in my accounts.

The tenth entry diminiſhes my caſh, and is made Dr. to caſh.

Inſtructions to diſtinguiſh the Dr. in every Tranſaction, to be particularly attended to by Learners.

1ſt. Every thing I receive is debtor to the perſon from whom received.

2d. Every perſon to whom I pay money or ſell goods, is debtor to the thing he receives.

3d. If I exchange or barter one commodity for another, the article received is debtor to that given in lieu thereof.

As the whole Art of keeping the Journal in a proper Manner depends on a judicous Diſtinction of the Debtors and Creditors, we ſhall give an Example for the Illuſtration of general Practice.

EXAMPLE PRACTICALLY EXPLAINING THE ABOVE THREE POSITIONS.

EXAMPLE.

WASTE BOOK.

Received in full of Mr. Moody £.72

Bought of Mr. Hoggard, 10 cwt. Sugar, at 45s. per cwt. 11 2

JOURNAL.

Caſh Dr. to Mr. R. Moody
Received in full 72

Sugar Dr. to Mr. J. Hoggard
Bought 10 cwt. Sugar, at 45s. per cwt. 11 2

This example, diligently peruſed and compared with what precedes, is ſufficient to qualify any perſon to manage the Journal; and the following example, and obſervations reſpecting the Ledger, will inſtruct the ſtudent in the Syſtem of DOUBLE ENTRY.

SECT. IV.

LEDGER.

The Ledger is a volume, containing all the tranſactions of a man's affairs, in ſuch order, as thoſe belonging to every different ſubject lie together in oppoſite leaves, making ſo many diſtinct or ſeveral accounts. The Ledger is the waſte-book and journal, farther digeſted, and brought to a point or focus. It is ruled in columns; and all the accounts diſperſed in the journal are drawn out, and ſtated to debtor and creditor. To form each account, two pages are required oppoſite to each other; that on the left ſerving for debtor, the other for creditor: each article to conſiſt of five parts, or members; the date, the perſon whom we credit, or are credited by; the thing credited or indebted for; the page where it was transferred from the journal; and the ſum or amount of the article.

The management of the Ledger, correctly, being of great importance in accounts; attention to the following rules will render the theory familiar to practice.

1. That every perſon with whom you deal, on mutual truſt and credit, or who, by any means becomes your debtor, or you his, as well as for every thing you deal in, there muſt be a place in the book allowed: wherein is to be written all, and only the tranſactions relating to that ſubject, whoſe name is to be written on the head thereof; in order to form diſtinct accounts.

2. Every account to be diſtinguiſhed into two parts, on the right and left pages, of one folio or opening; the name of the perſon or thing being written on the head of the account, on the debtor ſide, diſtinguiſhed by the word debtor, and creditor on the right, or oppoſite leaf.

3. Every perſonal account to be opened in this manner, i. e. every perſon to be made debtor for what he owes you; and creditor for what you owe him.

4. Every real account ſhould contain, on the debtor ſide, the quantity and value of what was upon hand at the beginning of the account, and what was afterwards received, with all coſts and charges; and on the creditor ſide, the quantity and value of what is diſpoſed of, taken away, or gone out of it, with all the returns that you made.

5. To facilitate the uſe of the Ledger, there ſhould be an alphabet to ſerve as an index, conſiſting of twenty-ſix leaves, each cut on the edge, and marked with one of the letters; wherein the perſons names, with whom you have accounts, &c. are inſerted, with the folio of the Ledger, where the account is ſtated. It is impoſſible to arrange the alphabet annexed to the following Ledger after the manner in general uſe, as the conſtruction of a book for that purpoſe is in a peculiar form, known to every ſtationer, or clerk; we ſhall, therefore, conform to the uſage formerly in practice, a method by no means ſo convenient as the prevailing mode.

ALPHABET.

A	B Balance, fo. 8.	C Caſh, fo. 1.	D Davis Rd. fo. 5.
E	F	G	H Houſe Ex. fo. 6.
I	J	K	L
M Madeira, fo. 7.	N	O	P
Q	R Rum, fo. 2.	S Stock, fo. 4.	T
U	V	W White Rd. fo. 3.	X
Y	Z	—	—

BOOK-KEEPING.

LEDGER.

(1)

CASH, DEBTOR.

				£.	s.	d.
Jan. 2	1	To Cash in the Banker's Hands	4	500		
	1	Ditto in my own Hands -	4	250		
28	1	Richard White, received on Account - - - - -	3	150		
				£. 900		

(2)

RUM, DR.

				£.	s.	d.
Jan. 1	1	To Stock, 6 puncheons, at 50l. per puncheon - -	4	300		
		Gained on this Account - -		88		
				£. 388		

(3)

RICHARD WHITE, DR.

				£.	s.	d.
Jan. 1	1	To Stock, due by him on Note	4	450		
				£. 450		

(4)

STOCK, DR.

				£.	s.	d.
Jan. 1	1	To Richard Davis, due to him in my Note - - -	5	475		
	29	House Expences and Horse Hire	1	12		
	30	Balance being what I am now worth - - - - - -	8	1201		
				£. 1588		

(5)

RICHARD DAVIS, DR.

				£.	s.	d.
Jan. 20	1	To Rum 4 puncheons at 72l.	2	288		
29	1	Cash paid him on Account -	1	30		
		Balance due to him - - -	8	57		
				£. 375		

(6)

HOUSHOLD EXPENCES, DR.

				£.	s.	d.
Jan. 30	1	To Bills this Month - -	4	12		

(7)

MADEIRA, DR.

				£.	s.	d.
Jan. 10	1	To Rd. White 2 pipes at 36l. per pipe - - - - -	3	72		

(8)

BALANCE, DR.

				£.	s.	d.
Jan.		To Cash now in Hand - -	1	858		
		Rum 2 puncheons remaining on Hand, valued at -		100		
		Madeira 2 pipes in Hand, cost		72		
		Richard White due by him -		228		
				£. 1258		

LEDGER.

(1)

CREDITOR.

				£.	s.	d.
Jan. 29	1	By Rich. Davis paid on Account	5	30		
	1	Houshold Expences and Horse Hire - - - - - -	6	12		
		Balance in Hand - - -	8	858		
				£. 900		

(2)

CR.

				£.	s.	d.
Jan. 20	1	By Rd. Davis, 4 puncheons of Rum, at 72l. per puncheon	5	288		
		Balance 2 puncheons on Hand, valued at - - - -	2	100		
				£. 388		

(3)

CR.

				£.	s.	d.
Jan. 1	1	By 2 pipes Madeira at 36l. per pipe - - - - -	7	72		
28	1	Cash received on Account -	1	150		
		Balance due to me - - -	7	228		
				£. 450		

(4)

CR.

				£.	s.	d.
	1	By Cash now at Banker's -	4	500		
	1	Ditto in my own Hands -	4	250		
	1	Rum 6 puncheons on Hand	2	300		
	1	Richard White due to me -	3	450		
	1	Rum gained on account of -	2	88		
				£. 1588		

(5)

CR.

				£.	s.	d.
Jan. 1	1	By Stock, by my Note to him	4	375		
				£. 375		

(6)

CR.

				£.	s.	d.
	1	By Stock expended in House	4	12		

(7)

CR.

				£.	s.	d.
Jan. 10		By 2 pipes Madeira at 36l. per pipe - - - - -	8	72		

(8)

CR.

				£.	s.	d.
		By Stock for what I am now worth - - - - -		1201		
		Richard Davis due to him -		57		
				£. 1258		

OBSERVATIONS ON THE LEDGER, WITH DIRECTIONS FOR STATING AND BALANCING.

TO give any directions how to rule the three preceding books would be unneceſſary; as no more is required than to imitate the mechanical order in the different examples.

The figures in the ſmall columns of the margins where the dates of tranſactions are, refer to the pages of the Journal from whence the oppoſite accounts were taken.

In the debtor ſides of the folios, in the ſmall columns adjoining thoſe of caſh, are the figures to ſhew what folio of the Ledger contains the creditor of the account annexed; and on the creditor ſides are the like ſmall columns, in which there are figures to direct you to the folio of the debtor.

The number of folios in the preceding Ledger are eight; having as many different titles, and all real.

Directions for opening accounts were given in the beginning of this Section.

The RULES *for knowing the* Dr. *and* Cr. *of every Account, are theſe:*

Every article I have on commencing buſineſs, is then made Debtor to Stock; and the title or account of Stock is Creditor by each article for its reſpective value. See Folio 4. of the Ledger.

Every thing I receive in a future tranſaction, is to be made Debtor to the perſon from whom it is received; and that perſon is immediately to be credited, on the creditor ſide of his account, with the ſame account.

See the Journal for the 28th day of the month, where I received 150l. from Mr. White; Caſh being the thing received, is made Debtor in folio 1. of the Ledger, to the perſon from whom it was received; and that being done, without delay, I give him credit, on the creditor ſide of his account, in folio 3. of the Ledger.

By a ſtrict obſervance of this one example, you diſcover the Dr. and Cr. ariſing from all things received; for in the Ledger entries,

entries, every Dr. muſt have a Cr. immediately, to continue the uniformity of Double Entry.

And when I deliver any thing, the perſon to whom I deliver it is to be made debtor for the amount of what he receives; and the articles delivered is to be credited, in the folio bearing its name for a title, for the ſame value.

See the Journal for the 29th day of the month; having delivered to Mr. Davis 30l. he is made Debtor for the ſum, on the ſame date in folio 5. of the Ledger; and caſh bearing title in folio 1. of the Ledger, I proceed directly to give credit for the money I paid away. So much for ſtating the Debtor and Creditor of things delivered.

Paying and Receiving.

These particulars form the general employments of mankind, and are all that are required in a courſe of book-keeping. If then the mark of finding the Debtors and Creditors in theſe two caſes can be fixed to a certainty, and all the negociations of life are comprehended in paying and receiving, what difficulty is there in opening an account according to Double Entry, but ſuch as an implicit obedience to blind cuſtom has occaſioned?

If I give one piece of goods, and receive another; will not the ſame law hold good? is not the conſideration received a pledge, a real debtor, for the thing given; and muſt not I conſider that the commodity given away in the exchange is diminiſhed by ſo much delivered out, and of courſe claims credit for ſuch under its proper title?

Or, if I give different things to one perſon, or for one certain thing; will not the rules given, at once aſcertain the Debtor for my different articles ſo given? and will not their reſpective titles direct me to a view of their reſpective decreaſe; and conſequently give each of them credit equal to the diminution they ſuffered?

Likewiſe, if I receive different articles, for one certain article of mine, or have different perſons bound in the ſame bond or contract to me: will not the ſame reaſons immediately diſcover where to place the Debtors and the Creditors?

Leſt the foregoing obſervations may be ſaid not clearly to vindicate me in the examples I have here offered in my own Ledger, I ſhall reconſider and explain the principal articles.

The firſt three accounts opened in the Ledger, are Caſh, Rum, and Richard White; and they are reſpectively charged Debtors to Stock, in the different folios 1, 2, and 3. where they are opened; and each of them is immediately entered on the creditor ſide of ſtock, in folio 4.

Stock, the 4th Entry in the Journal, is made Debtor in the Ledger, for what I owe to Mr. Davis.

The different Drs. and Crs. in theſe Entries, ariſe from the neceſſary form of ſtating my preſent circumſtances before I commence buſineſs.

The following tranſaction is ſelling Rum to Mr. Davis, for which he is made Debtor folio 5. and the account of Rum gets credit, folio 2. for its loſs.

The 9th and laſt Entry in the Journal is that of Houſhold Expences Debtor to Caſh, being the 6th title or account opened in the Ledger. It is the law of Cuſtom, to place conſumptions of this nature under the title, Profit and Loſs; and, indeed, the title has ſome ſhadow of claim here, in particular; as the manner of houſekeeping, according to the managers, may have a great ſhare of both. Yet, in the preſent caſe, I ſhall make choice of a more ſubſtantial title; I will venture to make the Account of Stock in folio 4. to anſwer for money expended in this or any ſimilar manner. It is evident that this expence diminiſhed my caſh; but it was to gratify me; and, in the name of reaſon, why ſhould I charge any part of it to loſs?

When the Journal is transferred into the Ledger, I proceed to balance all theſe accounts; and open an account of Balance in the 8th folio.

Taking a piece of paper and beginning with the Caſh account, folio 1, I find the ſeveral amounts of the Debtor and Creditor ſides, and find the difference is 858l. which is the money remaining in my banker's hands and my own; this amount I transfer to folio 8, and make balance Dr. to Caſh; then referring back to Caſh account, credit balance for the ſum, and finally cloſe the Caſh account.

In folio 2. Rum, the difference is 100l. which I carry to balance as Rum unſold, and placing the ſame to the credit of Rum, and the account balances.

In folio 3. Richard White owes me 228l. for which I make balance Dr. to him, and give him credit by balance, and this account balances alſo.

In folio 4. I make Stock, or Myself, Dr. to Richard Davis: alſo to Houſhold Expences. On the oppoſite, or Creditor ſide of this account, is the ſtate of my Stock at the commencement of the year, and ſince that a gain of 88l. on Rum.

On adding up each of thoſe ſides, I find the difference 1201l. being the amount of my property. This ſum being transferred to the Creditor ſide of Balance, and afterwards to the Debtor ſide of Stock, the totals of both ſides are equal to each other.

In folio 5. There appears due to Mr. Davis 57l. which being a debt I owe, it muſt of courſe be transferred to the Creditor ſide of balance, and to the Dr. ſide of Mr. Davis's account, and thus both ſides are balanced.

In folio 6. The title is Houſhold Expences, which is already diſpoſed of in the Caſh account folio 1, being the ſource from whence it came.

In folio 7. Madeira is made Dr. to Richard White, and in folio 3, is placed to the credit of Mr. White, conſequently is accounted for by leſſening the debt he owes me.

We now come to folio 8, or the Balance, and finding what I anxiouſly wiſhed for, that both ſides agree, I diſcover there remains for me, after paying my juſt debts, 1201l.

THE CASH BOOK

Is certainly neceſſary in extenſive concerns; when a perſon becomes acquainted with the method of Book-keeping here laid down, he will find little difficulty in extending the number of his books at pleaſure. I ſhall preſent the reader with a brief deſcription of the Caſh book, any thing further I preſume would be unneceſſary and tedious.

This book is kept in a folio form like the Ledger, ſerving to abridge the Caſh account there. On the Dr. ſide, or left hand page, Caſh is made Dr. for all the ſums received by way of title, and on the right hand ſide Caſh is made Cr. for all the ſums paid. Every week, or what is more common, every month, this book is poſted to the Ledger in one total ſum; by this means the Caſh account in the Ledger will be ſo contracted as to conſiſt only of twelve lines, one for each month in the year.

Such other books as are uſed are book of Petty Charges, book of Houſe Expences, &c. theſe ſometimes may be deemed neceſſary auxiliaries, and are chiefly intended to keep large and important concerns ſeparate from thoſe contingencies of an inferior nature. A multiplicity of Books of Accounts ſhould be avoided as much as poſſible, as they create labour, and make the buſineſs of the Counting-houſe complex and tedious, where the great object ſhould be a ſimple, correct, and clear brevity.

SINGLE ENTRY.

The method of Book-keeping, called Single Entry, is certainly too generally known and eaſily acquired, to need a treatiſe upon it; I ſhall therefore conciſely give the outlines of a mode which may with eaſe be reduced to practice.

1ſt. Prepare a Book on the ſame plan as Waſte Book, deſcribed in the Syſtem of Double Entry, it may be called a Waſte Book, Day Book, or what you pleaſe. In this book enter the ſundry tranſactions of the day as they occur, ruling a line between each article, or the buſineſs you do with each perſon. Let the particulars of this book conſiſt of the date, quantity, quality, value, and every other deſcriptive requiſite, to make each entry not only familiar in every reſpect to your own mind, but alſo to every other perſon who may have occaſion to inſpect your concerns at any future period, in caſe of death or other unforeſeen caſualties; in fact let every circumſtance be as full and explicit as plain language can make it.

2d. Procure another book larger, and of a different kind from the former, it ſhould conſiſt of whole ſheets of paper folded once, called folio; ſuch a book as this, conducted as follows, is in every reſpect a Ledger.

At the beginning of this book prepare an alphabet, by cutting a ſmall piece from the edge of twelve leaves, beginning with the firſt leaf and continuing within one inch of the top, purſuing the ſame method with each leaf, finiſhing the laſt at an equal diſtance from the bottom. This method is well known among ſtationers; I therefore think it uſeleſs to give a more exact deſcription.

The next buſineſs will be to page or folio this book, obſerving that every right and left page is to bear the ſame figure.

When you poſt or transfer the accounts from the Day Book to the Ledger, firſt write the perſon's name on the top of the left hand page by way of title, and on the right ſide oppoſite make a title with the word Creditor, proceeding in the ſame manner with the name of every other perſon you deal with, making ſome conſpicuous mark of diſtinction againſt every article immediately as you poſt it in the Ledger.

Obſerving this rule, ſet down every thing you pay, or are liable to pay, on the right hand page or creditor ſide; and every thing you receive, or ſhould receive, on the left hand page or debtor ſide.

This Ledger is ruled on the left ſide of each page, with a column for the date, and on the right for caſh.

BOOK-SELLER, a profeſſed trader in books; whether he prints them himſelf, or procures them to be printed by others, for ſale. Bookſellers, among us, are the ſame with the *bibliopolæ* among the ancients, whoſe office was diſtinct from that of *librarii*. At Rome, the Argiletum was the mart of books, as St. Paul's Church-yard, or Fleet-ſtreet, and Paternoſter-row, have been among us; whence that of Martial.

Argiletanas mavis habitare tabernas,
Cum tibi, parve liber, ſcrinia noſtra vacent.

Bookſellers are a kind of agents, or curators in the republic of letters: in many places they are ranked among the members of univerſities, and entitled to the privileges of ſtudents: as at Tubingen, Saltzburg, and Paris, where they have always been diſtinguiſhed from the vulgar and mechanical traders, and exempted from divers taxes and impoſitions laid on other companies. Formerly, the offices of bookſellers and printers were united in the ſame perſons. Labbe gives a liſt of learned book-ſellers; moſt of whom were alſo authors. Of late days, book-ſellers have drawn their buſineſs into leſs compaſs, leaving the labour of compoſing books to one ſet of perſons, and that of printing them to another.

In this view, they have been very important and uſeful agents between authors and the public; and have contributed, in no ſmall degree, to the encouragement of genius and literary induſtry, and the ſpread of ſcience. There are few authors, who have undertaken the printing and publiſhing of any work likely to be tranſmitted to poſterity, without being connected with ſome bookſeller, eminent in his profeſſion.

The fairs of Frankfort and Leipſic are famous for the reſort of book-ſellers, not only from all parts of the empire, but Holland, Flanders, &c. They have each their ſhop or warehouſe, over which is inſcribed the name of ſome celebrated book-ſeller of former times; *officina Elzeviriana, Frobeniana, Morelliana, Janſoniana*, &c.

BOOTES, in Aſtronomy, a conſtellation of the northern hemiſphere, whoſe ſtars, in Ptolemy's catalogue, are 23; in Tycho's 28; in Bayer's 34; in Hevelius's 52; and in Mr. Flamſteed's catalogue 54. See the Syſtem, Sect VIII. Plate 6.

BORAX, in Chymiſtry, a ſalt in appearance ſomewhat ſimilar to cryſtals of alum, brought originally from the Eaſt Indies in an impure ſtate, and afterwards freed from its impurities by certain proceſſes in the European countries. It is chiefly uſed in ſoldering and fuſing of metals; ſometimes alſo in medicine, as an emetic, and promoter of delivery.

There are two kinds of borax; natural, which is crude; and artificial, which is purified and refined. Crude, or natural borax, *borace non rifatto*, is a mineral ſalt, dug out of the earth in ſeveral parts of Perſia; and found alſo at the bottom of a torrent running in the mountains of Purbeth, near the frontiers of White Tartary: when taken up, it is expoſed to the air, where it acquires a reddiſh fatneſs, which ſerves to feed it, and prevent its calcining. When in its perfection, it is ſent to Amadavat, in the territories of the Great Mogul, where the European merchants buy it.

It was long a matter of uncertainty whether Borax be a natural or factitious ſubſtance in thoſe countries from whence it is brought; but it is now beyond a doubt, that it is naturally produced in the mountains of Thibet, from whence other parts of the eaſtern continent are ſupplied. Mr. Kirwan, in his Mineralogy, informs us, that Mr. Grill Adamſon ſent ſome to Sweden in the year 1772, in a cryſtalline form, as dug out of the earth, in the kingdom of Thibet, where it is called *pounxa, my poun*, and *houi poun*. It is ſaid to have been found in Saxony, in ſome coal-pit.

In the Philoſophical Tranſactions, vol. 77, we have two different accounts of the place where it is found, and the manner of obtaining it. One of theſe is by William Blane, Eſq. who tells us that in the language of the country it is called *ſwagah*, and is brought into Hindoſtan from the mountains of Thibet. It is produced in the kingdom of Jumlate, about thirty days journey north from Betowle, a ſmall principality about 200 miles N. E. of Lucknow. The place where it is found is ſaid to be a ſmall valley ſurrounded with ſnowy mountains, in which is a lake about ſix miles in circumference, the water of which is conſtantly ſo hot, that the hand cannot bear it for any length of time. Around this lake the ground is perfectly barren, not producing even a blade of graſs; and the earth is ſo full of a ſaline matter, that after falls of rain or ſnow, it concretes in white flakes on the ſurface, like the natron of Hindoſtan. On the banks of this lake, in the winter ſeaſon, when the falls of ſnow begin, the earth is formed into ſmall reſervoirs ſix inches high: when theſe are filled with ſnow, the hot water from the lake is thrown upon it; which, together with the water from the melted ſnow, remains in the reſervoir, to be partly abſorbed by the earth, and partly evaporated by the ſun; after which there remains at bottom a cake of ſometimes half an inch thick of crude borax, which is taken up and reſerved for uſe. It can only be made in the winter ſeaſon, becauſe the falls of ſnow are indiſpenſably requiſite, and alſo becauſe the ſaline appearances upon the earth are ſtrongeſt at that time. When once it has been made on any ſpot, it cannot be made again on the ſame till the ſnow has fallen and diſſolved three or four times, when the ſaline efflorеſcence appears as before. The borax, in the ſtate in which it is taken off the earth, is carried from hill to hill upon goats, and paſſes through many hands, which increaſes the difficulty of obtaining any authentic information concerning the original manufacture. When brought down from the hills, it is refined from the groſs impurities by boiling and cryſtallization. Our author could obtain no anſwer from thoſe who gave him the account, to any of his queſtions concerning the quality of the water and mineral productions of the ſoil. All they could tell him was, that the water was very hot, very foul, and as it were greaſy; that it boils up in many places, and has a very offenſive ſmell; and that the ſoil is remarkable only for the ſaline appearances already mentioned. The country in general produces conſiderable quantities of iron, copper, and ſulphur; and our author was aſſured that all the borax in India came from this place.

As this part of Aſia is entirely unfrequented by Europeans, our author could only obtain his information from the natives: however, as he had an opportunity of ſeeing ſome of thoſe who reſided near the ſpot, it might be reckoned as genuine as could well be expected. The place, he tells us, is inacceſſible not only to the Europeans, but even to the inhabitants of Indoſtan, being never viſited by any of them except a few wandering Faquirs, who have been ſometimes led there, either with a view to viſit ſome of the temples in the mountains, or to do penance. They deſcribe the cold in winter to be ſo intenſe, that every thing is frozen up; and life can only be preſerved by loads of blankets and ſkins. In the ſummer, again, the reflection of heat from the ſides of the mountains, which are ſteep and cloſe to one another, renders the heat intolerable. With reſpect to the credibility of the account, he obſerves, firſt, "That borax is really brought from the mountains of Thibet is certain, as he himſelf often had occaſion to ſee large quantities of it brought down, and had purchaſed it from the Tartar mountaineers, who brought it to market; ſecondly, he had never heard of its being produced or brought into India from any other quarter; and, thirdly, if it was made on the coaſt of Coromandel, as ſome books mention, he thinks there can be little doubt but that the whole proceſs would have been fully inquired into, and given to the public long before this time.

The other account is from father Joſeph de Ravato, preſident of the miſſion of Thibet, and ſent in a letter to the Royal Society, communicated by Joſeph Banks, Eſq. He pretends alſo to have had his intelligence from a native of the country where the borax is made, though it differs very conſiderably from that of Mr. Blane. "In the province or territory of Marme (ſays he) 28 days journey to the north of Nepal, and 25 to the weſt of Laſſa, the capital of Thibet, there is a vale about eight miles broad. In a part of this vale there are two villages or caſtles, the inhabitants of which are wholly employed in digging the borax, which they ſell at Thibet and Nepal, they having no other means of ſubſiſtence, the ſoil being ſo barren as to produce nothing but a few ruſhes. Near theſe two caſtles there is a pool of moderate ſize, and ſome ſmaller ones, where the ground is hollow, and the rain water collects. In theſe pools, after the water has been ſome time detained in them, the borax is formed naturally: the men wading into the water, feel a kind of pavement under their feet, which is a ſure indication that borax is there formed; and there they accordingly dig it. Where there is little water, the layer of borax is thin; where it is deep, it is thicker; and near the latter there is always an inch or two of ſoft mud, which is probably a depoſit of the water after it has been agitated by wind or rain. Thus is the borax produced merely by nature, without either boiling or diſtillation. The water in which it is formed is ſo bad, that the drinking a ſmall quantity of it will occaſion a ſwelling of the abdomen, and in a ſhort time, death itſelf. The earth that yields the borax is of a whitiſh colour; and in the ſame valley, about four miles from the pools, there are mines of ſalt, which is there dug in great abundance for the uſe of all the inhabitants of theſe mountains, who live at a great diſtance from the ſea. The natives, who have no other ſubſiſtence on account of the ſterility of the ſoil, pay nothing for digging borax; but ſtrangers muſt pay a certain retribution, and uſually agree at ſo much per workman. Ten days journey farther north, there is another valley called *Tapre*, where they dig borax; and another ſtill farther to the northward, named *Cioga*. Borax, in the Hindoo and Nepaleſe languages, is called *Sauga*. If it be not purified, it will eaſily deliqueſce; and in order to preſerve it for any time till they have an opportunity of ſelling it, the people often mix it with earth and butter. In the territory of Mungdan, 16 days journey to the north of Nepal, there are rich mines of arſenic; and in various other places are found mines of ſulphur, as alſo of gold and ſilver, whoſe produce is much purer than thoſe of the mines of Pegu."

The *borax* now uſed in Europe, is prepared from the *tincal* that is brought from the Eaſt-Indies. Dr. Lindolff thinks it might be made in Europe without tincal, by alum, ſoap, and a ſtrong alkaline ley. D. W. Linden thinks that Dr. Lindolff is well acquainted with the nature of borax, and that it might be made after his method; but that it would be too expenſive, and not ſuperſede the importation of tincal. He therefore recommends the ſour acid and water that comes out of coal mines, train oil, or any other fiſh oil, or indeed any fat that could be had cheap; the ſtrongeſt alkali of kelp; and all theſe ingredients to be worked in a liquid ſtate, till they are well mixed, and cryſtallize like a ſalt, which he thinks would anſwer all the ends of borax.

Borax is ſoluble with difficulty in water, and cryſtallizable as alum, only that it requires more water for its ſolution, and retains leſs of it in its cryſtallization. It ſuffers no decompoſition by fire; but may be decompoſed by vitriolic, nitrous, and marine acids, which unite with the ſaline alkaline matter that is its baſis, and form with it the ſame neutral ſalts exactly, as thoſe that are produced from the union of theſe acids with the marine alkali; i.e. the vitriolic acid forms Glauber's ſalt, the nitrous acid forms cubic nitre, and the marine acid forms ſea ſalt. Acids thus combining with the baſis of borax, ſeparate from it a ſaline ſubſtance, ſingular, and little underſtood, called *ſedative* ſalt.

This was firſt diſcovered by Homberg, who obtained the ſedative ſalt by diſſolving it with vitriol; but the younger Lemery diſcovered that the ſame ſalt might be alſo obtained by the nitrous and marine acids: theſe chymiſts uſed, for this purpoſe, the embarraſſing and tedious operations of diſtillation and ſublimation; but Mr. Geoffroy has ſhewn the method of obtaining the ſame ſalt from borax by acids with evaporation and cryſtallization only, in greater quantity and leſs trouble. He has alſo demonſtrated that borax contains the baſis of ſea-ſalt. M. Baron has ſhewn, that borax yields the ſedative ſalt by means of vegetable acids; and that the ſalt is a conſtituent part of the borax, and only diſengaged from the alkaline matter with which it is united by the acids, and that it may be reunited with its alkali, and again form borax. Macquer. Dict. Chem. and Mem. Acad. Sc. An. 1728, 1729, 1732.

Borax is of great uſe in collecting the particles of any metal over the fire, and running them into a maſs; and this, with very litte diminution of their weight. Dirt or aſhes, though in ever ſo ſmall a quantity, will certainly hinder ſome ſmall particles of gold and ſilver from running together into a maſs over the fire; but if they are ſo diſpoſed by a very ſtrong fire as to meet into a regulus, a great part of the metal will always adhere to the dirt that is thrown away. The leſs perfect metals not only ſuffer the above-mentioned accidents, but their ſurfaces being greatly increaſed, copper and iron turn into a *ſcoriæ*, and are deſtroyed, and lead and tin are ſo in great part. It is therefore very detrimental when theſe baſer metals are mixed in any, even in ever ſo ſmall a quantity, with gold or ſilver; for in the melting, there come upon the ſurfaces light *ſcoriæ*, in which part of the gold or ſilver is retained, as in the pores of a ſponge, and prevented from running into a regulus.

To remedy this miſchief, *borax* is added, becauſe as it helps the melting of metals and of all bodies by fire, its bringing the whole maſs into a quick fuſion, gives the metals an opportunity to ſink together in a maſs to the bottom, and vitrifies the lighteſt *ſcoriæ*, throwing them off the ſurface; and the uſe of this ſalt is not reſtrained to gold and ſilver, but takes place as well in regard to iron as copper. This ſalt alſo cauſes metals to melt in a much leſs fire than they otherwiſe would, and is of very ſingular uſe in preſerving the leſs perfect metals while in fuſion. It flows over them, and covers the ſurface while tortured in the fire, as if it were a kind of very thin glaſs, which defends them againſt the combined force of the fire and air, ſo deſtructive of the imperfect metals.

The aſſayers have a cuſtom of rubbing with *borax* the inſides of veſſels, in which the more precious metals are to be melted, which always fills up the ſmall cavities in their ſides, that might otherwiſe take in a part of the metals. When gold is melted with *borax* alone, it makes it pale; but this is obviated by the adding a ſmall quantity of nitre, or of *ſal ammoniac*. Care muſt be taken, however, not to add both theſe ſalts together, becauſe they would cauſe a detonation. The above-mentioned uſe of *borax* has cauſed it to be reckoned, by ſome writers, among the reducing bodies; that is, ſuch bodies as reſtore metals, however deſtroyed, to their priſtine form: but this is an error; for *borax* does not reduce the deſtroyed metals, but only the ſcattered particles of them, while they yet retain their true metallic form. For a further account of the nature and properties of this ſalt, ſee the Syſtem of CHYMISTRY, Part I. Chap. 5. Sect. 6. throughout.

Borax is alſo uſed by the dyers to give a gloſs to ſilks; in Italy by the ladies as a coſmetic; and in making Glauber's ſalt. A principal uſe of *borax* is to facilitate the ſoldering of metals, by accelerating the fuſion of the ſurfaces of the metals to be joined, and clearing them of any calx or other matter by which they might be prevented from being perfectly applied to each other.

Borax, in *Medicine*, is uſed to promote delivery. Med. Eſſ. Edinb. vol. i. p. 341. The uſe of *borax* is that of an inciſive and aperient ſalt, by virtue of which it is effectual againſt diſeaſes which proceed from an inſpiſſation of the humours, and obſtructions thence ariſing. The doſe is a dram.

Its ſtimulus, however, is too weak to be depended upon for preſent relief in a difficult birth, unleſs it be joined with other ingredients of more efficacy. For this reaſon, *borax* is commonly given in powder mixed with ſaffron, myrrh, oil of cinnamon, caſtor, the volatile ſalt of amber, and the like. Some adviſe a few grains of it to be taken in a poached egg, as a provocative to venery. *Borax* calcined, is reckoned of ſpecific virtue in fluxes of the belly, or the ſemen, as being a kind of ſtyptic earth. The doſe is from a ſcruple to half a dram.

Borax is of ſome farther uſe in medicine, as it enters the compoſition of the *unguentum citrinum*. It is alſo uſed in the preparation of *fucus* or paint for the ladies.

Glaſs of Borax is obtained by melting the cryſtals of this ſalt; and it is the only ſalt that aſſumes a vitreous appearance from fire without addition. The glaſs becomes opake, and pulverizes in the air. *Borax* forms with earths different ſorts of glaſs, which are in general very hard and compact, and at firſt extremely tranſparent; but they are liable to become cloudy and opake by being long expoſed to the air. It is alſo uſed in preparing the imitations of precious ſtones.

BOREAS, a Greek name, now in common uſe for the north wind. Pezron obſerves, that anciently *Boreas* ſignified the north-eaſt wind, blowing at the time of the ſummer ſolſtice. The Greeks erected an altar to *Boreas*. He is repreſented on the temple at Athens with his robe before his mouth, as if he felt the cold of the climate over which he preſides, agreeably to the deſcription of Ovid, who calls him *gelidus tyrannus*, "the ſhivering tyrant," Met. vi. ver. 711. But he is uſually deſcribed by the Roman poets as violent and impetuous; ibid. ver. 686—ver. 707. In painting, he is generally repreſented like an old man with a horrible look, his hair and beard covered with ſnow or hoar froſt, with the feet and tail of a dragon.

BORECOLE, in *Botany*, a ſpecies of the *braſſica*, or cabbage. Of this there are three ſorts; the common, the green, and the Siberian or curled colewort, called by ſome Scotch kale. *Borecole* has lately been found to be an excellent food for cattle. See the Syſtem of AGRICULTURE, Sect. XI.

BOROUGH, BURROUGH, BOROW, or BURGH, is frequently uſed for a town, or corporation, which is not a city. *Borough*, in its original Saxon *borge*, or *borgh*, is by ſome ſuppoſed to have been primarily meant of a tything or company conſiſting of ten families, who were bound or combined together as each other's pledge. Afterwards, as Verſtegen informs us, *borough* came to ſignify a town that had ſomething of a wall or incloſure about it: ſo that all places which among our anceſtors had the denomination *borough*, were one way or other fenced or fortified. But in later times, the ſame appellation was alſo beſtowed on ſeveral of the *villæ inſignioriæ*, or country towns of more than ordinary note, though not walled.

The ancients Saxons, according to Spelman, gave the name *burgh* to thoſe called, in other countries, cities. But divers canons being made for removing the epiſcopal ſees from villages and ſmall towns to the chief cities, the name *city* became attributed to epiſcopal towns, and that of *borough* retained to all the reſt; though theſe too had the appearance of cities, as being governed by their mayors, and having laws of their own making, and ſending repreſentatives to parliament, and being fortified with a wall and caſtle, and the like.

Borough, or *burgh*, is now particularly appropriated to ſuch towns and villages, as ſend burgeſſes or repreſentatives to parliament. *Boroughs* are equally ſuch, whether they be incorporate or not; there being great numbers of our Engliſh *boroughs* not incorporated; and, on the contrary, ſeveral corporations that are not *boroughs*; e. gr. Kingſton, Deal, Kendal, &c.

Boroughs are diſtinguiſhed into thoſe by charter or ſtatute, and thoſe by preſcription or cuſtom. The number of *boroughs* in England and Wales, including cities and cinque ports, which elect members, is 215; ſome whereof ſend one, ſome two repreſentatives.

Royal Boroughs, in Scotland, corporations made for the advantage of trade, by charters granted by ſeveral of their kings; having the privilege of ſending commiſſioners to repreſent them in parliament, beſides other peculiar privileges. Theſe form a body of themſelves, and ſend commiſſioners, each, to an annual convention at Edinburgh.

According to Chamberlayne, they have the ſole power of trade and merchandize, excluſive of all others, a power of holding courts, exerciſing the juriſdiction of ſheriffs, making bye-laws, &c. The company of merchants in a *royal borough* make what is called a *gild*; the chief of which is a dean of *gild*, who is next magiſtrate to the bailiff.

The *royal boroughs* are not only ſo many diſtinct corporations, but

but do alſo conſtitute one entire body, governed by, and accountable to one general court, anciently called the *court of four boroughs*, held yearly to treat and determine concerning matters relating to the common advantage of all *boroughs*. The four *boroughs* which compoſed this court were Edinburgh, Stirling, Roxburgh, and Berwick; which two laſt falling into the hands of the Engliſh, Linlithgow and Lanerk were put in their places; with a ſaving to the former, whenever they ſhould return to their allegiance. But this court not being ſufficient to anſwer the neceſſities of the *royal boroughs*, they were all empowered, under James III. in 1487, to ſend commiſſioners to a yearly convention of their own, which was then appointed to be held at Inverkeithing, and is now held at Edinburgh, under the denomination of the *convention of boroughs*, veſted with great power, and having for its object, the benefit of trade and the general intereſts of the borough.

Borough-Courts are certain courts held in boroughs, by preſcription, charter, or act of parliament: ſuch are the ſheriff's court, and the court of huſtings in London.

Borough-Engliſh, denotes a cuſtomary deſcent of lands or tenements in certain places, whereby they come to the youngeſt, inſtead of the eldeſt ſon; or if the owner hath no iſſue, to the youngeſt, inſtead of the eldeſt brother; becauſe the youngeſt is ſuppoſed, in law, the leaſt able to ſhift for himſelf. 1 inſt. 140. b. And in ſupport of this reaſon, other uſages in favour of the youngeſt, as that in Kent, where the lands being equally divided among all the ſons, the youngeſt is to have the privilege of aſtre or hearth in the manſion-houſe, in his ſhare, as being ſuppoſed the tendereſt, and more in need of warming. Others, notwithſtanding, ſuſpect a different reaſon for the riſe of *Borough-Engliſh*, viz. the places where this cuſtom now obtains, were anciently liable to that cuſtom granted the lords of manors in Scotland by King Eugenius, who had the privilege of enjoying the firſt night of their tenants brides; ſo that the eldeſt ſon being preſumed to be the lord's, they uſually ſettled their lands on the youngeſt ſon, whom they thought their own; which being practiſed a long time, grew at length into a cuſtom. The cuſtom, however, never obtained in England, though it did in Scotland till it was aboliſhed by Malcolm III. Perhaps, ſays Judge Blackſtone, the origin of this practice, may be illuſtrated by that of the Tartars, mentioned by Du-Halde, among whom the ſame cuſtom of deſcent to the youngeſt ſon prevails. As the nation is compoſed of ſhepherds and herdſmen, the eldeſt ſons migrate from their father with an allotment of cattle, to ſeek a new habitation. The youngeſt ſon, continuing lateſt with his father, is naturally the heir of his houſe. This cuſtom of migrating obtained in many other northern nations; and *Borough-Engliſh* may be a remnant of that paſtoral ſtate of our Britiſh and German anceſtors, which Cæſar and Tacitus deſcribe. Blackſtone's Comm. vol. ii. p. 83, 84. *Borough-Engliſh* obtains only in ſome ancient boroughs and copyhold manors.

BOS, in the Syſtem of MAMMALIA, a genus of quadrupeds belonging to the order of pecora. The characters of this genus are taken from the horns and teeth. The horns are hollow within; and turned forward in the form of creſcents: there are eight fore-teeth in the under jaw, and none in the upper, their place being ſupplied by a hard membrane; and there are no dog-teeth in either jaw. The moſt remarkable ſpecies are the following:

The *Taurus*, including the bull and cow, has cylindrical horns bent outwards, and looſe dewlaps. The bull, or male, is naturally a very fierce and terrible animal. For repreſentation ſee Plate IX. Genus 3. Species 1. When the cows are in ſeaſon, he is ſometimes ungovernable. Caſtration remarkably ſoftens the nature of this animal; it deſtroys all his fire and impetuoſity, and renders him mild and tractable, without diminiſhing his ſtrength; on the contrary, after this operation, his weight is increaſed, and he becomes fitter for the purpoſes of plowing, &c.

The beſt time for caſtrating bulls is at the age of puberty, or when they are 18 months or two years old; when performed ſooner, they often die. However, it is not uncommon to caſtrate calves a few days after birth. But ſuch as ſurvive an operation ſo dangerous to their tender age, generally grow larger and fatter, and have more courage and activity than thoſe who are caſtrated at the age of puberty. When the operation is delayed till the age of ſix, ſeven, or eight years, they loſe but few of the qualities of bulls; are much more furious and untractable than other oxen; and when the cows are in ſeaſon, they go in queſt of them with their uſual ardour.

Cows are generally in ſeaſon, and receive the bull, from the beginning of May to the middle of July. Their time of geſtation is nine months, which naturally brings the veal or calves to our markets from the beginning of January to the end of April. However, luxury has fallen upon methods of interrupting this natural courſe, and veal may be had almoſt every month in the year. Cows, when improperly managed, are very ſubject to abortion. In the time of geſtation, therefore, they ought to be obſerved with more than ordinary care, leſt they ſhould leap ditches, &c. They ſhould be put into the beſt paſture, and ſhould not be milked for ſix weeks or two months before they bring forth their young. The calf ſhould be allowed to ſuck and follow its mother during the firſt ſix or eight days. After this it begins to eat pretty well, and two or three ſucks in a day will be ſufficient. But if the object be to have it quickly fattened for the market, a few raw eggs every day, with boiled milk, and a little bread, will make it excellent veal in four or five weeks. This management of calves applies only to ſuch as are deſigned for the butcher. When they are intended to be nouriſhed and brought up, they ought to have at leaſt two months ſuck; becauſe the longer they ſuck they grow the ſtronger and larger. Thoſe that are brought forth in April, May, or June, are the moſt proper for this purpoſe; when calved later in the ſeaſon, they do not acquire ſufficient ſtrength to ſupport them during the winter. The cow comes to the age of puberty in 18 months, the bull requires two years: but although they are capable of propagating at theſe ages, it is better to reſtrain them till they be full three years. From three to nine years thoſe animals are in full vigour; but when older they are fit for nothing but to be fed for the butcher. The beſt time for inuring them to labour is at the age of two and a half or three years. The ox eats very quick, and ſoon fills his firſt ſtomach; after which he lies down to ruminate or chew the cud. The firſt and ſecond ſtomachs are continuations of the ſame bag, and very capacious. After the graſs has been chewed over again, it is reduced to a kind of maſh, not unlike boiled ſpinage; and under this form it is ſent down to the third ſtomach, where it remains and digeſts for ſome time; but the digeſtion is not fully compleated till it comes to the fourth ſtomach, from which it is thrown down to the guts. The contents of the firſt and ſecond ſtomachs are a collection of graſs and other vegetables roughly macerated; a fermentation, however, ſoon commences, which makes the graſs ſwell. The communication between the ſecond and third ſtomach is by an opening much ſmaller than the gullet, and not ſufficient for the paſſage of the food in this ſtate. Whenever the two firſt ſtomachs are diſtended with food, they begin to contract, or rather perform a kind of reaction. This reaction compreſſes the food, and makes it endeavour to get out: now the gullet being larger than the paſſage between the ſecond and third ſtomachs, the preſſure of the ſtomach neceſſarily forces it up the gullet. The action of ruminating, however, appears to be in a great meaſure voluntary; as animals of this kind have a power of increaſing the reaction of their ſtomachs. After the food undergoes a ſecond maſtication, it is then reduced into a thin pulp, which eaſily paſſes from the ſecond to the third ſtomach, where it is ſtill further macerated; from thence it paſſes to the fourth, where it is reduced to a perfect mucilage, every way prepared for being taken up by the lacteals, and converted into nouriſhment. What confirms this account of chewing the cud is, that as long as theſe animals ſuck or feed upon liquid aliment, they never ruminate; and in the winter, when they are obliged to feed upon hay and other dry victuals, they ruminate more than when they feed upon freſh graſs.

Bulls, cows, and oxen, are fond of licking themſelves, eſpecially when at reſt. But this practice ſhould be prevented as much as poſſible; for as the hair is an undigeſtible ſubſtance, it lies in the ſtomach or guts, and is gradually coated by a glutinous ſubſtance, which in time hardens into round ſtones of a conſiderable bulk, which ſometimes kills them, but always prevents their fattening, as the ſtomach is rendered incapable of digeſting the food ſo well as it ought.

The age of theſe animals may be diſtinguiſhed by the teeth and horns. The firſt fore-teeth fall out at the age of ſix months, and are ſucceeded by others of a darker colour, and broader. At the end of ſixteen months, the next milk-teeth likewiſe fall out; and at the beginning of the fourth year all the fore teeth are renewed, and then they are long, pretty white, and equal: However, as the animal advances in years, they become unequal and blackiſh. The horns of oxen four years of age are ſmall pointed, neat, and ſmooth, but thickeſt near the head: this thick part next ſeaſon is puſhed further from the head by a horny cylinder, which is alſo terminated by another ſwelling part, and ſo on (for as long as the ox lives the horns continue to grow); and theſe ſwellings become ſo many annular knots by which the age may eaſily be reckoned: but from the point to the firſt knot muſt be counted three years, and every ſucceeding knot only one year. The bull, cow, and ox, generally live about 14 or 15 years.

The northern countries of Europe produce the beſt cattle of this kind. In general, they bear cold better than heat; for this reaſon they are not ſo plenty in the ſouthern countries. There are but few in Aſia to the ſouth of Armenia, or in Africa beyond Egypt and Barbary. America produced none till they were carried there by the Europeans. But the largeſt are to be met with in Denmark, Podolia, the Ukrain, and amongſt the Calmuck Tartars; likewiſe thoſe of Ireland, England, Holland, and Hungary, are much larger than thoſe of Perſia, Turky, Greece, Italy, and Spain; but thoſe of Barbary are leaſt of all.

In

In all mountainous countries, as Wales, the Highlands of Scotland, &c. the black cattle are ſmall, but hardy, and when fattened make excellent beef. In Lapland, they are moſtly white, and many of them want horns.

The Britiſh breed of cattle, Mr. Pennant obſerves, has been in general ſo much improved by foreign mixture, that it is difficult to point out the original kind of theſe iſlands. Thoſe which may be ſuppoſed to have been originally Britiſh are far inferior in ſize to thoſe on the northern part of the European continent: the cattle of the Highlands of Scotland are exceedingly ſmall; and many of them, males as well females, are hornleſs: the Welſh runts are much larger: the black cattle of Cornwall are of the ſame ſize with the laſt. The large ſpecies that is now cultivated through moſt parts of Great Britain, are either entirely of foreign extraction, or our own improved by a croſs with the foreign kind. The Lincolnſhire kind derive their ſize from the Holſtein breed; and the large hornleſs cattle that are bred in ſome parts of of England, come originally from Poland.

About 250 years ago, there was found in Scotland a wild race of cattle, which were of a pure white colour, and had, if we may believe Boethius, manes like lions. Mr. Pennant ſays, he cannot but give credit to the relation; having ſeen in the woods of Drumlanrig in North Britain, and in the park belonging to Chillingham Caſtle in Northumberland, herds of cattle probably derived from the ſavage breed. They had loſt their manes, but retained their colour and fierceneſs, and were of a middle ſize. Theſe cattle were wild as any deer; on being approached, they would inſtantly take to flight, and gallop away at full ſpeed; never mix with the tame ſpecies; nor come near the houſe, unleſs conſtrained to it by hunger in very ſevere weather. When it is neceſſary to kill any, they are always ſhot; if the keeper only wounds the beaſt, he muſt take care to keep behind ſome tree, or his life would be in danger from the furious attacks of the animal, which will never deſiſt till a period it put to its life.

Frequent mention is made of our ſavage cattle by hiſtorians. One relates that Robert Bruce was (in chaſing theſe animals) preſerved from the rage of a wild bull by the intrepidity of one of his courtiers, from which he and his lineage acquired the name of *Turn-bull*. Fitz-Stephen names theſe animals *(uri ſylveſtres)* among thoſe that harboured in the great foreſt that in his time lay adjacent to London. Another enumerates, among the proviſions at the great feaſt of Nevil archbiſhop of York, ſix wild bulls; and Sibbald aſſures us, that in his days a wild and white ſpecies was found in the mountains of Scotland, but agreeing in form with the common ſort. Theſe were probably the ſame with the *biſontes jubati* of Pliny found then in Germany, and might have been common to the continent and our iſland; the loſs of their ſavage vigour by confinement might occaſion ſome change in the external appearance, as is frequent with wild animals deprived of liberty; and to that we may aſcribe their loſs of mane. The urus of the Hercynian foreſt deſcribed by Cæſar (lib. vi.) was of this kind; the ſame which is called by the modern Germans, *aurochs*, i. e. *bos ſylveſtris*. For repreſentation of this animal, ſee Plate X, Genus 32, Species 4.

The ox is the only horned animal in theſe iſlands that will apply his ſtrength to the ſervice of mankind. It is now generally allowed, that in the draught, oxen are in many caſes more profitable than horſes; their food, harneſs and ſhoes, being cheaper; and ſhould they be lamed or grow old, an old working beaſt will be nearly as good meat, and fatten as well, as a young one.

There is ſcarce any part of this animal without its uſe. The blood, fat, marrow, hide, hair, horns, hoofs, milk, cream, butter, cheeſe, whey, urine, liver, gall, ſpleen, bones, and dung, have each their particular uſe in manufactures, commerce, and medicine.

The ſkin has been of great uſe in all ages. The ancient Britons, before they knew a better method, built their boats with oſiers, and covered them with the hides of bulls, which ſerved them for ſhort coaſting voyages.

Primum cana ſalix madefacto vimine parvom
Texitur in puppim, cæſoque indata juvenco,
Veſtoris patiens, tumidum ſuper emicat amnem:
Sic Venetus ſtagnante Pado, fuſoque Britannus
Navegat oceano. LUCAN. lib. iv. 131.

The bending willow into barks they twine;
Then line the work with ſpoils of ſlaughter'd kine,
Such are the floats Venetian fiſhers know,
When in dull marſhes ſtands the ſettling Po:
On ſuch to neighb'ring Gaul, allur'd by gain,
The bolder Britons croſs the ſwelling main.
ROWE.

Veſſels of this kind are ſtill in uſe on the Iriſh lakes; and on the Dee and Severn: In Ireland they are called *curach*; in Engliſh, *coracles*; from the Britiſh *cwrwgl*, a word ſignifying a boat of that ſtructure. At preſent the hide, when tanned and curried, ſerves for boots, ſhoes, and numberleſs other conveniencies of life.—Vellum is made of the thinneſt calve-ſkins, and the ſkins of abortions. Of the horns are made combs, boxes, handles for knives, and drinking veſſels; and when ſoftened by water, obeying the manufacturer's hands, they form pellucid laminæ for the ſides of lanthorns. Theſe laſt conveniences were invented by the great king Alfred, who firſt uſed them to preſerve his candle time-meaſurers from the wind; or (as other writers will have it) the tapers that were ſet up before the reliques in the miſerable tattered churches of that time. The very ſmalleſt fragments, and even the duſt and filing, of horn, are found very ſerviceable in manuring cold lands. The matter lying within, on which the horn is formed, is called the *ſlough*; and, when dry is uſed in making walls or fences, in which, covered from wet, it will laſt a long time. It is alſo moſt admirable in mending roads, where the ſoil is ſoft and ſpewy; for, diſſolving, it becomes a glutinous ſubſtance, that binds amazingly with gravel. As a manure, they allow between two and three quarter-ſacks to an acre. Horn ſaw-duſt with mould is an excellent compoſt for flowers. It is alſo of uſe in hardening, and giving what is called a proper temper, to metals.

The teguments, cartilages, and griſtles, for the indifferent,—and, for the finer, all the cuttings, parings, and ſcrapes of hides, are boiled in water, till the gelatinous parts of them are thoroughly diſſolved; and the maſs, properly dried, becomes glue. See GLUE.

The bones are uſed by mechanics where ivory is too expenſive; by which the common people are ſerved with many neat conveniences at an eaſy rate. From the tibia and carpus bones is procured an oil much uſed by coach makers and others in dreſſing and cleaning harneſs, and all trappings belonging to a coach; and the bones calcined afford a fit matter for teſts, for the uſe of the refiner in the ſmelting trade. The blood is uſed as an excellent manure for fruit trees, and is the baſis of that fine colour the Pruſſian blue. The ſinews are prepared ſo as to become a kind of thread or ſmall cord, uſed in ſewing ſaddles, in making racquets, and other things of a like nature. The hair hath alſo its value, and is employed in many different ways. The long hair of the tail is frequently mixed with horſe-hair ſpun into ropes, and ſometimes wove. The ſhort hair ſerves to ſtuff ſaddles, ſeats of ſeveral kinds, mattreſſes, and chairs. The refuſe is a good manure, and operates more ſpeedily than the horns. The fat, tallow, and ſuet, furniſh us with light; and are alſo uſed to precipitate the ſalt that is drawn from briny ſprings. The gall, liver, ſpleen, and urine, had alſo their place in the materia medica, though they have now reſigned it to more efficacious and agreeable medicines. The uſes of butter, cheeſe, cream, and milk, in domeſtic œconomy, and the excellence of the latter in furniſhing a palatable nutriment for moſt people whoſe organs of digeſtion are weakened, are too obvious to be inſiſted on.

The *Biſon* has ſhort black rounded horns, with a great interval between their baſes. On the ſhoulders is a vaſt hunch, conſiſting of a fleſhy ſubſtance, much elevated. The fore-parts of the body are thick and ſtrong; the hind-part, ſlender and weak. The hunch and head are covered with a very long undulated fleece, divided into locks, of a dull ruſt-colour: this is at times ſo long, as to make the fore-part of the animal of a ſhapeleſs appearance, and to obſcure its ſenſe of ſeeing. During winter, the whole body is clothed in the ſame manner. In ſummer the hind part of the body is naked, wrinkled, and duſky. The tail is about a foot long; at the end is a tuft of black hairs, the reſt naked. It inhabits Mexico and the interior parts of North America. It is found in great herds in the Savannahs; and is fond of marſhy places, where it lodges amidſt the high reeds. In Louiſiana they are ſeen feeding in herds innumerable, promiſcuouſly with multitudes of ſtags and deer, during morning and evening; retiring in the ſultry heats into the ſhade of tall reeds, which border the rivers of America. They are exceedingly ſhy; and very fearful of men, unleſs they are wounded, when they purſue their enemy and become very dangerous. For repreſentation, ſee Plate X, Genus 32, Species 3.

The chaſe of theſe animals is a favourite diverſion of the Indians; and is effected in two ways. Firſt, by ſhooting: when the marksman muſt take great care to go againſt the wind; for their ſmell is ſo exquiſite, that the moment they get ſcent of him they inſtantly retire with the utmoſt precipitation. He aims at their ſhoulders, that they may drop at once, and not be irritated by an ineffectual wound. Provided the wind does not favour the beaſts, they may be approached very near, being blinded by the hair which nearly covers their eyes.—The other method is performed by a great number of men, who divide and form a vaſt ſquare; each band ſets fire to the dry graſs of the ſavannah where the herds are feeding; theſe animals have a great dread of fire, which they ſee approach on all ſides, they retire from it to the centre of the ſquare; when the bands cloſe and kill them (preſſed together in heaps) without the leaſt hazard. It is pretended, that on every expedition of this nature they kill 1500 or 2000 beeves. The hunting-grounds are preſcribed with great form, leſt the different bands ſhould meet and interfere in the diverſion. Penalties are enacted on ſuch who infringe the regulations, as well as on thoſe who quit their poſts and ſuffer the beaſts to eſcape from the hollow ſquares; the puniſhments are, the

the ſtripping the delinquents, the taking away their arms (which is the greateſt diſgrace a ſavage can undergo), or laſtly the demolition of their cabins.

The uſes of theſe animals are various. Powder-flaſks are made of their horns. The ſkins are very valuable; in old times the Indians made of them the beſt targets. When dreſſed, they form an excellent buff; the Indians dreſs them with the hair on, and clothe themſelves with them; the Europeans of Louiſiana uſe them for blankets, and find them light, warm, and ſoft. The fleſh is a conſiderable article of food, and the bunch on the back is eſteemed a very great delicacy. The bulls become exceſſively fat, and yield great quantities of tallow, 150 pounds weight having been got from a ſingle beaſt, which forms a conſiderable matter of commerce. Theſe over-fed animals uſually become the prey of wolves; for, by reaſon of their great unwieldineſs, they cannot keep up with the herd. The Indians, by a very bad policy, prefer the fleſh of the cows; which in time will deſtroy the ſpecies: they complain of the rankneſs of that of the bulls; but Du Pratz thinks the laſt much more tender, and that the rankneſs might be prevented by cutting off the teſticles as ſoon as the beaſt is killed. The hair or wool is ſpun into cloth, gloves, ſtockings, and garters, which are very ſtrong, and look as well as thoſe made of the beſt ſheeps wool; Governor Pownall aſſures us, that the moſt luxurious fabric might be made of it. The fleece of one of theſe animals has been found to weigh eight pounds.

Attempts have been made to tame and domeſticate the wild, by catching the calves and bringing them up with the common kind, in hopes of improving the breed; but it has not yet been found to anſwer: notwithſtanding they had the appearance for a time of having loſt their ſavage nature, yet they always grew impatient of reſtraint, and by reaſon of their great ſtrength would break down the ſtrongeſt incloſure, and entice the tame cattle into the corn-fields. They have been known to engender together, and to breed.

a. The *muſk-ox* of Hudſon's Bay, a variety of this ſpecies, wants the hump between the ſhoulders. It is about the ſize of a Scotch bullock; has a thick body, and ſhort legs. The horns are large, and very remarkable: they are united at the origin in the ſkull; but immediately after, they fall down on each ſide of the crown of the head, then taper away ſmall, the points turning up. The hair is black, and grows to a great length; underneath which is a fine wool ſuperior to Vigonia wool. The male only has the curious ſcalp; the female is covered with hair. Theſe animals frequent the country about 100 miles inwards to the north-weſt of Churchill River in Hudſon's Bay, where they are very numerous. They live in herds of 30, 40, and upwards to the number of 80 or 100. The bulls are very few in proportion to the cows; for, according to Mr. Graham's information, it is rare to ſee more than two or three full-grown bulls with the largeſt herd; and from the number of males which at times are found dead, the Indians are of opinion that they kill each other in contending for the females at the rutting ſeaſon. They are then ſo jealous of their miſtreſſes, that they run at either man or beaſt who offers to approach them, and have been ſeen to run and bellow even at ravens and other large birds which chanced to fly or light near them. They go to rut in Auguſt. The females bring forth their young about the latter end of May or beginning of June, and are never known to have more than one at a time. They delight moſt in the ſtonieſt and mountainous parts of the barren grounds, and are ſeldom found at any great diſtance through the woods. Though a beaſt of conſiderable magnitude, and apparently unwieldy form, yet it climbs the rocks with great eaſe and agility; and is nearly as ſure-footed as a goat, and like that animal will feed on any thing: for though they ſeem fondeſt of graſs, yet in winter they eat moſs and other herbage they can find; alſo the tops of the willows and the bruſh of the pine-tree. The fleſh of this animal no way reſembles that of the weſtern buffalo; but is more like that of the mooſe or elk, the fat being of a clear white ſlightly tinged with a light azure. The calves and young heifers are exceeding good eating; but the fleſh of the bulls both ſmells and taſtes ſo ſtrong of muſk, as to render it very diſagreeable. It ſeems to have been from want of better information, that Mr. Drage aſſerts the heart to be the moſt impregnated: had he ſaid the kidneys, he would have been much nearer the truth. The urine muſt contain this ſcent in a very great degree: for the penis is always lubricated with a brown gummy ſubſtance, ſo highly ſcented with muſk, that after having been kept for ſeveral years it does not ſeem to have loſt any of its quality. The dung of this animal (though ſo large) is all in little round knobs; and ſo exactly like that of the varying hare both in ſize and colour, that it would be very eaſy to miſtake the one for the other, were it not for the quantity. The Indians kill great numbers of them. From 2000 to 4000 weight of the fleſh frozen is brought to Prince of Wales's Fort annually, and is ſerved out as proviſions to the Europeans.

The *Cape Buffalo*, or Bos Caffer of Sparrman, another variety, inhabits the interior parts of Africa north of the Cape of Good Hope, but does not extend to the north of the Tropic. They are ſaid to be greatly ſuperior in ſize to the largeſt Engliſh ox: hang their heads down, and have a moſt ferocious and malevolent appearance. They are in fact exceſſively fierce and dangerous to travellers; will lie quietly in wait in the woods, and ruſh ſuddenly on paſſengers, and trample them, their horſes, and oxen of draught, under their feet: ſo that they are to be ſhunned as the moſt cruel beaſts of this country. They will even return to the attack, and delight to lick the ſlaughtered bodies. They are alſo found in the interior parts of Guinea; but are ſo fierce and dangerous, that the negroes who are in chaſe of other animals are fearful of ſhooting at them. They live in great herds, eſpecially in Krake-Kamma, and other deſarts of the Cape; and retire during the day into the thick foreſts. They are reckoned good meat by the Dutch of the Cape. They are called *Aurochs*, but differ totally from the European. The warmth of the climate has prevented the vaſt length and abundance of hair which diſtinguiſhes the former, and the luxuriance of herbage in this country has given it the vaſt ſuperiority of ſize.

Of this animal we have the following account by Dr. Sparrman, who was the firſt who gave a diſtinct delineation and deſcription of it. "The hairs of the buffalo are of a dark brown colour, about an inch long; harſh; and on ſuch males as are advanced in years, very thin, eſpecially on the middle of the ſides of the belly: hence they appear at ſome diſtance as if they were girt with a belt; and what contributes not a little to this appearance is, that the buffaloes in general are very fond of rolling in the mire. The hairs on the knees are in moſt buffaloes ſomewhat longer than thoſe on the reſt of the body, and lie as it were in whirls. The eyes are ſomewhat ſunk within their prominent orbits. This, together with the near ſituation of them to the baſes of the horns, which hang ſomewhat over its pendant dangling ears, and its uſual method of holding its head inclined to one ſide, gives the buffalo a fierce and treacherous aſpect. The diſpoſition likewiſe of the animal ſeems to correſpond with its countenance. He may in ſome ſort be called treacherous, as he is wont to hide himſelf among the trees, and ſtand there ſkulking till ſomebody happens to come very near him, when he ruſhes out at once into the road, and attacks them. This animal likewiſe deſerves the appellation of fierce and cruel; as it has been remarked, that, not content with throwing down and killing the perſon whom he attacks, he ſtands over him afterwards, in order to trample upon him with his hoofs and heels, at the ſame time cruſhing him with his knees, and with his horns and teeth tearing to pieces and mangling the whole body, and ſtripping off the ſkin by licking it with his tongue. This, however, he does not do all at once, but at intervals, going away between whiles to ſome diſtance off. Notwithſtanding all this, the buffalo will bear to be hunted; though ſometimes he will turn and hunt his purſuer, whoſe only dependence in that caſe is upon the ſwiftneſs of his ſteed. The ſureſt way to eſcape from him is to ride up ſome hill, as the great bulk of the buffalo's body, like that of the elephant, is a weight ſufficient to prevent him from being able to vie with the ſlender and fine limbed horſe in ſwiftneſs; though, on the other hand, the buffalo, in going down-hill, gets on much faſter than the horſe; a fact to which I have more than once been an eye-witneſs.

"The fleſh of the buffalo is coarſe and not very fat, but full of juice, and of a high and not diſagreeable flavour. The hide is thick and tough, and is in great requeſt with the farmers for thongs and harneſſes. Of it we made the only halters that can be depended upon for ſecuring our horſes and oxen; ſo that theſe beaſts cannot get looſe by ſnapping them aſunder, which they are otherwiſe apt to do when the lions and wolves make their appearance in the neighbourhood. Every ſuch halter ſhould be a finger and a half in breadth, and about three yards long, and are ſold a good way up the country for a quarter of a rixdollar a-piece.

"The hide of the buffalo we had now ſhot, after it had been dreſſed in ſome ſort by my Hottentots, by being ſtretched out and ſalted a little, and afterwards half dried, ſerved to make a pair of new four-plaited traces for my waggon. We obſerved, that the ball had hit the lower part of the neck, and entered the lungs; where, though it did not ſeem to have ſtruck againſt any bone, and though it was alloyed with the uſual quantity of tin, it was yet found to be very much flattened. In other buffaloes that we ſhot ſince, I have ſometimes found the balls, though alloyed with tin, ſhivered into ſeveral pieces againſt the bones in the internal parts, or at leaſt very much flattened. It is not, therefore, worth while to ſet about ſhooting the buffalo with balls made of lead only, for they will ſeldom be able to penetrate into thoſe parts where they are likely to prove mortal. Beſides being poſſeſſed of the degree of hardneſs requiſite, a ball ſhould be of a tolerable ſize, in order to kill ſo large an animal as the buffalo. The leaſt that ought to be uſed for this purpoſe ſhould weigh two ounces and a quarter.

"My Hottentots ſhewed ſo much diligence and zeal, both in cutting up and eating this beaſt, that the encouragement and

ſtimulation which is otherwiſe frequently neceſſary to ſet their ſluggiſh and heavy ſouls in motion, would on this occaſion have been quite ſuperfluous. They drove the waggon then up to the place where the beaſt lay, and loaded it with the beſt and fatteſt part of the ſlew. The raw hide, which was of conſiderable weight and extent, was tied under the waggon till it would be wanted, and the two remaining legs or marrow-bones were faſtened to each ſide of the body of the waggon. Notwithſtanding this, our Boſhies-men had each of them loaded themſelves with a quantity of ſlips of fleſh made up into bundles. Thus covered up to the eyes and ears in meat, we made a ſingular appearance, which might have given any traveller who had happened to paſs that way the idea of a walking fleſh-market. As we proceeded on our journey, a ſwarm of other carnivorous animals in a conſiderable nnmber, *viz.* eagles, falcons, and common hawks, were ſeen ſoon afterwards to occupy our places about the buffalo's remains; though we ſaw none of them either in the trees or flying about in the air till we had got to the diſtance of a few gun-ſhots from the ſpot."

Another hunt of this formidable animal he afterwards deſcribes as follows: "There was now again a great ſcarcity of meat in the waggon; for which reaſon my Hottentots began to grumble, and reminded me that we ought not to waſte ſo much of our time in looking after inſects and plants, but give a better look out after the game. At the ſame time they pointed to a neighbouring dale over-run with wood at the upper edge of which, at the diſtance of about a mile and a quarter from the ſpot where we then were, they had ſeen ſeveral buffaloes. Accordingly we went thither; but though our fatigue was leſſened by our Hottentots carrying our guns for us up a hill, yet we were quite out of breath and overcome by the heat of the ſun before we got up to it. Yet, what even now appears to me a matter of wonder is, that as ſoon as we had got a glimpſe of the game, all this languor left us in an inſtant. In fact, we each of us ſtrove to fire before the other, ſo that we ſeemed entirely to have loſt ſight of all prudence and caution. When we advanced to within twenty or thirty paces of the beaſt, and conſequently were perhaps likewiſe in ſome degree actuated by our fears, we diſcharged our pieces pretty nearly at the ſame time; while the buffalo, which was upon rather lower ground than we were, behind a thin ſcrambling buſh, ſeemed to turn his head round in order to make towards us. In the mean while, however, the moment we had diſcharged our guns, we had the pleaſure to ſee him fall, and directly afterwards run down into the thickeſt part of the wood. This induced us to hope that our ſhot had proved mortal; for which reaſon, we had the imprudence to follow him down into the cloſe thickets, where luckily for us we could get no farther. We had, however, as we found afterwards, only hit the hindmoſt part of the chine, where the balls, which lay at the diſtance of three inches from each other, had been ſhivered to pieces againſt the bones. In the mean while our temerity, which chiefly proceeded from hurry and ignorance, was conſidered by the Hottentots as a proof of ſpirit and intrepidity hardly to be equalled; on which account, from that inſtant they ever after appeared to entertain an infinitely higher opinion of our courage than they had ever done before. Several of our Hottentots now came to us, and threw a great number of ſtones down into the dale, though without ſucceſs, in order to find out by the bellowings of the beaſt whither he had retired: afterwards, however, he ſeemed to have plucked up his courage; for he came up at laſt out of the dale, of his own accord, to the ſkirts of the wood, and placed himſelf ſo as to have a full view of us on the ſpot where we were reſting ourſelves ſomewhat higher up: his intention was, in all probability, and in the opinion of our old ſportſmen, to revenge himſelf on us, if we had not happened to ſee him in time, and fired at him directly. What, perhaps, in ſome meaſure put a ſtop to his boldneſs was, that we ſtood on higher ground than he did: for ſeveral veteran ſportſmen have aſſured me of it as a fact, that they know from experience, that the buffaloes do not willingly venture to aſcend any hill or eminence in order to attack any one. The third ſhot, which afterwards was obſerved to have entered at the belly, was fatal. This occaſioned the buffalo to take himſelf down again into the vale, dying the ground and buſhes all the way he went with his blood. Though ſtill hot upon the chaſe, yet we advanced with the greateſt caution, accompained by two of our Hottentots, through the thin and more pervious part of the wood, where the buffalo had taken refuge. He was advancing again in order to attack ſome of us, when Mr. Immelman, from the place where he was poſted, ſhot him in the lungs. Notwithſtanding this, he had ſtill ſtrength enough left to make a circuit of a hundred and fifty paces, before we heard him fall in a moſt ſtupendous manner; and this death-ſong of his inſpired every one of us with joy, on account of the victory we had gained: and ſo thoroughly ſteeled is frequently the human heart againſt the ſufferings of the brute creation, that we haſtened forwards, in order to enjoy the pleaſure of ſeeing the buffalo ſtruggle with the pangs of death. I happened to be the foremoſt among them; but think it impoſſible for anguiſh accompanied by a ſavage fierceneſs, to be painted in ſtronger colours than they were in the countenance of this buffalo. I was within ten ſteps of him when he perceived me, and bellowing raiſed himſelf ſuddenly again on his legs. I had reaſon to believe ſince, that I was at that time very much frightened; for before I could well take my aim, I fired off my gun, and the ſhot miſſed the whole of his huge body, and only hit him in the hind legs, as we afterwards diſcovered by the ſize of the ball. Immediately upon this I flew away like lightning, in order to look out for ſome tree to climb up into. Notwithſtanding the tedious prolixity it might occaſion me to be guilty of, I thought the beſt and readieſt method of giving my reader an idea of the nature of this animal, and of the method of hunting it, as well as of other contingent circumſtances, would be to adduce an inſtance or two of what occurred during the chace. My Hottentots cut up the buffalo with their uſual alacrity and ardour; but as they had a great way to carry the fleſh to the waggon, they took it thither in a rather unuſual way. This was as follows: they cut out large ſlips of fleſh, whole and entire, with holes in the middle, wide enough for them to put their heads and arms through, and loaded themſelves with it in this manner before, behind, and on every ſide of them; the meat all the while dangling about their bodies in a manner ludicrous enough, though not much adapted to create an appetite in the ſpectator. In this way, their hands being entirely diſengaged, excepting that each man carried a ſtick, they clambered up the brow of the hill that overhung the vale, and thus walked on towards the waggon, whither one might trace them all the way by the blood."

The *Grunniens*, or hog-cow, has cylindrical horns bent backwards. The body is ſo hairy, that the hair hangs down upon its knees like a goat. The colour of the body is black, but the front is white. It has briſtles on its back, tail, and hind-legs, and it grunts like an hog. It is an inhabitant of the north of Aſia.

A variety of this ſpecies is the *Indian ox*, with a vaſt hump on the ſhoulders. They differ much in ſize and in the form of their horns. Some are very large, and of a reddiſh colour; with horns ſhort, and bending cloſe to the neck; others very ſmall, with horns almoſt upright, bending a little forward. In Surat is a minute kind not biggar than a great dog, which have a very fierce look, and are uſed to draw children in ſmall carts. In Celebes is a ſmall ſpecies not bigger than a middle-ſized ſheep, called *Anoa*, very fierce and wild, of a dark aſh-colour, inhabiting the rocks. Mr Loten, when in India, put ſome of them into a paddock, and in one night's time they killed 14 or 15 of his deer by ripping up their bellies.

The *Bubalus*, or common buffalo, has large black horns bent backward and inward, and plain before. The hair on the back is very hard, but thinly ſcattered over the body. It is a native of Aſia; but they are tamed in Italy, and uſed for the ſame purpoſes as black cattle in other countries. They draw carriages, and are guided by a rope tied to a ſtring thruſt through their noſes. This buffalo is larger than an ox, has a thicker body, and a very hard hide. His pace is ſlow; but he will carry a great burden. They feed in herds like cows; and yield plenty of milk, of which very good butter and cheeſe is made. Their fleſh is pretty good, but not to be compared to beef. The wild buffalo is a very fierce and dangerous animal; he often attacks travellers, and tears them in pieces. However, they are not ſo much to be feared in woods as in the plains, becauſe their horns, which are ſometimes ten feet long, are apt to be entangled in the branches of trees, which gives thoſe who are ſurpriſed by them time to eſcape. They are excellent ſwimmers, and will croſs the largeſt rivers without any difficulty. They run wild in great troops on the coaſt of Malabar; for which reaſon ſtrangers are allowed to hunt and kill them at pleaſure. For repreſentation, See plate X. Genus 32. Speices 5.

The *Indicus*, or little Indian buffalo, has horns ſhorter than its ears, a bunch on its back, and no mane. It is about the ſize of a calf ſix months old, and uſed in the Eaſt Indies for drawing coaches.

BOSPHORUS, or BOSPORUS, in *Geography*, a long and narrow ſea running in between two lands, or ſeparating two continents, and by which two ſeas, or a gulf and a ſea, are made to communicate with each other. In which ſenſe *boſphorus* amounts to the ſame with what we otherwiſe call an arm of the ſea, channel, or ſtrait; the Italians, *faro*; the Latins, *fretum*, and the French, *pas*, *manche*.

The name *boſphorus* is chiefly confined to two ſtreights, in the Mediterranean ſea, viz the *Boſphorus of Thrace*, commonly called the *Streights of Conſtantinople*, or *Channel of the Black Sea*; and the *Cimmerian* or *Scythian Boſphorus*, ſo called, it ſeems, from it reſemblance to the Thracian: now more commonly the *Streights of Kapha*, or *Kiderleri*, from two cities ſtanding on it.

A NEW

A NEW SYSTEM OF BOTANY.

INTRODUCTION.

BOTANY, in the utmoſt extent of the word, ſignifies a knowledge of plants, and of the uſes to which they may be applied, either in medicine, chymiſtry, or in the different arts. But as the medical virtues of plants fall properly under the province of the phyſician, their chymical properties belong to the chymiſt, &c.; hence the ſcience of botany is commonly reſtricted to a bare knowledge of the different plants themſelves, and of the diſtinguiſhing marks whereby each individual ſpecies may be known from every other. This knowledge is indiſpenſably neceſſary neceſſary for thoſe who propoſe to apply plants to any uſeful purpoſe: For example, though we ſhould ſuppoſe a phyſician ever ſo well acquainted with the virtues of opium, and a chymiſt ever ſo well acquainted with the method of preparing it, yet if both of them were entirely ignorant of botany, ſo as to be unable to diſtinguiſh the particular ſpecies of poppy which produces opium from others of the ſame genus, it is evident their midicinal and chymical ſkill could be of no uſe.

Nature may be conſidered as an immenſe living power which animates the univerſe, in ſubordination to the ſupreme Being, at whoſe command it began and ſtill continues to act. Her productions are very different from human art, whoſe greateſt labours can only be reckoned as dead works: on the contrary, ſhe is an active and never ceaſing operator, who knows how to employ every material, and though always labouring on the ſame invariable plan, her power, inſtead of being leſſened, is perfectly inexhauſtible. Time, ſpace, and matter, are her means; the univerſe her object; motion and life her end.

The earth, elevated above the level of the ocean, is defended againſt its irruptions. Its ſurface enamelled with flowers, and adorned with verdure, which is always renewing, is given to man for his habitation, where he is directed to embelliſh, cultivate and extend the products of vegetation.

View theſe melancholy deſerts where man never reſided, over-run with briars, thorns, and trees, which are deformed, broken and corrupted; the ſeeds that ought to renew and embelliſh the ſcene, are choaked and buried in the midſt of rubbiſh and ſterility. Nature, who in other ſituations aſſumes the ſplendor of youth, has here the appearance of old age and decrepitude. The earth, ſurcharged with the ſpoils of its productions, inſtead of a beautiful verdure, preſents nothing but a diſordered maſs of groſs herbage. Trees encumbered with groveling uſeleſs plants, incapable of beauty or perfection.

But how beautiful is cultivated nature! how pompous and brilliant when decorated by the hand of man! He himſelf is her chief ornament, her nobleſt production:—Here what a ſource of unknown treaſures? Flowers, fruits, and grains, matured to perfection, and multiplied to infinity; the earth every where acceſſible, and rendered active and fertile; the vallies and plains converted into verdant meadows, rich paſtures, and cultivated fields: the hills loaded with vines and fruits, and their ſummits crowned with uſeful trees.

The Science of Botany certainly holds its moſt dignified ſtation, when ſubſervient to medicine, but its utility does not terminate in this alone, though it has too long been conſidered as having no other connexion. This, notwithſtanding, is but a partial, nay, an injurious idea of it; for nothing has more retarded its uſefulneſs than this contracted notion. It has a relation, in a variety of ways, to many other Arts and Sciences, among which may be mentioned, the arts of painting and dying; but of all others Agriculture certainly claims the ſtricteſt relation, ſome of its moſt important branches being greatly dependant on it, and others, from an happy application of it, being perhaps capable of further emolument.

But howſoever great the real dignity and importance of this art, yet it muſt be allowed, that it has not been cultivated ſufficiently on ſcientific principles, nor advanced in equal proportion with other branches of knowledge. It is not many years ſince Dr. Home obſerved, that Virgil and Columella, old as they are, remained almoſt the only writers worth conſulting upon this intereſting ſubject.

The writings of Gerard, Parkinſon, Evelyn, Ray, Grew, Dr. Stephen Hales, Philip Miller, Mr. Hudſon, Mr. J. Miller, Dr. Milne, Profeſſor Martin, Mr. Curtis, and various others, have done honour to themſelves and their country; and from that laudable ſpirit now diffuſing among us, throughout theſe kingdoms, for the improvement of Arts and Sciences, under the protection of our public inſtitutions, we may expect to ſee *every branch* of Botany ſtudied as it deſerves, and attended with that ſucceſs which commonly reſults from the right application of knowledge to the purpoſes of human life.

On the Continent, the Swedes are making large and daily progreſs in the improvement of this branch of œconomics.

In France, M. Duhamel has rendered himſelf conſpicuous by his writings and practice: and in various parts of Europe, Societies have been formed with a profeſſed view to this end.

The firſt race of ſhepherds had daily inſtances among their flocks of the ſelection and refuſal of particular herbs, and ſubſequent obſervations muſt have multiplied and confirmed them. But they were ſtill only known in the general, and no experiments had been inſtituted to aſcertain the preciſe ſpecies thus eaten or rejected.

The utility of aſcertaining what plants are thus rejected muſt be evident, as it would neceſſarily lay the foundation of farther improvement in the œconomy of all ſorts of cattle. The intelligent huſbandman would by this means have it in his power to extirpate from the paſtures various uſeleſs plants, and give room for the ſalubrious ones.

From theſe obſervations it will be ſeen, that phyſicians are not the only perſons who may ſtudy botany to advantage; many others would find not only a fund of pleaſure from this ſtudy, but numberleſs other advantages reſulting from the knowledge of the plants of their own country.

In the inſtance before us, ſcience has opened the way, and ſurely it is not too much to ſay, that it evidently points to greater improvements in one of the moſt important branches of agriculture, as it relates to the œconomy of cattle. More than this ought not to be expected from its aid. It is to the intelligent grazier, and the gentleman well verſed in the knowledge of the indigenous plants, fraught with careful obſervation, and practiced in the œconomy of cattle, that the reſt muſt be owing.

Nothing but the want of this knowledge, in ſuch gentlemen as reſide in the country chiefly, can deprive us of the benefit which might otherwiſe accrue from reducing it into practice. To this end, it is indeed the province of the Botaniſt to make plants of his own country the principal object of his attention. This has been eminently the caſe with Linnæus, and his country will continue to reap the fruit of his labours.

It is needleſs to urge the neceſſity of *method*, in the ſtudy of nature, as it is the very ſoul of ſcience, and amidſt ſuch a multitude of objects which the vegetable kingdom affords, all attempts towards the acquiſition of knowledge without it, muſt end in uncertainty and confuſion.

We have ſufficient proof of this in the writers upon plants, before the invention of Syſtems, and ſee and deplore the want of them, in the loſs of many valuable articles, not only in the materia medica, but in the materia pictoria, and tinctoria of the ancients: articles, the virtues and properties of which appear to have been well aſcertained, are now loſt to us for want of a more ſcientific arrangement in the ſubjects, and accuracy in their deſcription.

BOTANIC HISTORY.

Botanic Writers choſe very different methods of arranging plants, not only before, but ſince the invention of ſyſtematic botany. The alphabetic has been much followed, eſpecially in local catalogues. Some have diſpoſed plants according to the time of flowering; Pauli, in his Quadripartitum Botanicum, publiſhed in 1639, Beſler, in the Hortus Eyſtettenſis 1640, and Dillenius in the Catalogus Giſſenſis 1719.

Others have arranged them according to the different places of their growth; as the authors of the Hiſtoria Lugdunenſis in 1587.

Another way was purſued, by obſerving that numbers of vegetables agreed with each other in their general external habit and appearance, or had a certain harmony and proportion in the form and diſpoſition of their roots, leaves, flowers or fruits, in their particular mode of growing, flowering, or foliation; ſo that they naturally fell, as it were into claſſes, agreeably to ſuch diſtinctions. Hence their diviſions of trees pomiferæ, pruniferæ, bacciferæ, nuciferæ, glandiferæ, &c. of herbs, into bulboſæ, ſiliquoſæ, umbelliferæ, verticillatæ, papilionaceæ, &c.

Theſe were ſo many claſſes or orders, which nature had ſo characterized, that they could not eſcape their notice; and could all the ſubjects of the vegetable kingdom be properly reduced to ſuch combinations, and the whole chain properly connected, we ſhould ſee what is meant by the NATURAL METHOD that *ultimatum et deſideratum* of Botany, of which Linnæus ſays, however, "*Nec ſperare fas eſt quod noſtra ætas ſyſtema quoddam naturale videre queat, et vix ſeri nepotes.*" Nevertheleſs, the beſt writers of the ſixth century, ſuch were John and Caſpar Bauhine, endeavoured to preſerve the abovementioned arrangement, although it was in a rude manner. In this they were followed by our own countrymen, Gerard and Parkinſon; but as they eſtabliſhed no preciſe definition to their claſſes, ſo in their ſubdiviſions they paid little or no regard to the minuter parts of diſtinction, taken from the fructification; hence nothing like generical notes can be diſcovered in their methods, ſo that the only reſource in finding many of their plants, was to read over their long and tedious deſcriptions, which were frequently inſufficient to diſtinguiſh the plant ſought for.

The great naturaliſt Conrade Geſner, who died 1565, in his 50th year, appears to have been the firſt who thought with any preciſion, of a method of claſſing plants from the flower or fruit, but lived not to bring any regular ſyſtem to perfection. It was reſerved for Cæſalpinus, phyſician to Pope Clement VIII. to be the firſt author who arranged plants in a true ſyſtematic manner, in his Libri de Plantis, publiſhed in 1583, in which he eſtabliſhes the characters principally from the fruit, a knowledge he derived from hints originally received from Geſner.

It is ſurpriſing that after this time, though ſo many eminent botaniſts flouriſhed, yet none of them thought of purſuing the plan laid down, until Moriſon and Ray, who both publiſhed, nearly at the ſame time, their ſyſtems, were founded alſo upon the diſtinction of fruit.

Since their time, others have laboured to bring their ſyſtems to perfection; as Knaut in Germany; Paul Herman and Boerhaave in Holland: and Dillenius, late profeſſor at Oxford, had ſtill farther perfected Mr. Ray's method, as is evident from the arrangement he has given to the Britiſh plants in the third edition of that author's ſynopſis.

Several elegant ſyſtems have alſo been formed from the flower, as the baſis of the claſſical character; in conſidering which, both regularity and irregularity, as well as the number of petals, have been made the principal diſtinction. Rivinius at Leipſic, in 1690, was the firſt who took the flower as the foundation of his method, as did Ruppius, in 1718. But no one carried this method to ſuch perfection as Tournefort, in 1694, who forms his claſſical character from the figure of the flower, and eſtabliſhes his orders or ſubdiviſions on the different ſituation of the fruit, whether above or below the empalement or receptacle.

The ſyſtem of Tournefort was generally received before that of the illuſtrious Linnæus was adopted.

Beſides theſe methods, in which the authors have conſidered one part only, either flower or fruit, as the baſis of their ſyſtems, ſeveral others have been conſtructed of late years, in which vegetables have been arranged, as far as poſſible, according to what have been called the natural claſſes; the foundations of which take in a numerous ſet of characters, ariſing from a combination and agreement in the habit of the plants, as well as their harmony in the eſſential parts of fructification. Among theſe that of Van Royen, late profeſſor at Leyden, is among the moſt elegant attempts towards this ultimatum in botany. This is exhibited in the Prodromus Floræ Leydenſis, 1740. He is followed by Gmelin in the Floræ Sibirica 1747.

Theſe authors, as alſo L. Gerard, in his Flora Gallo Provincialis, Paris 1761, preſerve the natural generical characters of Linnæus, almoſt entire, through their ſyſtems; and the latter writer has, with ſome variations, taken the orders of a natural method, conſtructed by B. Juſſieu, for his claſſes.

Haller alſo planned and brought to great perfection, a method of this kind, as is exhibited in his Enumeratio Stirpium Helvetiæ 1742, and in the Hortus Gottingenſis, 1753, which he has ſince ſtill more elaborated, in a work of infinite labour and merit, the Hiſtoria Stirpium Helvetiæ, 3 tom. fol. 1768.

Linnæus very clearly attempted a natural method, but it is evident he thought there were too many links in the chain, to render it the readieſt guide to botanical ſcience; however, he continued to improve it to the laſt; though he only brought the genera into orders, and did not venture ſo far as to form the claſſical part of a Syſtem on that plan. Dr. Hope, of Edinburgh, the late learned profeſſor, whoſe zeal and ſucceſs in cultivating the principles of the Linnæan Syſtem are well known, has contracted perhaps the moſt elaborate attempt of this kind that the botaniſts have ever ſeen.

Methods have alſo been formed from the different ſpecies and arrangement of the calyx or cup of the flower in plants. Profeſſor Magnol, of Montpelier, as well as Linnæus, publiſhed on this plan, but neither of them thought proper to purſue it.

Every arrangement hath its advantage in ſome reſpect or other; and it is ſurely rather to be regretted, howſoever the flower may claim the preference, that a method founded in the diſtinctions of the fruit, ſhould not alſo have as it were a ſecondary place in common uſe; for as all artificial methods are only ſuppoſed to be ſo many ſuccedanea to the natural one, a due attention to each might tend to illuſtrate the natural claſſes, to connect them, and reduce the anomalies; and ſo far pave the way to the completion of that ſcheme, which however, will yet by many be conſidered as impracticable in Botany.

Linnæus was the firſt who conſtituted the ſtamina and piſtils as the baſis of an artificial method of arranging plants, and in his claſſes Plantarum ſays, "That he was led to this by conſidering the great importance of theſe parts in vegetation." They alone are the eſſentials neceſſary to fructification; all the other parts, except the anthera and ſtigma, being wanting in ſome flowers, and the philoſophy of Botany regards the former as the male, and the latter as the female organs of generation in plants.

As ſuch indeed may be conſidered analogically, and in a philoſophical

view;

view; yet, perhaps, the Linnæan System, admirable as it is, would not have been less acceptable had the classical terms been expressive only of number and situation, without regard to the offices of the parts in framing the terms.

This great Naturalist, however, availed himself of every advantage that access to the several museums afforded him, in the different branches of Natural History, and the number and importance of his publications sufficiently demonstrate that fund of knowledge which he must have imbibed from such assiduous investigation, and most extraordinary application. This remark is abundantly evident from his *Systema Naturæ Fundamenta Botanica & Genera Plantarum*. The last book of Linnæus's composition, published during his residence in Holland, was the *Classes Plantarum*, which is a copious illustration of the second part of the *Fundamenta*. Nature, it may be truly said, had in an eminent manner been liberal in the endowments of his mind. He possessed a lively imagination, corrected by a ripened judgment, and guided by the laws of system. To all who observe the improvement this exalted character has made in the science of Botany, his talents must appear in a very illustrious point of view; but more especially to those who from similarity of taste are qualified to see more distinctly the vast extent of his designs, the greatness of his labour, and the elaborate execution he has given to the whole.

In this historic view of the Science of Botany, we have purposely avoided the legends, of enumerating by a Bibliotheca of ancient authors, the rise and progress of it; as we considered the bare mention of the names of king Solomon, Anaxagoras, Pythagoras, Theophrastus, Dioscorides, Pliny, and to add Aristotle and Hippocrates, who are all reputed to have studied Botany, to be but trifling time with the reader, whom we wish to satisfy, as no authentic remains of their arrangements are to be found in the annals of literature.

As to the works of Antonius Musa, Cato, Varro, and even Virgil and Columella, little can be said as to their knowledge in the vegetable kingdom of nature; therefore, it is hoped, that the concise particulars already given as a critical history, will be more acceptable than a tedious detail.

Before we proceed to the definitive parts which constitute the body of this science, we shall briefly consider its applications in two principal points of view, viz. to Food and Medicine.

1. *Food.*

Many animals are endowed with an instinctive faculty of distinguishing with certainty whether food presented to them be salutary or noxious. Mankind have no such instinct. They must have recourse to experience and observation. But these are not sufficient to guide us in every case. The traveller is often allured by the agreeableness of smell and taste to eat poisonous herbs and fruits. Neither will a general caution not to eat any thing but what we know from experience to be salutary, answer in every emergency.

A ship's company, in want of provisions, may be thrown upon an uninhabited coast or a desert island. Totally ignorant of the nature of the plants they meet with, diseases, or scarcity of animals may make it absolutely necessary to use vegetable food. The consequence is dreadful: they must first eat before any certain conclusion can be formed. This is not the description of danger arising from an imaginary situation. Before the vegetables that grow in America, the East and West Indies, &c. became familiar to our sailors, many lives were lost by trials of this kind: neither has all the information received from experience been sufficient to prevent individuals from falling a prey to ignorance or rashness.—If the whole science of Botany were as compleat as some of its branches, very little skill in it would be sufficient to guard us infallibly from committing such fatal mistakes. There are certain orders and classes which are called *natural*, because every genus and species comprehended under them are not only distinguished by the same characteristic marks, but likewise possess the same qualities, though not in an equal degree. For example: Shew a botanist the flower of a plant whose calyx is a double valved glume, with three stamina, two pistils, and one naked seed: he can pronounce with absolute certainty, that the plant from which the flower was taken, bears seeds of a farinaceous quality, and that they may be safely used as food. In like manner, show him a flower with 12 or more stamina all inserted into the internal side of the calyx, though it belonged to a plant growing in Japan, he can pronounce without hesitation, that the fruit may be eat with safety. On the other hand, show him a plant whose flower has five stamina, one pistil, one petal, or flower leaf, and whose fruit is of the berry kind, he will tell you to abstain from it, because it is poisonous. Facts of this kind render Botany not only a respectable, but a most interesting, science.

2. *Medicine.*

When applied to medicine, the same law holds good; as it is found by experience, that plants which are distinguished by the same characters in the flower and fruit, have the same qualities, though not always in an equal degree as to strength or weakness; so that upon the inspection of the flower and fruit, a botanist can form his opinion with confidence, a priori, on the effects that will result when taken into the stomach.

In order therefore to determine the medical virtues of all the plants belonging to a natural class, the physician has nothing to do but to ascertain, by a list of clear and unquestionable experiments, the virtues of any one of them.

This greatly shortens the labour of investigation, supposing the number of known species to amount to upwards of twenty thousand; by ascertaining the virtues of one genus, at a medium, may be determined the virtues of twelve species: but by ascertaining the virtues of one genus belonging to a natural order, the virtues of perhaps three or four hundred species are ascertained.

Arrangement of the Botanical Terms used in the Linnean System.

To explain those Terms more clearly we have attached to this System three Plates, taken from the Philosophia Botanica of Linnæus. As the representations were so much unlike the Plants he had selected to illustrate his ideas, Mr. Sowerby, Botanical Draughtsman, has furnished us with the three Plates, exhibiting accurate representations of those parts so rudely delineated by Linnæus. We shall therefore proceed to describe them as follows.

EXPLANATION OF PLATE I.

Simple and Compound Leaves.

Simple Leaves.

Fig. 1 A round leaf, orbicular (folium orbiculatum)—2 A leaf nearly round, subrotund (subrotundum).—3 An egg shaped leaf, ovate (ovatum).—4 An oval leaf (ovale).—5 An oblong leaf (oblongum).—6 A spear shaped leaf, lanceolated (lanceolatum).—7 A linealin leaf, or which is equally broad every way, (lineare).—8 An awl shaped leaf, subulated (subulatum).—9 A kidney shaped leaf (reniforme).—10 A heart shaped leaf, cordated (cordatum).—11 A crescent shaped leaf, (lulnuatum).—12 A triangular leaf (triangulare).—13 An arrow shaped leaf, sagittated (sagittatum).—14 A leaf partly arrow and partly heart shaped (cordato sagittatum).—15 A halbert shaped leaf, hastated (hastatum).—16 A divided or cleft leaf, fissured (fissum).—17 A three lobed leaf (tribolum).—18 An abruptly or bitter leaf, premorse (præmorsum).—19 A leaf divided to the midrib, lobated, (lobatum).—20 A leaf with five angles, quinquangula (quinquangulare).—21 A grieved angled leaf (erosum).—22 An hand shaped leaf, palmated (palmatum).—23 A simple winged leaf, (pinnatifidum).—24 A jagged leaf, laciniate (laciniatum).—25. An indented leaf, sinuated (sinuatum).—26 A tooth like leaf (dentato sinuatum).—27 A leaf with indentments, hooked backwards (retrorsum sinuatum).—28 A parted leaf (partitum). 29 A serpentine edged leaf, repanded (repandum).—30 A tooth cut leaf, dentated (dentatum).—31 A sawed leaf, serrated (serratum).—32 A doubly sawed leaf (duplicato serratum).—33 A doubly notched leaf (duplicato crenatum).—34 A gristly bordered leaf (cartilagineum).—35 A leaf sharply notched (acuté crenatum).—36 A leaf bluntly notched (obtusé crenatum).—37 A plaited leaf, plicated (plicatum).—38 A notched leaf, cranated, (crenatvm).—39 A curled leaf, crispated (crispuatum).—40. A leaf terminating bluntly, obtuse (obtusum).—41 A leaf terminating in a point, acute (acutum).—42 A leaf terminating gradually to the point, acuminated (acuminatum).—43 A blunt pointed leaf (obtusum acumine).—44 A leaf sharply notched at the apex (emerginatum acute).—45 A wedge shaped notched leaf (cuneiforme emerginatum).—46 A blunted leaf, retuse (retusum).—47 A hairy leaf, pilose (pilosum).—48 A downy leaf, tomentose, (tomentosum).—49 A bristly leaf, hispid (hispidum). 50 A fringed leaf, ciliated (ciliatum).—51 A wrinkled leaf, rugose (rugosum).—52 A veined leaf, venose (venosum) 53 A ribbed leaf, nervose (nervosum).—54 A blistered leaf, papillose (papillosum).—55 A tongue shaped leaf, linguiform (linguiforme).—56 A scimiter shaped leaf, acinaciform (acinaciforme).—57 An hatched shaped leaf, dolabriform (dolabriforme).—58 A delta shaped leaf, deltoid (deltnides).—59 A three sided leaf, triquetrous (triquetrum).—60 A channelled leaf, canicular (canilicutum).—61 A furrowed leaf, sulcated (sulcatum—62 A cylindrical leaf (teres).

Compound Leaves.

63 A finger shaped leaf, compounded of two, binated (binatum).—64 A finger shaped leaf, compounded of three (ternatum foliolis sessilibus).—65 A three'd leaf, properly stalk'd (ternatum follolis peticlatis).—66 A fingured leaf improperly stalked, digitated (digitatum).—67 A foot shaped leaf, pedated (pedatum)—68 A winged leaf terminated by an odd one (pinnatum cum impari).—69 A winged leaf abruptly terminated (pinnatum abrupte).—70 A winged leaf alternately (pinnatum alternatum)—71 A winged leaf interruptedly (pinnatum interrupte).—72 A winged leaf tendrilled (pinnatum cirrhosum).—73 A winged leaf paired (dinnatum conjugatum).—74 A winged leaf decensively (pinnatum decursive).—75 A winged leaf jointedly (pinnatum articulaté).—76 A lyre shaped leaf lyrated (lyratum).—77 A leaf doubly three leaved biternated (biternatum).—78 A doubly winged leaf bipinnated (bipinnatum.).—79 A leaf triply three leaved triternated (triternated).—10 A thrice feathered leaf, without an odd one (tripinnatum sine imperi).—81 A thrice feathered leaf with an odd one (tripinnatum cum imperi).

Determinate Leaves.

82 Bent inwards or inflected (inflexum).—83 Upright or erect (erectum).—84 Spreading or expanding patent (patens).—85 Horizontal (horizontale).—86 Curved or reclined (reclinatum).—87 rolled back or revolute (revolutum).—88 Seminal (seminale).—89 Stem leaf (caulinum).—90 Branch leaf (ramum).—91 Floral (florale).—92 A leaf furnished with a foot stalk petiolated (petiolatum).—93 A leaf which has the foot stalk inserted into the centre of the lower disk or surface, and not into the base or margin, peltated (peltatum).—94 A leaf seated on the stem (sessile).—95 A leaf running along the stem, decurrent (decurrens).—96 A clasping or embracing leaf amplexicaul (amplexicaule).—97 A leaf perforated by the stem perfoliate (perfoliatum).—98 Twins or conjoined (connata).—99 Sheating (vaginans) This is called also a glove embracing leaf, as it goes round the stem and shoots from the middle.—100 Jointed articulated (articulatum).—101 Starry leaves stellated (stellata).—102 Fourfold quaternated (quaterna).—103 Opposite opposite (opposita).—104 Alternate (alterna).—105 Awry or chaffy acerose (acerosa).—106 Leaves imbricated or laid over each other, like the tiles of a house, imbricated (imbricata).—107 Fascicled or bundled leaves fasticulated (fasciculata).—108 Frond or union of the fructification (frons).—109 Spatula shaped leaf spatulated (spathulatum).—110 Parabolic shaped leaf (parabolicum).

Items.

111 Bealycum or straw (squasmosus calmus).—112 A climbing or creeping stem (repens caulis).—113 A naked flower or scape (scapus).

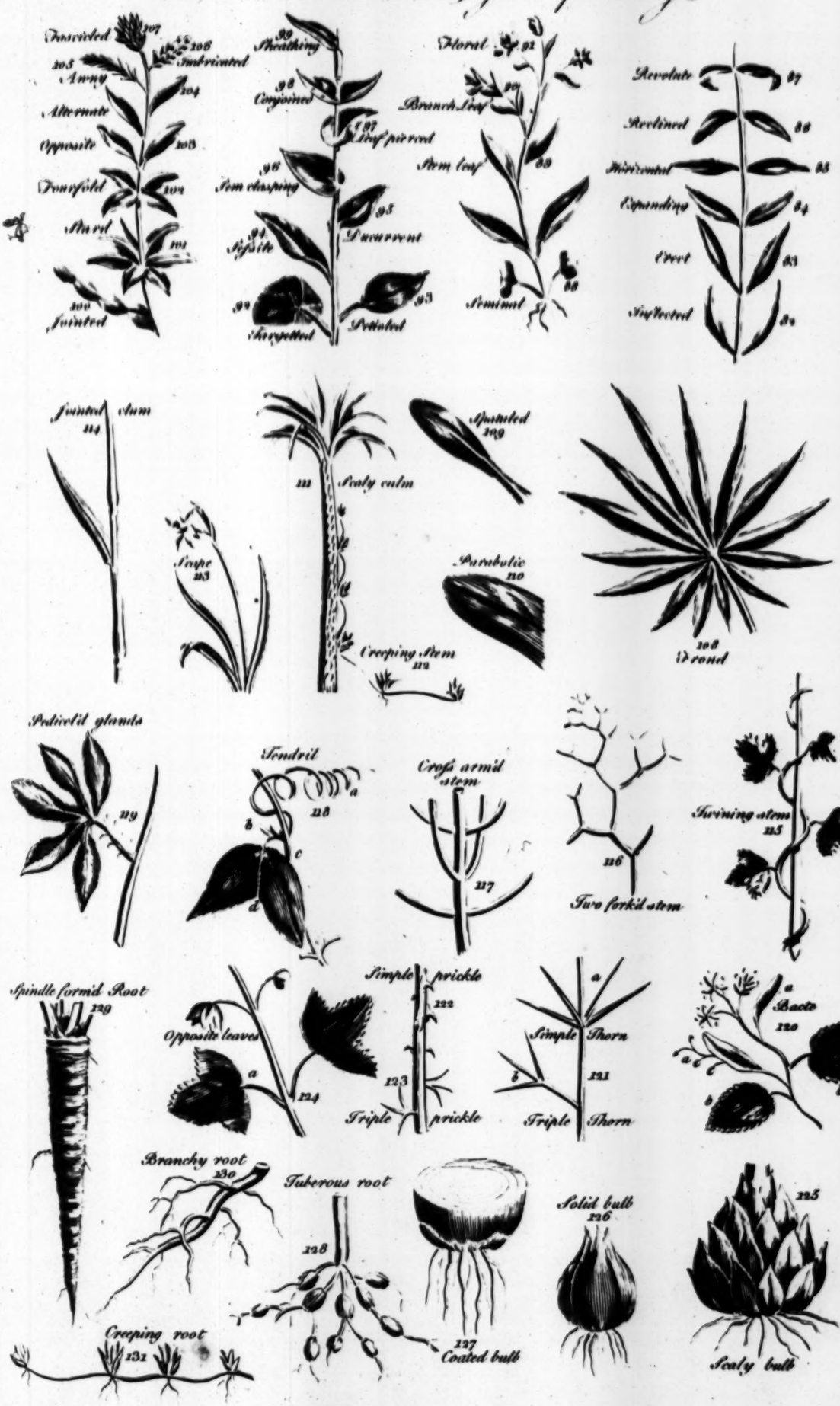
114 Jointed

Classes and Orders, according to Linneus.
See System of Botany. Sect. 4. Art. 4. Class 1.

Class 1. Monandria Order 1. Monogynia
Indian Flowering Reed
Class 1. Monandria Order 2. Digynia
Virgate Strawberry Blite
Class 2. Diandria Order 1. Monogynia.
Oswego Tea
Class 2. Diandria Order 2. Digynia.
Vernal Grass
Class 2. Diandria Order 3. Trigynia.
Black Pepper
Class 3. Triandria Order 1. Monogynia.
Garden Crocus
Class 3. Triandria Order 2. Digynia.
Wild Oat
Class 3. Triandria. Order 3. Trigynia.
Verticillate
Class 4. Tetrandria Order 1. Monogynia.
Laciniated Teazel
Class 4. Tetrandria Order 2. Digynia.
Witch Hazel
Class 4. Tetrandria Order 3. Tetragynia.
Pond Weed
Class 5. Pentandria Order 1. Monogynia
Rose Bay
Class 5. Pentandria Order 2. Digynia.
Common Fennel
Class 5. Pentandria Order 3. Trigynia.
Turnera
Class 5. Pentandria Order 4. Tetragynia.
Grass of Parnassus
Class 5. Pentandria Order 5. Pentagynia.
Navelwort
Class 5. Pentandria Order 6. Polygynia.
Mouse Tail
Class 6. Hexandria Order 1. Monogynia.
Belladona
Class 6. Hexandria Order 2. Digynia.
Rice
Class 6. Hexandria Order 3. Trigynia.
Great curled Dock
Class 6. Hexandria Order 4. Tetragynia.
Petiveria
Class 6. Hexandria Order 5. Polygynia
Water Plantain
Class 7. Heptandria Order 1. Monogynia.
Horse Chesnut
Class 7. Heptandria Order 3. Tetragynia.
Lizards Tail
Class 8. Octandria Order 1. Monogynia.
Tree Primrose
Class 8. Octandria Order 2. Digynia.
Galenia
Class 8. Octandria Order 3. Trigynia.
Buck wheat
Class 8. Octandria Order 4. Tetragynia.
Tuberous Sheathed
Class 9. Enneandria Order 1. Monogynia.
Rocky Fumitory
Class 9. Enneandria Order 2. Trigynia.
Palmated Rhubarb
Class 9. Enneandria Order 3. Hexagynia.
Flowering Rush
Class 10. Decandria Order 1. Monogynia.
Narrow Leaved
Class 10. Decandria Order 2. Digynia.
Sassafras
Class 10. Decandria Order 3. Trigynia.
Greater Stitchwort
Class 10. Decandria Order 4. Pentagynia.
Wood Sorrel
Class 10. Decandria Order 5. Decagynia.
American Nightshade
Class 11. Dodecandria Order 1. Monogynia.
Asarabacca
Class 11. Dodecandria Order 2. Digynia.
Quicken Tree

Determinate Leaves, Stems, Supports, and Roots.

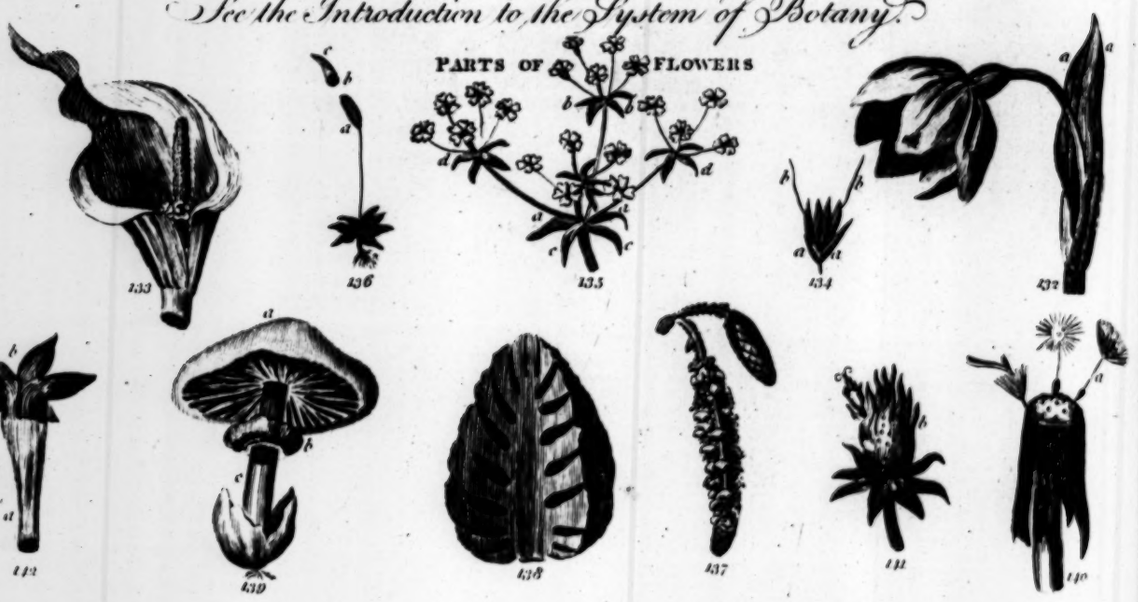
See the Introduction to the System of Botany.



Parts of Flowers, Fructification, Peduncle, and Foliation.

See the Introduction to the System of Botany.

PARTS OF FLOWERS



FRUCTIFICATION

PEDUNCLE

FOLIATION

114 Jointed ſtraw or culm (articulatis culmus). 115 A twining ſtem (volubilis caulis). 116 A two forked ſtem (dichotomus caulis). 117 A croſs armed ſtem (brachiatus caulis).

Supports.

118 *a* Tendril (cirrhus). *b* Stipules (ſtipulæ). *c* Concave glands (glandulæ concavæ). 119 Pedicled glands (pedicellatæ glandulæ). 120 *a* Bracte, differing from the leaves. *b* Bractea (bractea). 121 *a* Simple thorn (ſpina ſimplex). *b* Triple thorn (ſpina triplex). 122 Simple prickle (aculeus ſimplex). 123 Triple prickle (aculeus triplex). 124 Oppoſite leaves (oppoſita folia). *a* Axil (axilla).

Roots.

125 Scaly bulb of the lily (bulbus ſquamoſus). 126 Solid bulb (bulbus ſolidus). 127 Coated bulb tranſverſely diſſected (bulbous tunicatus). 128 Tuberous root of ſilipendula (tuberoſa radix). 129 Spindle formed root of a carrot (fuſiformis radix). 130 Branched root (ramoſa radix). 131 Creeping root (repens radix).

EXPLANATION OF PLATE III.

Parts of Flowers, Fructification, Peduncle, and Foliation.

Parts of Flowers.

132 The ſpathe or calyx of the Narciſſus (ſpatha calyx Narciſſi). 133 Spathe ſpadix (ſpatha ſpadix). 134 *a* A glume calyx (gluma calyx). *b* Awn (ariſta). 135 *a* Univerſal umbel (umbella univerſalis). *b* Partial one (partialis). *c* Univerſal involucre (involucum univerſale). *d* Partial one (partiale). 136 *c* Calyptre; *b*, lid; *a*, head; (*c*, calyptra; *b*, operculum; *a*, capitulum). 137 Ament (amentum). 138 Strobile (ſtrobilus). 139 *a*, Hat; *b*, volve; *c*, ſtipe of a fungus; (fungi; *a*, pileus; *b*, volva; *c*, ſtipes). 140 *a*, Common naked receptacle (receptaculum commune nudum). 141 Common receptacle imbricated with chaff (receptaculum commune paleis imbricatum). 142 *a*, tube (tubus); *b*, border (limbus); of one petalled corol (corollæ monopetalæ). 143 Flower; *a*, germ; *b*, ſtyle; *c*, ſtigma; *d*, filaments; *e*, anthers; *f*, petals; (flos; *a*, germen; *b*, ſtylus; *c*, ſtigma; *d*, filamenta; *e*, antheræ; *f*, petela). 144 Claws (ungues); *c*, folds (laminæ); of many petalled corol (corollæ polypetalæ). 145 Belled nectary in Narciſſus (nectarium campanulatum). 146 Horned nectaries in aconitum (nectiria cornuta). 147 Horned nectary in the calyx of tropæolum. 148 Nectaries in Parnaſſia.

Parts of the Fructification.

149 *a*, Perianth; *b*, germ; *c*, ſtyle; *d*, ſtigma; *e*, filaments; *f*, anthers, gaping; *g*, anthers, entire; (*a*, perianthium; *b*, germen; *c*, ſtylus; *d*, ſtigma; *e*, filamenta; *f*, antheræ dehiſcentes; *g*, antheræ integræ). 150 *a*, Filament; *b*, anther; (*a*, filamentum; *b*, antheræ). 151 *a*, duſt (pollen) ſeen in the microſcope; *b*, elaſtic vapour; (halitus elaſticus). 152 *a*, germ; *b*, ſtyle; *c*, ſtigma; (*a*, germen; *b*, ſtylus; *c*, ſtigma). 153 Follicle (folliculus) a receptacle of ſeeds. 154 Legume *a*, *a*, (legumen) the ſeeds, are annexed to the ſuperior future. 155 Silique (ſiliqua) *a*, *b*, each edge of the receptacle. 156 Pome, *a*, (pomum) included capſule, *b*, (capſula inclusa). 157 *a*, Drupe; *b*, with a nucleus. (*a*, Drupa; *b*, nucleo). 158 Berry (bacca). 159 Capſule gaping at top (capſula apice dehiſcens). 160 Of the capſule; *a*, the valvelet; *b*, the partition; (capſulæ; *a*, valvulæ; *b*, diſſipementum); *c*, column; *d*, receptacle; (*c*, columnella; *d*, receptaculum). 161 *a*, Capſule longitudinally diſſected, that the receptacle of the ſeeds may appear. 162 *a* Hairy pappus (pappus piloſus). *b* Feathery pappus (pappus plumoſus). *c* Seed (ſemen). *a* Stipe of the pappus (ſtipes pappi).

Peduncle.

163 Corymbe (corymbus). 164 Raceme (racemus). 165 Spike (ſpica). 166 Verticil (verticillus). 167 Panicle (paniculа). 168 Faſcicle (faſciculus).

Foliation.

Leaves tranſverſely Diſſected.

1 Convolute (convolutum). 2 Involute (involutum). 3 Revolute (revolutum). 4 Conduplicate (conduplicatum). 5 Equitant (equitans). 6 Imbricated (imbricatum). 7 Obvolute (obvolutum). 8 Plaited (plicatum). 9 Convolute (convoluta). 10 Involute oppoſite (involuta oppoſita). 11 Involute alternate (involuta alterna). 12 Revolute oppoſite (revoluta oppoſita). 13 Equitant two edged (equitantia anclpita). 14 Equitant three ſided (equitantia triquetra).

SECTION I.

ARRANGEMENT and DEFINITION of the BOTANIC TERMS uſed by Linnæus.

General Terms, applicable to all Parts whatever.

I. Names of Parts.
II. Duration.
III. Magnitude.
IV. Subſtance.
V. Diviſion.
VI. Direction.
VII. Figure; as
  1. of Surfaces.
  2. of Solids.
  3. of Similitude.
VIII. Expanſion.
IX. Place.
X. Situation.
XI. Surface.
XII. Margin.
XIII. Point or Top.
XIV. Root.
XV. Trunk.
XVI. Petiole.
XVII. Leaf: as being either
  1. Simple: or
  2. Compound, Decompound, or Supradecompound.
XVIII. Down, Hair, &c.
XIX. Armour.
XX. Floral-leaves.
XXI. Peduncle.

Under this are included the Inflorescence, and its different modes.

XXII. Terms applicable to the Fructification. Under this are included,
1. The calyx or cup.
2. The corolla, or coloured part of the flower.
3. The ſtamina, or chives.
4. The piſtillum.
5. The pericarpium or ſeed-caſe.
6. The ſeed.
7. The receptacle.

XXIII. Terms applicable to Vernation.
XXIV. Additional Terms.

No. I. *The* Parts *of a* Plant *are*

1 The root, the organ that nouriſhes the plant. 2 The trunk or ſtalk, the organ that multiplies it. 3 The branches, or diviſions and ſubdiviſions of the ſtalk. 4 The petioles, or ſtalks that ſupport the leaves (6).—5 The peduncles, or ſtalks that ſupport the fructification (285).—6 The leaves, which are the organs of motion to the plant.

The Fructification, conſiſting of the Flower and the Fruit.

The *Parts* of a *Flower* are,

7 The cup, or outer rind of the plant, continued to and preſent in the fructification. 8 The corolla, or inner rind of the plant, continued to and preſent in the coloured part of the flower, fig. 142.—9 The ſtamina, or chives, the organs deſtined for the preparation of the pollen (332) or flower-duſt, fig. 143. *ddd*, *eee*.—10 The piſtil, or organ adhering to the fruit, for the reception of the pollen, fig. 143, *a b c*.

The *Parts* of the *Fruit* are,

11 The pericarpium, or ſeed-caſe; the bowel or organ, containing the ſeeds (12), which, when ripe, it lets go fig. 156, *a*. 12 The ſeed, or rudiment of a new plant, ſuppoſed to be vivified by the irrigation or ſprinkling of the pollen or flower duſt, fig. 162, *c*.—13 The receptacle, or baſe with which the parts of the fructification are connected, fig. 140, *a*. 141.—14 The ſtipula, or ſmall ſcaly leaf that uſually ſtands at the baſe of the petioles when they are riſing. 15 A cirrhus, tendril, or ſpiral thread, by which a plant is tied to any neighbouring body, fig. 118. 16 A bractea, ſpangle, or floral leaf, differing in its appearance from the other leaves of the plant, fig. 91, 120.—17 The pubes, the down or hairyneſs of any ſort on plants. 18 Arma, the armour or ſharp points that defend a plant from being hurt by animals. 19 A bulb, the winter habitation of a plant, conſiſting of the remains of its former leaves. 20 A gem or bud, conſiſting of the rudiments of the plant's future leaves, fig. 143, *a*; fig. 149, *b*; 152, *a*.

GENERAL TERMS.

No. II. *The* Duration *of a* Plant *is either*

21 Annual, or dying within one year. 22 Biennial, or flowering the ſecond year, and then dying. 23 Perennial, or flouriſhing for many years. 24 Caducous, or falling down and dying before the end of one ſeaſon. 25 Deciduous, dying at the end of one ſeaſon. 26 Periſting, not dying after one ſeaſon. 27 Sempervirent, evergreen, or remaining freſh and green through all the ſeaſons of the year.

No. III. Magnitude.

"I very ſeldom admit," ſays Linnæus, "any other than the "proportional meaſure between the different parts of plants, "where this or that part is longer or ſhorter, broader or narrower "than another." *Phil. Bot.* p. 262.

No. IV. Subſtance *is either*

28 Solid, filled internally with hard matter. 29 Inane, filled only with ſpongy matter. 30 Pulpous, filled with tenacious or glutinous matter. 31 Carnous, or fleſhy, filled with a hardiſh pulp. 32 Cartilaginous, conſiſting of griſtly matter. 33 Membranaceous, conſiſting of dry and ſkinny matter. 34 Fiſtulous, tubulated or hollow within.

No. V. Diviſion *is either*

35 Fiſſured, or divided by linear (70) notches, with ſtraight (42) margins, fig. 16. 36 Fiſid, triſid, &c. to quinqueſid, according to the number of fiſſures. 37 Partite, divided almoſt to the baſe. 38 Bipartite, tripartite, &c. to quinquepartite, according to the number of diviſions. 39 Lobate, or lobed, divided down to the middle, into parts ſtanding aſunder, fig. 17, 19.—40 Sinuated, admitting of wide ſinuſes or notches on the ſides, fig. 25, 26, 27.—41 Dichotomous, trichotomous, &c. divided ſucceſſively into two, three, or more parts, fig. 116.

No. VI. Direction *is either*

42 Right, or ſtraight, free of bendings. 43 Erect, riſing nearly to a perpendicular, fig. 83.—44 Oblique, departing from a perpendicular, or horizontal line. 45 Aſcending, or turned archwiſe upward. 46 Declining, or declined, turned archwiſe downward. 47 Incurvated, turned archwiſe inward, fig. 82. 48 Nutant, nodding, having the point turned outward. 49 Reflex, having any part turned backward. 50 Revolute (377) rolled back into a ſpiral line. 51 Procumbent, weak and leaning on the ground. 52 Flexuoſe, bent hither and thither.

The following Terms reſpect chiefly the Direction of Branches (3).

53 Patent, expreſſes the direction of an acute angle, or an angle above 45 degrees, fig. 84.—54 Diverging, parting at a right angle. 55 Divaricated, expreſſes the direction of an obtuſe angle. 56 Dependent, looking ſtraight to the ground. 57 Diſtich, or diſtichated [flowers, leaves, or branches] turning to the two ſides, though inſerted all round. 58 Sequent, turning all to one ſide. 59 Appreſt, approaching ſo as to be almoſt parallel to the ſtalk or trunk. 60 Coarctate, almoſt incumbent towards the top. 61 Diffuſe, having ſmall patent (53) branches.

No. VII. FIGURE *is that either of* Surfaces, *or* Solids, *or* Similitudes.

1. The figure of *Surfaces* is either

62 Orbicular, of a circular form, fig. 1.—63 Subrotund, almoſt circular; and Subgloboſe, almoſt ſpherical, fig. 2.—64 Ovate, having its longitudinal diameter longer than the tranſverſe, with the baſe terminated by a ſegment of a circle, and the top narrower, fig. 3.—65 Parabolical, reſembling a parabola, fig. 110.—66 Elliptical, reſembling an ellipſe, or oval, fig. 4. 67 Cuneiform, wedge-ſhaped, growing by degrees narrower toward the baſe. 68 Oblong, having the longitudinal diameter any number of times longer than the tranſverſe diameter, fig. 5. 69 Lanceolate, oblong (68) and attenuated (75) on either end, fig. 6.—70 Linear, every where of equal breadth, fig. 7.—71 Triangular, quadrangular, &c. according to the number of angles, fig. 12, 20.—72 Rhombeous, or rhomboidal, of the ſhape of a rhombus. 73 Trapeziform, of the ſhape of a trapezium.

2. The figure of *Solids* is either

74 Filiform, every where of equal thickneſs. 75 Attenuated, gradually loſing its thickneſs towards the point. 76 Subulated, awl-ſhaped; linear, but attenuated towards the point. 77 Clavated, club-ſhaped, growing thicker towards the point or top. 78 Turbinated, top-ſhaped like an inverted cone. 79 Globoſe, globular, like a ſphere. 80 Conical, reſembling a cone. 81 Teres, round, like a cylinder, fig. 62.—82 Semiteres, half-round; ſemicylindrical. 83 Anceps two-edged, having the two oppoſite angles acute. 84 Trigonous, tetragonous, &c. having three, four, &c. prominent longitudinal angles. 85 Triquetrous, having three exactly plain ſides (109) fig. 59.—86 Gibbous, or gibboſe, having both upper and under ſurface convex, by reaſon of a more copious pulp (30) intervening. 87 Compreſſed pulpous (30), having the edges flatter than the diſk or middle. 88 Depreſſed pulpous, having the diſk flatter than the edges. 89 Lingulated, tongue-ſhaped; linear (70), carnous (31), convex (112), below, fig. 55.—90 Enſiform, ſword-ſhaped, ancipitous (83), gradually attenuated, or tapering from the baſe to the top. 91 Acinaciform, ſabre-ſhaped, compreſſed (87), carnous, having the one edge convex and thin, and the other ſtraighter and thicker, fig. 56.—92 Dolabriform, hatchet-ſhaped, compreſſed, ſubrotund (63), gibbous on the outſide (86), with the edge ſharp, and roundiſh below, fig. 57.

The tubulated Figures that are moſtly applied to the Corolla, are

93 Infundibuliform, funnel-ſhaped, an inverted cone, placed upon a tube. 94 Campanulated, bell-ſhaped, ventricoſe (107), without any tube. 95 Inflated, hollow, and, as it were, blown up like a bladder. 96 Rotated, wheel-ſhaped, plain, and not placed on a tube.

3. The Figure of *Similitudes* is either

97 Cordate, heart-ſhaped, ſubovate, having a notch cut out of the baſe, without any poſterior angles, fig. 11.—98 Reniform, kidney-ſhaped, ſubround (63), having a notch cut out of the baſe, without poſterior angles, fig. 9.—99 Lunular, creſcent-ſhaped, ſubrotund, having the baſe notched, with acute poſterior angles, fig. 11.—100 Sagittated, arrow-ſhaped, triangular (71), having acute poſterior angles ſeparated by a notch, fig. 13, 14.—101 Haſtated, halberd-ſhaped, ſagittated (100), having the poſterior angles divided by a blunt notch, and prominent towards the ſides, fig. 15.—102 Lyrated, lyre-ſhaped, divided acroſs into laciniæ, or ſegments of no determinate form, whereof the under ones are leſſer and more remote from one another than the upper ones, fig. 76.—103 Runcinated, pinnatifid (*i. e.* divided acroſs into horizontal oblong ſegments) in ſuch ſort that the ſegments are convex on the fore-ſide and tranverſe behind, *e. g.* the dandelion. 104 Panduriform, pandour-ſhaped, oblong, and coarctated or narrowed below. 105 Spathulated, ſubrotund or roundiſh, with a linear and narrower baſe, fig. 109.—106 Palmated, divided paſt the middle into lobes nearly equal, fig. 22. 107 Ventricoſe, gibbous, or ſwelling out on the ſides. 108 Deltoid, rhomboidal (72), conſiſting of four angles, of which the lateral ones are leſs diſtant from the baſe than the other two; as the leaves of the black poplar. See alſo the figure of the ancient *delta* of the Greeks, fig. 58.

No. VIII. EXPANSION *is either*

109 Plain, having an equal ſurface. 110 Canuliculated, hollowed above with a deep longitudinal furrow, fig. 60.—111 Concave, by the margin being leſs in proportion than the diſk, and the diſk of courſe depreſſed or puſhed downwards. 112 Convex, by the margin being leſs in proportion than the diſk, ſo that the diſk is elevated or puſhed upwards. 113 Cucullated, cowl-ſhaped, having the edges folded or curling inwards at the baſe, and ſpreading at the top like a cowl. 114 Undated, waved, having the diſk alternately bending up and down in obtuſe plaits. 115 Criſped, curled, by having the margin ſo luxuriant that the diſk becomes longer than its rachis (283) or quill.

No. IX. PLACE.

1. A *Leaf* is either

116 Radical, growing out of the root. 117 Cauline, growing on the caulis (197) or ſtalk, fig. 89.—118 Ramous, growing on a branch, fig. 80.—119 Axillary, placed under the baſe of a branch. 120 Floral, next the flower. See Def. 16. fig. 91.

2. A *ſtipula*, or *ſcale*, is either

121 Lateral, inſerted into the ſide of a petiole. 122 Extrafoliaceous, placed below a leaf. 123 Intrafoliaceous, placed above a leaf. 124 Oppoſitifolious, placed on the ſide of the ſtalk oppoſite to a leaf.

3. A *Cirrhus*, or *Tendril*, is either

125 Petiolar, growing out of a petiole or leaf-ſtalk. 126 Peduncular, growing out of a peduncle or flower-ſtalk, &c. &c.

No. X. *The* SITUATION *of the Parts of a Plant is either*

127 Oppoſite, when the leaves, &c. are placed in decuſſated (129) or croſs pairs, fig. 103, 124.—128 Alternate, growing all round a ſtalk or branch one after another gradually, fig. 104. 129 Decuſſated, placed oppoſite in ſuch a manner, that if on looking down from the top of the plant, the leaves, &c. repreſent four diſtinct rows. 130 Verticillated, whirled; leaves, flowers, &c. ſurrounding the ſtalk or trunk at the joints in great number like a whirl, fig. 166.—131 Bifarious, leaves, &c. growing only on the oppoſite ſides of a ſtalk or branch. 132 Sparſe, placed without any certain order. 133 Faſciculated, pencilled, growing in numbers out of the ſame point like a pencil, fig. 107. 134 Confert, cloſe-ranged, leaves, &c. almoſt covering the whole ſurface. 135 Diſtant, parts remote from one another. 136 Terminal, placed at the top.

No. XI. *A* SURFACE *is either*

137 Naked, deſtitute of ſetæ (245) or briſtles, and pili (240) or hairs. 138 Levigated, ſmooth, of an equal plainneſs. The ſame with plain (109).—139 Glabrous, of a ſlippery nature. 140 Nitid, ſlippery and ſhining. 141 Lucid, as if it were illuminated. 142 Coloured, of a colour different from green (when that is the natural colour). 143 Lineated, lined, the nerves being depreſſed. 144 Striated, gently furrowed in parallel lines. 145 Sulcated, furrowed in deep lines, fig. 61. *a* Alveolated, honey-combed, a receptacle deeply pitted ſo as to reſemble a honey-comb. *b* Hiſpid, any ſurface planted with ſtiff ſhort hairs, fig. 49. *c* Rimoſe, full of rents or chinks.

[*The following terms, to* 156, *belong chiefly to Leaves.*]

146 Nervous, having unconnected ſmall veſſels, reſembling nerves, running from the baſe to the top, fig. 53.—147 Trinerved, having three ſmall nerves meeting at the baſe. 148 Triplinerved, having three nerves meeting above the baſe. 149 Trinervated, having three nerves meeting below the baſe. 150 *Enervis*, nerveleſs, the oppoſite to nervous. 151 Venous, having veins or ſmall veſſels divided variouſly, without any regular order. 152 *Avenis*, veinleſs, the oppoſite to venous. 153 Rugoſe, wrinkled, full of wrinkles, fig. 51.—154 Bullated, having the ſurface, from being rugoſe, raiſed up in the form of bubbles, by the veins being contracted, the other ſide by that means becoming concave. 155 Lacunous, pitted, by the diſk being depreſſed between the indiſperſed veins. 156 Punctated, beſprinkled with hollow points. 157 Papillous, covered with carnous or fleſhy points, fig. 54.—158 Papulous, covered with veſicular or bladder-like points. 159 Viſcid, beſmeared with a gluey moiſture. 160 Tomentoſe, covered with fine down interwoven together, hardly to be diſcerned, fig. 48.—161 Villous, covered with ſoft hairs. See *Villi* (241). 162 Sericious, ſilky, covered with very fine hairs laid cloſe down. 163 Lanated, woolly, covered as it were with a cobweb (or ſpontaneouſly curled hairs). See *Lana* (242).—164 Piloſe, hairy, covered with long diſtinct hairs. See *Pili* (240), and fig. 47.—165 Bearded, covered with parallel hairs. See *Barba* (243).—166 Setaceous, briſtly, ſet or covered with briſtles. See *Setæ* (245).—167 Scabrous having hard prominent points cauſing a roughneſs to the touch. 168 Aculeated, armed with prickles fixed only to the bark. See *Aculei* (253).—169 Strigoſe, having ſtiff lanceolated (69) prickles. See *Strigæ* (244).—170 Paleaceous, chaffy, covered with dry ſcales reſembling chaff. See *Palea* (246).—171 Muricated, beſprinkled with ſubulated points. 172 Spinous, thorny, beſet with ſpines, or prickles riſing out of the wood of the plant. 173 Burning, beſet with ſtimulating and inflaming points, as the nettle, &c.

No. XII. *A* MARGIN *is either*

174 Entire, linear without the leaſt dent or notch. 175 Crenated, having notches without reſpect to the extremity, fig. 33, 35, 36, 38.—176 Serrated, ſaw-toothed, all the notches and teeth looking towards the extremity, fig. 31, 32.—177 Ciliated, having parallel briſtles ſet in a row lengthwiſe, like eye-laſhes, fig. 60.—178 Dentated, toothed, with the points patent

patent and aſunder, fig. 30.—179 Repand, having a plain ſerpentine form, fig. 29.

No. XIII. *An* APEX *or Point is either*

180 Obtuſe, terminated within the ſegment of a circle, fig. 36, 40, 43.—181 Emarginated, terminated by a notch, fig. 44, 45.—182 Retuſe, terminated by a round boſom, fig. 46. 183 Truncated, terminated by a tranſverſe line. 184 Acute, terminated by an acute angle, fig. 44.—185 Acuminated, terminated by a ſubulated or awl-ſhaped point, fig. 42.—186 Cuſpidated, terminated by a briſtle or prickle.

SPECIAL TERMS.

No. XIV. *A* ROOT *is either*

187 Fibrous, conſiſting wholly of ſmall fibres. 188 Bulbous, furniſhed with a bulb (19).—189 Bulbous 1, Solid (28).—190 Bulbous 2, Scaly, with the ſcales imbricated (390).—191 Bulbous 3, Tunicated, having coats above coats. 192 Tuberous, conſiſting of fleſhy parts, connected by threads to the baſe. 193 Faſcicular, conſiſting of fleſhy parts, connected to the baſe without the intervention of threads, fig. 107.—194 Granulated, compoſed of ſmall fleſhy particles. 195 Fuſiform, ſpindle-ſhaped, ſingle and tapering, fig. 129.—196 Repent, running out a great way, and budding here and there.

No. XV. *A* TRUNK *is either*

197 1 A ſtem or ſtalk (fig. 112—117), a trunk ſupporting both the fructification and the leaves. 198 2 A culm, proper to graſſes, fig. 111, 114.—199 3 A ſcapus or ſhaft; a trunk ſupporting the fructification, but not the leaves, fig. 113. 200 4 A ſtipes or ſtock; a trunk changing into leaves, fig. 139, *c.* 162, *d.*—201 Scandent, climbing, but needing the ſupport of other bodies. 202 Voluble, twining, aſcending (45) in a ſpiral line, by the aſſiſtance of other bodies. 203 Repent, creeping, lying on the ground, and ſending out roots here and there (196) fig. 131.—204 Sarmentoſe, full of twigs, filiform, with rooting joints. 205 Stoloniferous, putting forth young ſhoots at the root or tillering. 206 Simpliciſſimus, very ſingle, having ſcarcely any branches. 207 Simplex, ſingle, extended in a continued ſeries towards the top. 208 Entire, very ſingle, with the branches gathering inwards. 209 Proliferous, putting forth branches only from the middle of the top. 210 Subramoſe, having only a few lateral branches. 211 Ramoſe, having many lateral branches, fig. 130.—212 Ramoſiſſimus, very ramoſe, loaded with numerous branches, without any determinate order. 213 Virgated, having ſmall weak pliant branches of unequal length. 214 Panicled, having branches variouſly ſubdivided.

No. XVI. *A* PETIOLE *is either filiform, or,*

215 Alated, winged, dilated on the ſides. 216 Spineſcent, hard and pricking.

No. XVII. *A* LEAF *is either ſimple or compound.*

A. *A ſimple Leaf*, fig. 108, *may be*

217 Submerſed, hid under the ſurface of water. 218 Natant, ſwimming, lying on the ſurface of the water. 219 Acerous, chaff-like, linear, and perſiſtent (26) fig. 81.

The Inſertion of Leaves.

220 Petiolated, having a petiole inſerted at its baſe, fig. 93. 221 Peltated, or targetted, having the petiole in the diſk of the leaf, fig. 92.—222 Adnate, connected with the branches at the baſe on the upper ſide. 223 Connate, having the oppoſite pairs united at the baſe on each ſide, fig. 98.—224 Coadunate, having more than two united. 225 Decurrent, having the baſe of the leaf running along the ſtalk downwards, fig. 95.—226 Amplexicaul, having the baſe ſurrounding or embracing the ſtalk, fig. 96.—227 Perfoliated, having the baſe ſurrounding the ſtalk ſtraight acroſs, without any opening before, fig. 97.—228 Vaginating, or ſheathing, having the baſe forming a tube that covers the ſtalk, fig. 99.

B. 1. *A Leaf is called Compound, when the ſame Petiole produces more Leaves than one. It is*

229 Articulated, jointed, when one leaf grows out of the top of another, fig. 100.—230 Digitated, when a ſimple petiole connects leaflets or ſmall leaves at the top. Binate, ternate, &c. are modifications of this, according to the number of leaflets thus connected, fig. 66.—231 Pedated, when a bifid or forked petiole connects ſeveral leaflets only by the interior ſide, fig. 67. 232 Pinnated, or feathered, when a ſimple petiole connects any number of leaflets to its ſides. Bijugous (double-paired) quadrijugous (four-paired), &c. when only four, eight, &c. &c. leaflets are thus connected, fig. 23, 68, 75. Pinnated with an odd one, when terminated by a ſingle or odd leaflet. Pinnated abruptly, when terminated neither by a tendril nor a leaflet. Pinnated cirrhous, when terminated by a tendril (15). Pinnated with oppoſite (127) leaflets. Pinnated with alternate (128) leaflets. Pinnated with interrupted leaflets, when the leaflets are alternately greater and ſmaller. Pinnated with decurſive leaflets, or leaflets running down the petioles.

2. *A Decompound Leaf is either*

233 Bigeminous, q. double-twin, leaves, when the petiole is dichotomous, or ſucceſſively divided into two, and every top carries a pair of leaflets. 234 Biternated, doubly ternated (230) fig. 77.—235 Bipinnated, doubly pinnated (232), fig. 78.

3. *A Supradecompound Leaf is either*

236 Tergeminous, when the petiole being twice dichotomous, or divided into two, bears a pair of leaflets. 237 Triternated, thrice ternated, fig. 79.—238 Tripinnated, thrice pinnated, fig. 80, 81. *Stipula*, or Scale. *Cirrhus*, or Tendril.

No. XVIII. PUBES, *the Hair, Wool, &c. of Plants, is either*

239 *Tomentum*, a flock, fine interwoven hairs *(villi)* ſcarcely viſible. See 160, 241, and fig. 48.—240 *Pili* (164) excretory ducts of a plant reſembling ſetæ, or briſtles (166).—241 *Villi* (161) ſoft hairs. 242 *Lana* (163) curled thick hairs. 243 *Barb a*, a beard, parallel hairs. 244 *Strigæ*, comb-teeth, ſtiff, rigid, plain hairs. 245 *Setæ*, briſtles, ſtiff round hairs. 246 *Palea* (170) a membranaceous ſcale (33).—247 *Hamus*, hook, an accuminated (185) crooked point. 248 *Glochis*, a point or prickle, with many teeth turned backwards. 249 Glandule, a papilla, or ſmall gland ſecreting moiſture, fig. 118, *b*; 119, *a.*—250 Utricle, a ſmall veſſel full of ſecreted moiſture. 251 Viſcoſity, expreſſes the quality of tenacious moiſture. 252 Glutinoſity, expreſſes the quality of ſlippery humour.

No. XIX. ARMA, *the arms of Plants are either*

253 *Aculei*, prickles, pricking points, affixed only to the bark. 254 *Furcæ*, forks, prickles (253) divided or forked. 255 *Spinæ* (172) thorns, points or prickles put forth from the wood of the plant, fig. 121.—256 *Stimuli* (273) points producing inflammatory punctures, whereby the parts become itching.

No. XX. *A* BRACTEA, *or Floral Leaf.*

257 *Coma*, the bracteæ or ſpangles on the top of the ſtalk of ſome plants, remarkable in ſize compared to the other leaves.

No. XXI. *A* PEDUNCLE *is either*

258 Common, to more flowers than one. 259 Partial, bearing any number of flowers of the common peduncle. 260 A pedicle, proper to flowers in a common peduncle. 261 Cernuous, ſtooping, having the top looking to the ground. 262 Retrofract, broken backward, reduced to a depending ſtate, as if by force. 263 Multiflorous, producing many flowers.—264 INFLORESCENCE is the mode in which flowers are connected to the peduncle of a plant; and this is either 265 1 *Verticillus*, a whirl, when a number of flowers ſurround the plant in a ring. 266 2 *Capitulum*, a knot, when a number of flowers are collected together in form of a globe. It ſignifies alſo the upper parts of the fructification of moſſes, fig. 136, *a.*—267 3 *Faſciculus*, a bunch, when erect parallel flowers of equal height are collected together (392).—268 4 *Spica*, a ſpike, when ſeſſile alternate flowers are placed on a common ſimple peduncle. A ſpike is either 269 Simple, continued and undivided. 270 Compound, when more ſmall ſpikes ſtand on one peduncle. 271 Glomerated, when the ſmall ſpikes are crowded together, without any certain order. 272 Interrupted, when the ſmaller ſpikes are placed alternately and diſtant one from another. 273 5 A *Corymbus* is formed of a ſpike (268) having every ſingle flower provided with a pedicle of its own, and the whole elevated to a proportionable height, fig. 163.—274 6 *Racemus*, a cluſter, when the common peduncle has lateral branches, fig. 164.—275 Unilateral, when all the flowers grow on one ſide. 276 7 *Panicula*, a panicle, when the flowers are ſparſe, and grow on peduncles variouſly divided, fig. 167.—277 8 *Thyrſus*, a panicle (276) gathered into an ovate (64) form. 278 *Umbella*, an umbel; a receptacle (13) lengthened out from one centre into filiform peduncles riſing to a proportionable height, ſo as to reſemble an umbrella above, fig. 135, *a a.* It is 279 Simple, when all the peduncles ſpring out of one and the ſame receptacle. 280 Compound, when every peduncle carries a ſmall umbel on its top. 281 *Umbellula ſeſſilis*, a ſmall ſeſſile umbel, when a number of peduncles riſe from the ſame centre, and ſtand equally all around it. 282 *Cyma*, a receptacle riſing from the ſame general centre, with partial ones here and there, and lengthened into peduncles all equally high at top. 283 *Rachis*, a filiform receptacle connecting any number of florets into a long ſpike 284 *Spadix*, the receptacle of a palm-tree riſing within a *ſpatha* or ſheath, and divided into fructifying branches, fig. 133.

No. XXII. FRUCTIFICATION *is*

285 The tempory part of a vegitable, deſtined to generation. And is either 286 Simple, conſiſting of few flowers. 287 Compound, when a number of flowers are ſet together.

A. *Calyx*, the Cup.

288 1 *Perianthium*, a cup contigious to the fructification, fig. 149. *a.*—289 *Perianthium* of the fructification, containing the ſtamina (9) and the germen (333).—290 *Perianthium* of the flower, containing ſtamina without a germen. 291 *Perianthium* of the fruit, containing a germen without ſtamina. 292 *Perianthium a*, Proper, belonging to any particular flower. And is either 293 *Perianthium* Monophyllous, conſiſting only of one leaf. 294 *Perianthium* Polyphyllous, conſiſting of a number of leaves. 295 *Perianthium* Superior, having the germen below the receptacle. 296 *Perianthium* Inferior, having the germen above the receptacle. 297 *Perianthium b*, Common, containing

containing a number of flowers ſet together. 298 *Perianthium* Calyculated, a calyx or cup, having as it were another leſſer cup round its baſe. 299 2 *Involucrum*, or wrapper, a cup remote from a flower, fig. 135.—300 *Involucrum* Univerſal, ſet under an univerſal umbel, (278 . *a*.—301 *Involucrum* Partial, ſet under a partial umbel, *d d*. 302 *Involucrum* Proper, ſet under any particular flower. 303 3 *Gluma*, a glume or chaff, the cup of any kind of graſs, conſiſting of valves embracing one another, fig. 134, *a*. Either 304 *Gluma* Uniflorus, containing a ſingle flower. 305 *Gluma* Multiflorous, containing any number of flowers. 306 Ariſta, or awn, fig. 134, *b*. a tapering point growing out of the glume or chaff, either ſtraight or 307 Tortile, twiſted like a cord. 308 4 *Amentum*, a catkin, conſiſting of a chaffy common receptacle like a gem or bud, fig. 30.—309 5 *Spatha*, ſpath or ſheath, a cup opening longitudinally, fig. 132.—310 6 *Calyptra*, hood, the cowl-ſhaped cup of ſome moſſes placed over the anthera (331) fig. 136. 311 7 *Volva*, the membranaceous cup of a muſhroom. *a*. *Perichætium*, a circular tuft of fine hair-like leaves, ſurrounding the baſes of the filaments in the genus Hypnum.

B. *Corolla*, or coloured part of a flower.

312 Petal, a part of a corolla when divided into more parts than one, fig. 143, *fff*.—313 Tube, the inferior part of a monopetalous corolla, fig. 132, *a*.—314 Limb, the ſuperior ſpreading part of a monopetalous corolla, fig. 142.—315 *Unguis*, heel, the inferior part of a polypetalous corolla, affixed to the receptacle. 316 *Lamina*, lappet, the ſuperior ſpreading part of a polypetalous corolla, fig. 144.—317 Regular, equal in figure, magnitude, and proportion of parts. 318 Irregular, when the ſegments of the limb differ in figure, magnitude, or proportion of parts. 319 Ringent, irregular (318), gaping like two lips opened very wide. 320 *Galea-ringertis*, the vizard or upper lip of a ringent corolla. 321 *Faux*, the throat or opening between the ſegments of a corolla where the tube (313) terminates. 322 Cruciated, croſſed, having four equal and patent petals. 323 *Perſonata*, maſked, ringent (319, but ſhut cloſe between the lips by the palate. 324 Papilionaceous, butterfly-ſhaped irregular; the inferior petal being cymbiform or ſhaped like a boat (called the *carina* or keel; the ſuperior aſcending, (called the *vexillum* or flag); the ſide petals ſtanding ſingle (called the *alæ* or wings). 325 Compound, conſiſting of a number of florets, on a common receptacle, and within a common perianthium. 326 1 Ligulated, having all the exterior florets plain on the outſide. 327 2 Tubulous, having all the ſmall corollæ of the florets tubulated. 328 3 Radiated, having all the ſmall corollæ of the diſk tubulous, and thoſe of the circumference ligulated and of a different form. 329 Nectary, the melliferous part proper to any flower, fig. 145, 146, 147, 148.

C. *Stamen*, a Chive.

330 Filament, the part ſupporting the anthera, and connecting it with the plant, fig. 149, 150, 143, *d d d*.—331 Anthera, the part of a flower which is full of pollen (332) or fine flower-duſt, which it diſcharges as ſoon as itſelf comes to maturity, fig. 143, *e e e*.—332 Pollen, flower-duſt, burſting by being brought into contact with moiſture, and throwing out elaſtic atoms. (According to the principles of the ſexual ſyſtem, this is the origin of generation in plants).

D. *Piſtillum*, a Piſtil.

333 Germen, the rudiment of the unripe fruit in a flower. This is either 334 Superior, included in the corolla. 335 Inferior, placed below the corolla. 336 Style, the part of the piſtil that raiſes the ſtigma (337) from the germen, fig. 149. *b*; 149, *c*; 152, *b*.—337 Stigma, the ſummit of the piſtil bedewed with moiſture, fig. 143, *c*; 149, *d*; 152, *c*.

E. *Pericarpium*, a Fruit-caſe, is a

338 1 Capſule, a fruit-caſe, hollow and opening in a certain determinate manner, fig. 156, *b*. 159, 160, 161.—339 2 Valvule, a ſcreen or defence, with which the fruit is covered on the outſide. 340 *Loculamentum*, a hole or cavity for lodging the ſeeds. 341 *Diſſepimentum*, a partition, by which the fruit is diſtinguiſhed or divided within into any number of cavities, fig. 160, *b b*.—342 Bicapſular, having two capſules (338). 343 Bilocular, having two cavities (340).—344 Tricoccous, a capſule having three protuberant knobs, and divided into three cavities within, each containing one ſeed. 345 Didymous, having two knobs protuberant on the outſide. 346 *Siliqua*, a huſk; a fruit-caſe having two valves, and attaching the ſeeds along both ſutures, fig. 155.—347 *Toruloſa*, having prominences ſwelling out on each ſide. 348 *Parallelum diſſepimentum*, a parallel partition of equal breadth with the valves. 349 *Contrarium diſſepimentum*, a croſs partition narrower than the valves. 350 3 *Legumen*, a cod or ſwob; a pericarpium having two valves and attaching the ſeeds only along the one ſuture, fig. 154.—351 *Iſthmis interceptum*, having parts at regular diſtances ſtraiter than the reſt, ſo as to divide it acroſs into different internal cavities. 352 4 Follicle, a pericarpium of one valve, opening longitudinally on one ſide, and not having the ſeeds attached to the ſuture, fig. 153.—353 5 *Drupa*, plum; a pericarpium ſtuffed with fleſhy ſubſtance, without any valve, and containing a nut or ſtone in the middle, fig. 157, *a*.—354 5 *Pomum*, apple or pear; a pericarpium ſtuffed with fleſhy ſubſtance without valves, and containing a capſule or ſeed-caſe in the middle, fig. 156.—355 6 *Bacca*, berry; a pericarpium full of pulpy or ſoft ſubſtance, without valves, and containing ſeeds otherwiſe naked. 356 7 Nidulant, neſtling; ſeeds diſperſed through a pulpy or ſoft ſubſtance. 357 8 *Strobilus*, cone; a pericarpium formed by the induration of the ſcales of a catkin, (308), fig. 138.

F. *Semen*, Seed.

358 *Hilum*, ſpeck; the external ſcar or mark of the ſeed, occaſioned by its attachment to the fruit-caſe before it comes to maturity. 359 *Corculum*, the original ſubſtance of a new plant within a ſeed. 360 *Corona*, crown, or dreſs adhering to the top of a ſeed, by which it is enabled to fly about after it is ripe. 361 *Pappus*, down; a feathery or hairy crown with which it flies, fig. 162, *a*, *b*.—362 *Stipitatus*, ſtalked, having a thread betwixt it and the down. 363 Capillary, conſiſting of fine undivided hairs. 364 Plumoſe, feathery; conſiſting of hairs feathered on the ſides. 365 *Cauda*, tail; a thread or membrane at the end of a ſeed. 366 *Hamus*, a hook, (247.—367 *Caliculus*, the interior and proper integument of a ſeed. 368 *Nux*, kernel; a ſeed covered with a bony ſhell. 369 *Arillus*; the outer coat of a ſeed, which falls off of its own accord.

G. *Receptaculum*, a Receptacle.

370 Common, containing more flowers and fruits than one. 371 Compound, or compoſite flower; having the receptacle dilated and entire, the florets ſeſſile. 372 Aggregate flower; having the receptacle dilated, and the florets ſubpedicellated, or ſtanding on very ſhort flower-ſtalks. *Bulbus*, a bulb. *Gemma*, a gem or bud.

No. XXIII. Vernation *is the*

373 Diſpoſition of leaves within the bud (20.—374 Conduplicated, doubled together, having the oppoſite edges approaching each other in parallel lines. 375 Convoluted, rolled together ſpirally like a cowl. 376 Involuted, rolled inwards, having the edges on both ſides rolled ſpirally, ſo as to be nearly met on the upper ſurface of the leaf. 377 Revoluted, rolled backwards, having the edges on both ſides rolled ſpirally ſo as to be nearly met on the back of the leaf, fig. 87.—378 Equitant, riding, when two leaves oppoſite to each other cloſe their edges, ſo that the one includes or claſps about the other. 379 Obvoluted, when two edges of one leaf cloſe on the upper ſurface, ſo that the one edge divides or lies betwixt the two ſides of the other. 380 Plicated, plaited, gathered into various plaits, fig. 37. 381 Circinal, rolled ſpirally from the top to the baſe, ſo that the comes to occupy the centre.

No. XXIV. General Terms *to be added.*

382 *Laxus*, flexible at pleaſure. *Debilis* (weak), and *flaccidus* (flagging, are almoſt ſynonimous. 383 Rigid, not enduring to be bent. 384 Articulated (229), jointed or knotted. 385 *Enodis*, without joints or knots. 386 *Præmorſus*, forebitten; having the top as it were bitten off, fig. 18.—387 Radicant, puſhing down roots. 388 Squamous, covered with ſcales. 389 Prolifcrous flowers, having one flower riſing within another. 390 Imbricated parts, one overlapping another like tiles or ſlates, fig. 141, 106.—391 Squarroſe, rough or ſcurfy, applied to the tops or irregular ſegments of leaves, &c. when they ſtand out on all ſides. 392 Faſtigiated, trunks, branches, or peduncles riſing all alike high. 393 Reſupinated, turned upſide down. 394 Lacerated, a term applied to the edges of flowers or leaves when divided irregularly as if they were torn. 395 Laciniated, divided into parts or ſegments in an indeterminate manner, fig. 24.

Terms *omitted to be inſerted in their proper places.*

396 Brachiated branches, when each pair ſtands at right angles with the pairs immediately above and below them, fig 117. 397 Aphyllous, without any leaves. 398 Adverſe leaves, turning their faces, not to the ſky, but to the ſouth; as *Amomum*. 399 *Arboreus*, arboreſcent, of the nature of a tree producing buds. A term of great lubricity. 400 Bulbiferous, bearing bulbs. Bulbs are either 401 Scaly, conſiſting of imbricated lamellæ, as the lily root, fig. 125.—402 Solid, conſiſting of ſolid ſubſtance, as the tulip, fig. 126.—403 Tunicated, coated like the common onion, fig. 127.—404 Articulated, conſiſting of lamellæ linked together as the *Lathrea*. 405 Calcareous, of a hard crumbly nature, like dry lime plaſter. 406 *Circumſciſſus*, parting as if cut ſtraight over; as the capſule of *Stellaria*. 407 Cirrhous, terminating in a tendril. 408 Columella, the part of a fruit-caſe that connects the internal partitions with the ſeeds, fig. 160, *c*.—409 Intortion, the twiſting of any part towards one ſide: 410 To the right, ſuppoſing one's ſelf placed in the centre; 411 To the left, ſuppoſing one's ſelf placed in the centre. 412 Cotyledon, the lateral body or lobe of a ſeed, porous, and imbibing moiſture, and afterwards falling off. 413 *Acotyledones*, plants whoſe ſeeds have no lateral bodies or lobes; as the *Muſci*. 414 *Monocotyledones*, plants whoſe ſeeds have only one lateral body; as the graſſes, &c. 415 *Dicotyledones*, plants whoſe ſeeds have two lateral bodies or lobes; as the *Legumina*, &c. 416 *Polycotyledones*, plants whoſe ſeeds have many lateral bodies or lobes; as the Pines, &c. 417. Monoſpermous, capſules or

ſeed-

ſeed-caſes that contain only one ſeed. 418 Di—tri—tetra—penta,—&c. ſpermous, containing 2, 3, 4, 5, &c. ſeeds in one capſule. 419 Polyſpermous, containing many ſeeds. 420 *Suberoſus*, reſembling cork. 421 *Echinatus*, beſet with ſpines or prickles, ſo as to reſemble a hedge-hog. 422 *Muticus*, without awn, beard, or prickle. 423 *Pileus*, the hat or bonnet of a muſhroom, which has the fructifications on its under ſide, fig. 139. *a*.—424 *Diſcus*, the middle part of a compound flower, conſiſting of regular florets. 425 *Radius*, the rim or outward part, conſiſting of irregular florets.

As the Science of Botany cannot be clearly underſtood without a full elucidation of the Terms, we ſhall, in addition to the preceding arrangement, affix a Nomenclature in alphabetical order, as it will direct the more readily to the articles referred to.

It was deemed neceſſary to have two arrangements of the Terms, as the former diſplays them with their relative connexions, and the latter will ſerve as an Index to the whole.

ALPHABETICAL INDEX of BOTANICAL TERMS.

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SECTION II.

DELINEATION OF A PLANT.

Before proceeding to explain this system, it will be proper to make the reader acquainted with the principal outlines of a plant, as delineated by *Linnæus* in his *Principia Botanica*.

A plant consists of Root, Trunk, Leaves, Props, Fructification, and Inflorescence; to which may be added the Habit.

I. The ROOT consists of two parts, *viz.* the caudex and the radicula, distinguished according to shape, direction, duration, &c.

1. CAUDEX, or *stump*, is the body or knob of the root from which the trunk and branches ascend, and the fibrous roots descend; and in different plants is either solid, bulbous (placed under a bulb), or tuberous. Solid, as in trees, shrubs, and many of the herbs. Bulbous will be explained under *Hybernacle*.—Tuberous knobs are also solid and hard, containing one or more embryos or eyes. They are either only one knob, as turnip, carrot, &c. containing only one eye at the top; or consist of many knobs connected together by slender fibres, as in potatoes, Jerusalem artichokes, &c. each containing many eyes dispersed over the surface: and are either pitted, when the eyes lie inward, as in potatoes, &c. or tuberculated, containing the eyes outward, as in Jerusalem artichokes, &c. In tuberous knobs, the fibres or stringy parts issue from every part of the surface; which is an essential difference from bulbous knobs, where they are confined to the caudex of the bulb only, and are the true and genuine roots, the bulb itself being only a large bud under ground. Those tuberous knobs with only one eye, differ as to duration, but are in general biennial; those with many eyes are perennial; both seem to be produced by the nutriment of the stem, like buds, and not by the fibrous roots, for the stem is first formed and becomes strong, and as it grows to maturity, the tuberous knobs increase.

2. RADICULA, a *little root*, is the stringy or fibrous part of the root, descending from the caudex: it is really the principal and essential part of every root, and by which the nourishment is drawn from the earth for the support of the plant.

II. The TRUNK, which includes the branches, is that part which rises immediately from the caudex, and produceth the leaves, flowers, and fruit. It is either herbaceous, shrubby, or arborescent; and is distinguished according to its shape, substance, surface, &c. and admits of the following sorts.

1. CAULIS, a *stalk* or *stem*, is the main or universal trunk which elevates the leaves and fructification, and is applied to trees, shrubs, and herbs: It is denominated *simple* when it doth not divide, and *compound* when it is divided into branches.

2. CULMUS, a *straw* or *haulm*, is the proper trunk of grasses; and also elevates both the leaves and fructification: It is sometimes jointed, and sometimes not; it is also sometimes round, and sometimes angular.

3. SCAPUS, a *stalk*, is an herbaceous trunk, which elevates the fructification, but not the leaves; that is, it is a stalk proceeding immediately from the root, and terminated by the flowers, as in narcissus, hyacinth, &c.

4. STIPES, a *trunk*, used by Linnæus for the trunk of mushrooms: as also for that slender thread or footstalk which elevates the feathery or hairy down with which some seeds are furnished and connects it with the seed.

III. The LEAVES are said by Linnæus to be the muscles or organs of motion of a plant; by others, the organs by which perspiration and inspiration are performed. They are defined as proceeding from the expansion of the vessels of the stalk, forming several ramifications like net-work, extended in length and breadth in a determinate manner, having the interstices filled up with a tender pulpy substance; and the external covering is supposed to be a continuation of the scarf skin of the stalk.

Leaves are either simple or compound; and are distinguished by their figure, situation, insertion, number, divisions, &c.

A *simple leaf*, is such as either adheres to the branch singly, or whose footstalk is terminated by a single simple expansion, not parted to the middle rib; and is determinated by its shape, surface, and divisions.

A *compound leaf*, is such whose footstalk is furnished with several separate simple expansions; or, in other words, whose divisions extend to the middle rib, now called a *common petiole* or footstalk, supporting several lobes or little simple leaves, of which the compound leaf consists: they are distinguished by shape, &c. and the form by which they are attached to the common footstalk, as palmated, winged, feathered, &c. Sometimes leaves are twice or more compounded; which divisions admit of many modifications, and give rise to as great variety of terms. It may sometimes be difficult, at first sight, to know a common footstalk to a compound leaf, from a branch: but it may be observed, that a common footstalk, where it issues from the branch, is either flat or hollow on one side, and convex on the other; whereas branches are alike on both sides, whether round, flat, or angular: again, buds are never found at the angles formed by the lobes of a compound leaf with the footstalk, but at the angles formed by the footstalk of the whole compound leaf and the stem: and it may always certainly be distinguished by its falling off with the little leaves which it supports.

The manner or place in which leaves are attached to the plant is called the *determination of leaves*; and is distinguished by several terms, according to number, disposition, insertion, figure, &c.

IV. The PROPS, *fulcra*, a term used to express those external parts which strengthen, support, or defend the plants on which they are found, or serve to facilitate some necessary secretion; and are as follows:

1. PETIOLUS, the footstalk or support of a leaf.

2. PEDUNCULUS, the footstalk or support of a flower.

3. STIPULA, *haulm* or *husk*, a sort of scale or small leaf, stationed on most plants (when present) on each side the base of the footstalk of leaves and flowers, at their first appearance, for the purpose of support: They are placed either single or double; and sometimes on the inside, as in the fig and mulberry; or on the outside, as in the birch, lime, and papilionaceous flowers: They are also either sitting, extended downwards, or sheathing along the stem, as in the plane tree. As to duration, they sometimes fall before the leaves, and sometimes are equally persistent: They often afford a good distinction for the species.

4. CIRRHUS, a *curl*, meaning a clasper or tendril, is the fine spiral string or fibre by which plants fasten themselves to some other body for support: They are sometimes placed opposite to the leaves; sometimes at the side of the footstalks of the leaves; sometimes they issue from the leaves themselves; and sometimes they put out roots, as in ivy, &c.

5. PUBES, a term applied to the hair, down, wool, beard, bristles, glands, and several other appearances on different parts of plants, serving the double purpose of defence and vessels of secretion.

6. ARMA, the defensive weapons of plants; as thorns prickles, &c.

7. BRACTEÆ, *thin plates of metal*, are the floral leaves; and mean not only those leaves situated on the stalk nearest to the lower parts of the flower, but those which sometimes terminate the flower stalk; being composed of large bracteæ resembling a bush of hair, and are then called *bracteæ comosæ*, as in crown-imperial, lavender, and some species of sage.

V. The FRUCTIFICATION, or *mode of fruit-bearing*, consisting of the calyx, corolla, stamina, pistillum, pericarpium, semina, and receptaculum; which will be afterwards explained.

VI. The INFLORESCENCE, or mode by which flowers are joined to their several peduncles, whether common or partial.

A *flower* in the Sexual botany hath a very different signification from the same term of former writers; for if the antheræ and stigma be present, though the calyx, corolla, filaments of the stamina, and style of the pistillum be wanting, it is still a flower; and if all the parts are present, it is a complete flower. The seed also constitutes the fruit, whether there be a pericarpium or not.

Complete flowers are either simple or aggregate; *simple*, when no part of the fructification is common to many flowers or florets, but is confined to one only; *aggregate*, when the flower consists of many florets collected into a head by means of some part of the fructification common to them all, as by a common receptacle, or common calyx; as in dipsacus, scabiosa, &c.

From the different structure, disposition, and other circumstances of the receptacle or calyx, being the only common part to aggregate flowers, arise seven divisions.

1. AGGREGATE, properly so called, consisting of such flowers as are formed by the union of several lesser flowers or florets, placed on partial peduncles, on a common dilated receptacle, and within a common perianthium; and in those flowers where each floret hath its proper calyx, that is also a perianthium. [A flower is said to be *radiate*, when the florets in the radius or circumference differ from those in the disk; in which case they are generally larger, and are called *semi-florets*, from their difference in form, and in distinction from those of the disk, which are called *proper florets*: and they also differ as to sex, which gives rise to several of the orders in the class syngenesia, which contains the compound flowers].

2. COM-

2. Compound aggregate, conſiſting alſo of ſeveral florets, placed ſitting (or without partial peduncles) on a common dilated receptacle, and within a common perianthium; and where each floret hath its proper calyx, it is alſo a perianthium. Compound flowers alſo admit of a further deſcription, viz. each floret conſiſts of a ſingle petal, with generally five diviſions, and having five ſtamina diſtinct at the baſe, but united at the top by the antheræ into a cylinder, through which paſſeth the ſtyle of the piſtillum, longer than the ſtamina, and crowned by a ſtigma with two diviſions that are rolled backwards, and having a ſingle ſeed placed upon the receptacle under each floret. This is the general character of a compound flower, to which there are a few exceptions; it alſo differs when the flower is radiate: but the eſſential character of a regular floret conſiſts in the antheræ being united ſo as to form a cylinder, and having a ſingle ſeed placed upon the receptacle under each floret.

3. Umbellate aggregate, when the flower conſiſts of many florets placed on faſtigiate peduncles proceeding from the ſame ſtem or receptacle; and which, though of different lengths, riſe to ſuch an height as to form a regular head or umbel, whether flat, convex, or concave; and both the common and partial calyx Linnæus calls an *involucrum*. It is called a *ſimple umbel*, when it hath no leſſer diviſions; a compound umbel when each peduncle is ſubdivided at its extremity into many leſſer peduncles for ſupporting the flowers, ſo as to form ſeveral little umbellas, uniting in one head; the whole together is called an *univerſal umbel*, and the little umbellas are called *partial umbels*. In ſome genera, that have radiated umbels, the florets of the centre and thoſe of the circumference, differ both as to ſex and ſize; but in general each have five petals, five ſtamina, and two ſtyles, or one that is bifid, with a germen placed beneath and two naked ſeeds, which when ripe, ſeparate below, but remain connected at the top.

4. Cymous aggregate, (from *cyma* a ſprout) called by Linnæus a *receptacle*, is when ſeveral faſtigiate peduncles proceed from the ſame centre like the umbel, and riſe to nearly an even height; but unlike the umbel, the ſecondary or partial peduncles proceed without any regular order, as in ſambucus, viburnum, &c.

5. Amentaceous aggregate, are ſuch flowers as have a long common receptacle, along which are diſpoſed ſquamæ or ſcales, which form that ſort of calyx called an *amentum* or *catkin*, as in corylus, pinus, juglans, &c. Amentaceous flowers generally want the petals, and all of them are of the claſſes monoecia and dioecia.

6. Glumose aggregate, are ſuch flowers as proceed from a common huſky calyx belonging to graſſes, called *gluma*: many of which are placed on a common receptacle called *rachis*, collecting the florets into the ſpike, as triticum, hordeum, ſecale, lolium, &c.

7. Spadiceous aggregate, are alſo ſuch flowers as have a common receptacle, protruded from within a common calyx called *ſpatha*, along which are diſpoſed ſeveral florets. Such a receptacle is called a *ſpadix*: and is either branched, as in phœnix; or ſimple, as in narciſſus, &c. In this laſt caſe the florets may be diſpoſed, either all around it, as in calla, dracontium, pothos, &c. on the lower ſide of it, as in arum, &c. or in two ſides, as in zoſtera, &c. Theſe flowers have generally no partial calyx.

Theſe are the ſeveral diſtinctions of aggregate flowers (according to Linnæus); beſides which there are ſeveral other modes of flowering, properly ſo called, that come under the general term *Inflorescence*, and often afford the beſt marks to diſcriminate the ſpecies. Theſe modes of flowering are chiefly expreſſed as follows:

1. Verticillus, a *whorl*, when the flowers are placed in whorls at each joint round the common ſtalk: they have very ſhort partial peduncles; are all of the labiated kind; and have either two or four ſtamina, and four naked ſeeds, as in ſalvia, marrubium, mentha, &c. A verticil hath ſeveral diſtinctions, as naked, bracted, &c. and all thoſe genera with four ſtamina are of the claſs Didynamia.

2. Capitulum, a *little head*, is when many flowers are connected into nearly a globular form or head, on the ſummit of the common ſtalk, ſometimes with, and ſometimes without partial peduncles, as in gomphrena, &c. and is diſtinguiſhed by its ſhape and other circumſtances.—Under *capitulum* is now introduced the term *faſciculus* (a little bundle), which in former editions ſtood diſtinct. It means when the peduncles are erect, parallel, approaching each other, and raiſed to the ſame height as in ſweet William, where they generally proceed from different parts of the common ſtalk, oppoſite to each other.

3 Spica, a *ſpike*, when the flowers, having no partial peduncles, are arranged alternately around a common ſimple peduncle. It is called *ſpica ſecunda* (a ſingle-row'd ſpike), when the flowers are all turned one way, following each other; and *ſpica diſticha* (a double-row'd ſpike) when the flowers ſtand pointing two ways, as in lolium, &c. And it is diſtinguiſhed by ſhape and other circumſtances.

4. Corymbus, (a *cluſter of ivy-berries*), when the leſſer peduncles of the flowers proceed from different parts of the common peduncle or ſtalk; and though of unequal lengths, and ſome times ſimple, and ſometimes branched, yet form a regular ſurface at the top; as in the ſiliquoſe plants (claſs *Tetradynamia*). The corymbus may be ſuppoſed to be formed from a ſpike, by adding partial peduncles to the flowers, and ſeems to be the mean between racemus and umbella, the peduncles riſing gradually from different parts of the common ſtalk, like thoſe of the raceme, and proceed to a proportionable height like thoſe of the umbel.

5. Thyrsus, (a *young ſtalk*); a mode of flowering reſembling the cone of a pine: Linnæus ſaith, it is a panicle contracted into an ovate or egg-ſhaped form; the lower peduncles, which are longer, horizontally; and the upper, which are ſhorter, mount vertically, as ſyringa, &c.

6. Racemus, (a *bunch of grapes*), is when the flowers are placed on ſhort partial peduncles, proceeding as little lateral branches, from and along the common peduncle. It reſembles a ſpike in having the flowers placed along a common peduncle, but differs from it in having partial peduncles: it alſo differs from a corymbus in the ſhortneſs and equal length of its peduncles, not forming a regular ſurface at the top; as in ribes-rubrum, vitis, &c.

7. Panicula, (the *tuft* upon *reeds*), is when the flowers are diſperſed upon peduncles variouſly ſubdivided; or it is a ſort of branching ſpike, compoſed of ſeveral ſmaller ſpikes, attached along a common peduncle, as in avena panicum, and ſeveral other graſſes, and many other plants. When the partial peduncles diverge and hang looſe, it is called a *diffuſe*, and when they converge, it is called a *cloſe panicle*.

To theſe may be added the term Axillares, (from *axilla*, the arm-pit), being ſuch flowers as proceed from the angle formed by the leaf and the ſtem, as is moſt common: And Terminales, being ſuch flowers as terminate the ſtalk or branch. Alſo every other mode of flowering is called the *Inflorescence*, whether oppoſite to the leaves, lateral, ſingle, double, erect, bending, &c.

Under this head of Inflorescence may be explained Luxuriant Flowers, (commonly called *double-flowers*); which, as they are conſidered only as varieties and unnatural, belong properly to the head, Habit of plants. A luxuriant flower is ſuppoſed generally to be owing to ſuperabundant nouriſhment; the luxuriant part is generally the corolla, but ſometimes the calyx alſo. It is divided into three degrees: 1. *multiplicatus*; 2. *plenus*; 3. *prolifer*: To which may be added, as an oppoſite imperfection, *flos mutilatus*.

1. Multiplicatus, when the petals of the coralla are only ſo far multiplied as to exclude part of the ſtamina; and is called *duplicate*, *triplicate*, *quadruplicate*, &c. according to the number of rows of petals.

2. Plenus, when the corolla is ſo much multiplied, as to exclude all the ſtamina; which is occaſioned by the ſtamina turning petals and the flower is often ſo crowded as to exclude or choak the piſtillum alſo. Therefore, as the eſſential parts of generation are thus wholly, or in part deſtroyed, the plants become barren and imperfect, and no ſeed or very little can be expected from them. Flowers with one petal are not very ſubject to fulneſs; when they are, it generally ariſes from an increaſe of the diviſions of the petal. It is moſt uſual in flowers of many petals, where it ariſes various ways; ſometimes by multiplication of the petals only, ſometimes of the calyx or nectarium, and ſometimes of all. Compound flowers are alſo ſubject to luxuriance, ariſing ſeveral ways.

3. Prolifer, when one flower grows out of another; this generally happens in full flowers, from their greater luxuriancy. In ſimple flowers, it ariſes from the centre, and proceeds from the piſtillum ſhooting up into another flower, ſtanding on a ſingle footſtalk. In aggregate flowers, (properly ſo called), many footſtalked flowers are produced out of one common calyx. In umbellate flowers, a ſecond umbel proceeds from the centre of the firſt umbel, producing little umbels; which by a greater exertion of luxuriancy may produce others with little umbels, and thus may proceed ſeveral heads of flowers, each growing out of that immediately below it, furniſhed with little umbels variouſly compounded. A prolific flower is alſo called *leafy* (frondoſus, when it produceth branches with flowers and leaves, which, though rare, ſometimes happens in roſa, anemone, monarda, and others. [As in luxuriant flowers many parts of the natural character are deficient in the whole or in part, they can only be diſtinguiſhed by the general habit, and by ſuch parts as remain in the natural ſtate; as very often by the calyx, and in polypetalous flowers, the loweſt ſeries or rows of petals remain the ſame, as in roſa, papaver, nigella, &c.]

Flos mutilatus, in ſuch a flower as occaſionally is deprived of all, or the greateſt part, of the petals, yet bears ſeeds, as in ſome ſpecies of tuſſilago, campanula, &c. This term is oppoſed to luxuriance, and is ſuppoſed by Linnæus to be cauſed by a defect of heat, though it may alſo happen by other cauſes.

Under this head of flowers, may alſo be mentioned the different ſexes.

Flowers, in reſpect to Sex, are diſtinguiſhed into male, female

female, hermaphrodite, and neuter. Male flowers are such as have only the stamina or males, as in the classes monoecia, dioecia, and polygamia. Female flowers are such as have only the pistilla or females, as in the same classes monoecia, dioecia, and polygamia. Hermaphrodite flowers are such as have both the stamina and pistilla in the same flower, as in all the other classes: hermaphrodites are also distinguished into male hermaphrodites, when the female is ineffectual; and female hermaphrodites, when the male is ineffectual. Neuter flowers are such as have neither stamina nor pistilla perfect. The plants themselves also take a denomination from the sex of their flowers; as male plants are such as bear male flowers only; female plants are such as bear female flowers only; hermaphrodite plants are such as bear hermaphrodite flowers only. Androgynous (male and female) plants are such as bear both male and female flowers, distinct, upon the same root, as in the class monoecia. Polygamous plants are such as bear hermaphrodite flowers, and male or female flowers, or both distinct, on the same or on different roots: if on the same root, the flowers are either male hermaphrodites and female hermaphrodites; or hermaphrodites and male; or hermaphrodites and female, distinct; if on different roots, the flowers are either hermaphrodites and male; hermaphrodites and female; hermaphrodites and both male and female; or are androgynous and male; and sometimes androgynous and male and female on three distinct plants.

VII. The HABIT of plants, by which ancient botanists meant the whole external appearance of every part thereof, whereby they were arranged in their several systems; but by Linnæus it is meant to be the agreement of plants of the same genus or natural order; chiefly in the following circumstances.

Gemmation. The structure and disposition of the bulb, as solid, coated, scaly, stem-bulb. Also of the bud; its origin petioled, stipuled, cortical; its contents leafy, floral, common.

Vernation. The complication of the leaves within the bud, as conduplicate or doubled together; convolute or rolled together; involute or rolled in; revolute or rolled back; imbricated or tiled; equitant or riding; obvolute or rolled against each other; plaited or folded over; spiral or coiled like a watch-spring, one end in the centre.

Æstivation. The state of the bud in summer, as convolute, imbricated, conduplicate, valved, unequal-valved.

Tortion. The twisting or bending of the parts, as uniform, dissimilar, from the right, from the left, reciprocal, resupine, spiral.

Nuptials. Male, female, androgynous, hermaphrodite.

Semination. The shape and other circumstances of the seed, as tail, wing, tuft, awn, hooks, gluten, curvature. Also of the pericarpium; as berrying, inflation, viscosity, elasticity, structure.

Placentation. The number and disposition of the cotyledons; or if wanting.

Variation. Of colour, size, pubescence, age.

External: plaited, bundled, broad-leaved, curled, awnless.

Internal: mutilated, great-flowered, luxuriant, crested; viviparous, bulb-bearing.

By *variation* or *variety* are meant such differences as are only incidental to vegetables, and are not found constant and unchangeable; that is, where plants raised from the same seed, by some accidental cause differ in form and appearance, from the true character of the species to which they belong; which cause being removed, the plant is restord to its true specific character: and these incidental varieties chiefly arise by difference of soil or culture, in some of the above circumstances. And though it is as necessary to collect varieties under their proper species, as the species under their proper genera; yet it is often more difficult; first, from the difficulty of ascertaining the genus, and secondly, from the variety of confounding the species; and sometimes some parts of the specific character itself are also subject to variety, particularly the leaves; though in general the true specific character is constant and unchangeable, arising only from such circumstances wherein plants of the same genus are found to disagree, which distinctions are commonly taken with most certainty, from the following parts, (viz.) root, trunk, leaves, fulcra, hybernacle, inflorescence: all which parts have been already explained, except hybernacle.

The HYBERNACULUM, *(winter lodgement)*, is that part of a plant which defends the embryo or future shoot from external injuries during the winter; and, according to Linnæus, is either a bulb or a bud.

I. A BULB (bulbus), is a large sort of bud produced under ground, placed upon the caudex of certain herbaceous plants, hence called *bulbous* plants; all of which are perennial, that is, perpetuated by their bulbs or ground buds, as well as by seeds; they are therefore improperly called roots, being only the hybernacle of the future shoot. Bulbs are of the following sorts:

1. Squamous; consisting of scales laid over each other like tiles, as in the lily.

2. Solid; consisting of a close substance, as in tulips.

3. Coated; consisting of many coats infolding each other, as in onions.

4. Cauline; produced not only from the sides of the principal bulb called a *sucker* or *offset*, but from other parts of the stem; as in crow or wild garlic, and in some species of onion (hence called *bulbiferous*); where they are produced at the origin of the umbel of flowers.

II. A BUD *(gemma)*, is the embryo of the plant, seated upon the stem and branches, covered with scales. In general there are three sorts of buds:—That containing the flower only, as in poplar, ash, &c. where the leaf-buds and flower-buds are distinct: That containing the leaves only, as in birch, &c. and, That containing both flower and leaves, as in the generality of plants; and these last sometimes contain leaves and male flowers, sometimes leaves and female flowers, sometimes leaves and hermaphrodite flowers.

Annual plants are only renewed from seeds; and several other plants, both trees and shrubs, have no winter buds: It is also observed in hot countries, that few plants have buds; or at least they are without that scaly covering which seems essential to a bud, and constitutes the hybernacle, instead whereof are protruded small feather-like branches from the wings of the leaves, (defence and protection from cold not being necessary); whereas in cold countries most plants have buds, which are wrapped up all the winter, in readiness to greet the approaching spring.

Lastly, what is called the SLEEP of plants, according to Linnæus, happens various ways; as by converging, including, surrounding, fortifying, conduplicating, involving, diverging, depending, inverting, imbricating. This disposition in plants is very remarkable in chick-weed, pimpernel, dandelion, goats-beard, &c. which expand their flowers only at certain times of the day, and shut them up at the approach of night or a storm: which shews the great care nature takes to protect and invigorate her feeble offspring; and from hence may often be prognosticated a change of weather. In many plants, not only the flowers, but the young shoots, are defended from external injuries, by the nearest leaves converging and inclosing the tender rudiments.

The essence of every vegetable, says Linnæus, consists in the fructification (or mode of fruit bearing), and the essence of the fructification consists in the flower and fruit, the essence of the flower consists in the antheræ and stigma, and the essence of the fruit consists in the seed. Hence, in his sexual theory, he necessarily makes the flower and fruit the foundation of his generic distinctions. These are generally composed of seven parts; the CALYX, the COROLLA, the STAMINA, the PISTILLUM, the PERICARPIUM, the SEMINA, the RECEPTICULUM; and the presence or absence, the number, figure, proportion, and situation of the several parts, constitute the genus. But as there are few genera wherein all the parts of the *natural* character are constant in every one of the species, it is necessary to fix upon such circumstances as are constant in both genus and species, and call those the *essential* or ruling character, as well the more easily to distinguish one genus from another, as to regulate and fix the several species and their varieties to their respective genera; for which purpose, in some cases, Linnæus was obliged to have recourse to the *nectarium*, afterwards explained. The first four parts of the fructification are properly parts of the flower, and the last three are parts of the fruit.

I. The CALYX (*), a *cup*, is the termination of the outer bark *(cortex)* of a plant. Its chief use is to inclose, support, and protect the other parts of the fructification. When present, it is seated on the receptacle: and is distinguished by its figure; by the number, division, and shape of its leaves, or segments; and by the following names, according to the circumstances with which it is attended.

PERIANTHIUM, *(surrounding the flower)*, when its station is close to, and surrounds the other parts of the fructification, and is then called the *perianthium of the fructification:* If it includes many floscules, as in scabiosa, and other aggregate and compound flowers, it is called a *common perianthium:* if it includes only one floscule, in such flowers it is called a *proper perianthium:* if it includes the stamina, and not the germen, it is the perianthium of the *flower*, and is said to be *above*, as in lonicera, ribes, campanula, &c. if it includes the germen, but not the stamina, it is the perianthium of the *fruit*, and is said to be *below*, as in linnea and morina, each of which have two calyxes and two receptacles above each other, one of the flower and the other of the fruit, and may therefore serve as instances in both cases.

INVOLUCRUM, (a *cover*), when stationed at the foot of an umbel, below the common receptacle, and at a distance from the flower: it is called *universal*, if placed under the universal umbel: and *partial*, if placed under a partial umbel.

AMENTUM, (a *thong*), meaning *a catkin*, when it consists of a great number of chaffy scales, disposed along a slender axis or common receptacle, which, from its resemblance to a cat's tail, hath

(*) The calyx is considered a part of the flower, though it more generally attends, and is permanent with, the fruit, as in the class didynamia, and most other plants; yet sometimes it drops before or with the corolla, and before the fruit is ripe, as in the class tetradynamia, and many other plants. It is also considered a part of the flower, as there is no instance of its coming out after the plant has done flowering; yet in patagonula it is observed to grow to a much larger size in the fruit than it had in the flower: In some plants there is none, or scarcely perceptible; in others it is only a rim or border (margo). The germen is also considered a part of the flower, as being the base of the pistillum, though it afterwards becomes the seed-vessel.

hath obtained the name *catkin*; and these flowers have generally no petals: Sometimes the same amentum supports both male and female flowers, distinct, on the same plant, as in carpinus, &c. sometimes the male and female flowers are removed from each other on the same plants, and the amentum supports only the male flowers, and the female flowers are inclosed by a perianthium, as in corylus, juglans, fagus, &c. and sometimes an amentum only supports male flowers on one plant, and female flowers on another plant, as salix, populus, &c.

SPATHA, (a *sheath*), being a sort of calyx growing from the stalk, bursting lengthways, and protruding a spadix or *receptacle*, supporting one or more flowers, which have often no perianthium; and consists either of one leaf, with a valve or opening on one side only, as in narcissus, galanthus, and the greater number of spathaceous plants; or of two leaves, with two valves or openings, as in stratiotes, &c. or is imbricated, as in musa, &c. with one or two valves.

GLUMA, (a *husk*), this chiefly belongs to corn and grasses consisting of one, two, three, or more valves, folding over each other like scales, and frequently terminated by a long, stiff, pointed prickle, called the *arista* (beard or awn).

CALYPTRA, (a *veil* or *covering*), the proper calyx to mosses; it is placed over the antheræ of the stamina, resembling an extinguisher, a hood, or monk's cowl.

VOLVA, from its *enfolding* or *involving*, is the proper calyx to funguses, being membranaceous, and surrounding the stalk or pillar before their expansion.

[It is often difficult to distinguish the calyx from the bractæa, or floral leaves, which are found on many plants, situated on the flower stalks; and are often so near to the lower parts of the fructification, as to be confounded with, and mistaken for, the calyx, as in tilia, helleborus, passiflora, &c. (in helleborus the calyx is wanting): but they may be best distinguished by this rule; the floral leaves differ in shape and colour from the other leaves of the plant, but are commonly of the same duration; whereas the calyx always withers when the fruit is ripe, if not before].

II. The COROLLA, (a *wreath* or *little crown*), is the termination of the inner bark *(liber)* of the plant; which accompanies the fructification, in the form of leaves variously coloured: it is generally seated on the receptacle, sometimes on the calyx; serving as an inner work of defence to the part it incloses; as the calyx, which is usually of stronger texture, does for an outer work. The leaves of which the corolla are composed are called *petals*, by the number, division, and shape of which it is distinguished. It is said to be *below*, when it includes the germen, and is attached to the part immediately below it, as in salvia, borago, convolvulus, primula, &c. and it is said to be *above*, when it is placed above the germen, as in lonicera, ribes, cratægus, &c. In respect to duration, the corolla either continues till the fruit is ripe, as in nymphæa: or falls off at the first opening of the flower, as in actæa, thalictrum; or falls off with the stamina and other parts of the flower, as in most plants; or does not fall, but withers, as in campanula, cucumis, and others.

There is also a part which Linnæus says principally belongs to the corolla, as an appendage to the petals; which he calls the *nectarium* (from nectar the fabled drink of the gods); and is that part containing the honey, which is the principal food of bees and other insects. But, though in such plants where it is found, it may more commonly be attached to the corolla, and be then most evident; yet it is almost as often attached to other parts of the fructification: Linnæus therefore chiefly makes use of it as an essential character in many of the genera, as being less variable than his other distinctions; and observes, that when it is distinct from the petals, that is, not united with their substance, those plants are generally poisonous: The tube or lower part of monopetalous flowers, he considers as a true nectarium, because it contains a sweet liquor. But as it affords very singular varieties in other instances, it hath obtained the following distinctions.

1. CALYCINE NECTARIA, such as are situated upon, and make a part of, the calyx; as in tropæolum, monotropa, &c.

2. COROLLACEOUS NECTARIA, such as are attached to the corolla. These are called calcariate (from *calcar*), when they resemble a spur or horn: which are either on flowers of one petal, as invaleriana, antirrhinum, &c. or on flowers of many petals, as in orchis, delphinium, viola, fumaria, &c. Or the nectarium lies within the substance of the petals, as in fritillaria, lilium, berberis, iris, ranunculus, &c.

3. STAMINEOUS NECTARIA, such as attend the stamina, and are either seated upon the antheræ, as in adenanthera; or upon the filaments, as in laurus, dictamnus, campanula, &c.

4. PISTILLACEOUS NECTARIA, such as accompany the pistillum, and are placed upon the germen, as in hyacinthus, butomus, cheiranthus, hesperis, &c.

5. RECEPTACULACEOUS NECTARIA, such as join to the receptacle, as in polygonum, sedum, sempervivum, &c.

6. NECTARIA, that crown the corolla, that is, when placed in a series or row within the petals, though entirely unconnected with their substance, as in passiflora, lychnis, silene, &c. and in this situation it often resembles a cup, as in narcissus, &c.

7. NECTARIA, of singular construction, being such as cannot properly be placed under any of the foregoing distinctions, as in amomum, circuma, salix, utrica, &c.

The proper use of the nectarium, and why it should have such very different situations, is not yet known: but as it is found in most plants, there is great reason to believe it an essential part in the fructification, though not always perceptible.

III. The STAMINA, *(threads* or *chives)*; the males of the flower, proceeding from the wood of the plant, each stamen consisting of two parts, viz. the filament and the antheræ. in most flowers they are placed upon the receptacle, within the corolla, and round the germen; and are chiefly distinguished by number.

The FILAMENT (from *filum*, a thread), is the thread-shaped part of the stamen, serving as a footstalk to elevate the antheræ, and is sometimes found to have jags or divisions *(laciniæ)*: which are either two, as in salvia; three, as in fumaria; or nine, as in the class Diadelphia. They are also distinguished by their form or figure, as awl-shaped, thread-shaped, hair-like, spiral, revolute, &c. by their proportion, as equal, unequal, irregular, long, or short: and by their situation, being generally opposite to the leaves or divisions of the calyx. and alternate with the petals; that is, when the divisions of the calyx are equal in number to the petals, and to the stamina. In monopetalous flowers they are generally inserted into the corolla; but scarcely ever in flowers of more than one petal, but into the receptacle: yet in the class Icosandria they are inserted into the calyx or corolla (though the flowers have many petals), as also in a few other plants. But in the class Polyandria, and most other polypetalous plants, they are inserted into the receptacle, like the calyx and corolla. The class Gynandria, however, is an exception to the above rules, where the stamina are placed upon the pistillum, or female part of the flower; and are sometimes without filaments.

The ANTHERA (from *anthos*, a flower), emphatically so called from its great utility in the fructification, is the top or summit of the filament, containing the impregnating pollen or farina; and is either one to each filament, as in most plants; or one common to three filaments, as in cucurbita, &c. or one common to five filaments, as in the whole class Syngenesia: or sometimes there are two antheræ to each filament, as in ranunculus, and mercurialis; three to each filament, as in fumaria; five to three filaments, as in bryonia; or five to each filament, as in theobroma. The anthera is also distinguished by its form or figure, as oblong, round, angular, &c. It also consists of one or more cells, which burst differently in different plants; either on the side as in most plants; on the top; or from the top to the base. It is also fastened to the top of the filament, either by its base, as in most plants, or horizontally by its middle, to the top of the filament, so poised as to turn like a vane *(versatilis)*; or it is fixed by its side, leaning to the top of the filament, then called incumbent: or it sometimes grows to the nectarium, as in costus; to the receptacle, as in arum; to the pistillum, as in the class Gynandria.

IV. The PISTILLUM, or the female of the flower, proceeding from the pith of the plant. It is that erect column which is generally placed in the centre of the flower, amidst the stamina; and consists of three parts, the germen, the style, and the stigma.

1. GERMEN (a *bud*), is the base of the pistillum, supporting the style. After a process of nature, it becomes a seed-vessel, and may therefore be considered as the rudiment of the pericarpium. It is distinguished by its shape, number, and situation; and is said to be *above* or *below*, according to its situation above or below the attachment of the corolla.

2. The STYLE (from *stylus*, a pillar), is that part which elevates the stigma from the germen, in order to receive the influence of the stamina, and to convey the effect down to the germen as through a tube. It is distinguished either by its number, which, when present (or when absent, the number of stigmata), gives rise to most of the orders, and are called so many females; or by its divisions *(laciniæ)*, being double, treble, or quadruple, &c. though jointed at the base; or by its length, being longer, shorter, or equal with the stamina; or by its proportion, being thicker or thinner than the stamina; or by its figure, being angular, cylindric, awl-shaped, bent, &c. or by its situation, being generally on the top of the germen, though in some instances supposed to be both above and below, as in capparis and euphorbia; unless the lower part in these genera be considered as the extension of the receptacle: it is also often placed on the side of the germen, as in hurtella, suriana; also in rosa, rubus, and the rest of the plants in the class and order Icosandria polygynia. With respect to duration, it generally falls with the other parts of the flower; but in some plants is premanent, and attends the fruit to its maturity, as in the class tetradynamia. In flowers which have no style, the stigma adheres to the germen.

3. The STIGMA (a *mark*), when single, is generally placed like

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like a head on the ſummit of the ſtyle; when ſeveral, they are either placed on the top, or regularly diſpoſed along the ſide; and covered with a moiſture, to retain the pollen of the antheræ. It is diſtinguiſhed either by its number, being ſingle in moſt plants; by its diviſions; by its figure or ſhape; by its length; by its thickneſs; and by its duration, as in moſt plants it withers when the germen is become a ſeed-veſſel; in ſome it is permanent, as in papaver.

V. The PERICARPIUM, *(round the fruit)*; the germen grown to maturity, and now become a matrix or ſeed-veſſel. All plants, however, are not furniſhed with a ſeed-veſſel, as in corylus, &c. In many, it is ſupplied chiefly by the calyx, which converging incloſes the ſeeds till they arrive at maturity; as is the caſe with the rough-leaved plants, and the labial and compound flowers of the ſeveral claſſes Pentandria, Didynamia, and Syngeneſia. Sometimes the receptacle ſupplies the office of ſeed-veſſel, as in gundelia; and ſometimes the nectarium, as in carex. The pericarpium is ſituated at the receptacle of the flower, either above or below, or both, as in ſaxifraga and lobelia; and is diſtinguiſhed by the following appellations, according to its different ſtructure.

1. CAPSULA (a *little cheſt* or *caſket*), which is frequently ſucculent while green; but when ripe, it is a dry huſky ſeed-veſſel, that cleaves or parts in ſome determinate manner to diſcharge its contents; and by ſome ſort of elaſtic motion the ſeeds are often darted forth with conſiderable velocity, as in dictamnus, &c. It opens alſo various ways; either at the top, as in moſt plants; at the bottom; at the ſide; horizontally acroſs the middle; or longitudinally; and if it is articulated or jointed, it opens at each of the joints, which contains a ſingle ſeed. It is further diſtinguiſhed externally, by its number of valves; and internally, by the number of its cells or diviſions, wherein the ſeed is incloſed; as alſo by its ſhape and ſubſtance.

2. SILIQUA (a *pod*), which is a pericarpium of two valves; but as ſome are long, others round or broad, Linnæus thought it neceſſary to diſtinguiſh them by their form into *ſiliqua* and *ſilicula*; which gives riſe to the two orders in the claſs Tetradynamia. The *ſiliqua* means a long pod, being much longer than broad, as in braſſica, ſinapis, &c. the *ſilicula* (a little ſiliqua), is a roundiſh pod, either flat or ſpherical, and the length and breadth nearly equal, as in lunaria, draba, thlaſpi, &c. In both the apex, which had been the ſtyle, is often ſo long beyond the valves, as to be of equal length with the pod; and the ſeeds in both are faſtened alternately by a ſlender thread, to both the ſutures or joinings of the valves.

3. LEGUMEN *(pulſe)*, is alſo a pod, and is likewiſe a pericarpium of two valves, wherein the ſeeds are faſtened to ſhort receptacles along the upper ſuture only, on each ſide, alternately: this chiefly belongs to the papilionaceous or butterfly flowers of the claſs Diadelphia.

4. FOLLICULUS (a *little bag*, in former editions called *conceptaculum*), is a pericarpium of one valve only, opening lengthwiſe on one ſide, and the ſeeds not faſtened to the ſuture, but to a receptacle within the fruit, as in apocynum, aſclepias, &c.

5. DRUPA (from *drupæ*, unripe olives), is a pericarpium that is ſucculent, or pulpy, having no valve or external opening. It contains within its ſubſtance a ſtone or nut; that is, a ſeed incloſed with an hard ligneous cruſt, as olea, cornus, juglans, prunus, amygdalus, &c. and when the drupa is ſeated below the calyx, it is furniſhed with an umbilicus like the pomum.

6. POMUM (an *apple*), is alſo a pericarpium that is ſucculent or pulpy, and without valve; but containing in the middle a membranous capſule, with ſeveral cells or cavities containing the ſeeds; and at the end oppoſite to the footſtalk there is generally a ſmall cavity called *umbilicus* (the navel), from its reſemblance to that part in animals, and which was formerly the calyx, ſeated above the fruit, and perſiſtent, as in pyrus, cucumis, cucurbita, &c.

7. BACCA (a *berry*), is alſo a pulpy pericarpium without valve, incloſing one or more ſeeds, which have no membranous capſule or covering, but are diſpoſed promiſcuouſly through the pulp, as in ſolanum, &c. and are generally placed on footſtalks attached to receptacles within the pulp, as in ribes, &c. The berry alſo admits of the following diſtinction: It is ſaid to be *proper*, when it is a true pericarpium formed of a germen; and *improper*, when it is formed from other parts of the fructification; as in morus, roſa, juniperus, taxus, &c. A large ſucculent calyx becomes a berry; and in juniperus the three petals become the umbilicus; in poterium the berry is formed of the tube of the corolla; in fragaria, &c. it is formed of the top of the receptacle; in rubus, &c. it is formed from a ſeed, which is the receptacle of the berry; in ruſcus, &c. it is incloſed within and is a part of the nectary. The berry is commonly either round or oval, and is frequently furniſhed with an umbilicus, as in ribes, &c. It does not naturally open to diſperſe the ſeeds like the capſule, that office being performed by birds and other animals.

8. STROBILUS (a *cone*), is a pericarpium formed of an amentum, being a ſeed-veſſel compoſed of woody ſcales placed againſt each other in the form of a cone, opening only at the top of the ſcales, being firmly fixed below to a kind of axis or receptacle, occupying the middle of the cone; as in pinus, thuya, cupreſſus, &c.

VI. SEMINA (the *ſeeds*). A *ſeed* is the eſſence of the fruit of every vegetable; and is defined by Linnæus to be "a deciduous part of the plant, containing the rudiments of a new vegetable, fertilized by the ſprinkling of the pollen;" and they are diſtinguiſhed according to number, ſhape, texture, appendage, &c. A ſeed, properly ſo called, conſiſts of the five following parts; to which is added the nux and propago.

1. The CORCULUM (from *cor*, a heart), is the eſſence of the ſeed, and principal of the future plant; and conſiſts of two parts, viz. plumula and roſtellum. *Plumula* is the ſcaly part and eſſence of the corculum, which aſcends and becomes the ſtem or trunk of the plant: it extends itſelf into the cavity of the lobes or cotyledons, and is terminated by a ſmall ſort of branch reſembling a feather. *Roſtellum* is the plain or ſimple part of the corculum, which deſcends into the earth, and becomes the root: its form is that of a ſmall beak, placed without the lobes, and adhering internally to the plumula.

2. The COTYLEDONS (from *cotyledon*, the hollow of the huckle-bone), are the thick porous ſide-lobes of the ſeed, conſiſting of farinaceous matter, and which involve and for ſome time furniſh nouriſhment to the embryo plant, but wither and die away when it becomes ſtrong. If a plant be cut below the cotyledons, it will ſcarce ever put out freſh leaves, but withers and decays; if it is cut above the cotyledons, it generally ſhoots out afreſh, and continues to grow: Therefore, if plants whoſe cotyledons riſe above ground, as turnips, &c. be cut or eat to the ground by cattle, they decay; but where the cotyledons remain below ground, as in graſſes, and are cut or eat to the ground, they will ſhoot out afreſh. The cotyledons are alſo called the *ſeminal* or *ſeed* leaves; ſome plants have only one, as in graſſes and in cuſcuta, &c. others two, as in vicia, &c. linum hath four; cupreſſes hath five; and pinus, Linnæus ſaith, hath ten. The cotyledons in muſhrooms, ferns, and moſſes, are not ſufficiently aſcertained to know if they have any.

3. The HILUM (the black ſpot on a bean, called the *eye*), is the external mark or ſcar on the ſeed, where it was faſtened within the pericarpium.

4. The ARILLUS, a term uſed to expreſs the proper exterior coat or covering of the ſeed; which falls off ſpontaneouſly, and is either cartillaginous or ſucculent: yet ſeeds are ſaid to be *naked*, when not incloſed in any ſort of pericarpium, as in the claſs and order didynamia gymnoſpermia.

5. The CORONULA, is either a little ſort of calyx adhering to the top of the ſeed, like a little crown, and aſſiſting to diſperſe it by flying, as in ſcabioſa, knautia, &c. where the little calyx of the floret becomes the crown of the ſeed: Or a down; which is either feathery, as in valeriana, leontodon, gnaphalium, &c. or is hairy, as in tuſſilago, ſenecio, hieracium, &c. [This down has generally been thought intended to diſperſe the ſeeds; yet as it frequently breaks off when thoſe have flown to ſome diſtance, and is ſeen flying alone, ſome have imagined that the down is only intended as a defence of the ſeed till arrived at maturity.] The coronula is alſo either ſitting *(ſeſſilis)*, that is, attached cloſe to the ſeed, as in hieracium, &c. or footſtalked *(ſtipitatus)*, by a thread elevating and connecting the crown or tuft with the ſeed, as in lactuca, crepis, &c. Some ſeeds are alſo furniſhed with a wing, a tail, a hook, an awn, &c. all coming under the term *coronula*, and tending either to diſperſe or fix the ſeveral ſeeds to which they belong. Some ſeeds are alſo furniſhed with an elaſtic force in order to diſperſe them; which is either in the calyx, as in oats and ſome others; in the pappus, as in centaurea-crupina; or in the capſule, as in geranium, fraxinella, ſpurting cucumber, &c. Other ſeeds, eſpecially thoſe whoſe pericarpium is a berry, as alſo the nutmeg and other nuts, are diſperſed by birds and other animals.

NUX *(Nut)*, a ſeed incloſed in a hard woody ſubſtance, called the *ſhell*, which is one-celled, two celled, &c. and the incloſed ſeed is called the *kernel*.

PROPAGO. The ſeed of a moſs, not coming under the above deſcription, Linnæus calls *Propago* (a *ſlip* or *ſhoot*); which hath neither coat nor cotyledon, but conſiſts only of a naked plumula where the roſtellum is inſerted into the calyx of the plant.

VII. The RECEPTACULUM is the baſe which receives, ſupports, and connects the other parts of the fructification; but it is only mentioned by Linnæus (in his *Gen. Pl.*) when it can be introduced as a character varying in ſhape and ſurface, as principally in the claſs Syngeneſia. It hath the following diſtinctions.

PROPER, when it ſupports the parts of a ſingle fructification only: when it is a baſe to which only the parts of the flower are joined, and not the germen, it is called a *receptacle of the flower*; in which caſe, the germen being placed below the receptacle of the flower, hath a proper baſe of its own, which is called the *receptacle of the fruit*: and it is called a *receptacle of the ſeeds*, when it is a baſe to which the ſeeds are faſtened within the pericarpium. In ſome ſimple flowers, where the germen is placed above the receptacle of the flower, the fruit hath a ſeparate

receptacle,

receptacle, as in magnolia, uvaria, &c. in which genera the numerous germina are ſeated upon a receptacle riſing like a pillar above the receptacle of the fructification.

COMMON, when it ſupports and connects a head of flowers in common; as in the amentum, and other aggregate flowers.

UMBELLA, which Linnæus calls a *receptacle*. See aggregate flowers, under the head of INFLORESCENCE above.

CYMA (a *ſprout*), is alſo called a *receptacle*. *Ibid.*

RACHIS (the *back-bone*); a filiform receptacle, collecting the florets longitudinally into a ſpike, in many of the glumoſe flowers, as wheat, barley, rye, &c.

SPADIX, anciently only ſignified the receptacle of a palm (*phœnix*) iſſuing out of a ſpatha, and branched; but now every flower-ſtalk that is protruded from a calyx called *ſpatha*, is denominated a *ſpadix*, as in narciſſus, &c.

When all theſe parts are underſtood, the genus may be eaſily inveſtigated. But in order ſtill further to aſſiſt the young botaniſt, we ſhall give a ſyſtematic deſcription of a few common plants belonging to different claſſes. [*The numbers refer to the figures in the preceding Explanation of the Plates.*]

DIANDRIA MONOGYNIA.

VERONICA, or SPEEDWELL.

The CALYX is a perianthium (fig. 149) divided into four parts or ſegments, and perſiſtent (*i. e.* does not fall off till the ſeeds are ripe); the ſegments are ſharp and lance-ſhaped.

The COROLLA (fig. 142) conſiſts of one rotated petal; the *tubus* (fig. 142) is about the ſame length with the calyx; the *limbus* (fig. 142) is plain, and divided into four oval ſegments, the loweſt of which is narrower than the reſt, and the one immediately oppoſite broader.

The STAMINA (fig. 143) are two, narrower below, and inclined upwards; the antheræ (fig. 143) are oblong.

The PISTILLUM (fig. 143) has a compreſſed germen (fig. 143), a filiform or thread-like ſtylus (fig. 143), about the ſame length with the ſtamina, and a little declined to one ſide: the ſtigma (fig. 143) is ſimple.

The PERICARPIUM (fig. 143) is a heart-ſhaped capſule, compreſſed at the top, and having two cells or partitions, and four valves.

The SEEDS are roundiſh and numerous.

ICOSANDRIA POLYGAMIA.

FRAGARIA, or STRAWBERRY.

The CALYX is a perianthium conſiſting of one plain leaf, divided into ten ſegments, each alternately narrower.

The COROLLA has five roundiſh open petals inſerted into the calyx.

The STAMINA are twenty in number, ſubulated or tapering, ſhorter than the corolla, and inſerted into the calyx. The antheræ are lunulated, or ſhaped like a creſcent.

The PISTILLUM conſiſts of many ſmall germina collected into a little head or knob. The ſtyli are ſimple, and inſerted into the ſides of their reſpective germina. The ſtigmata are ſimple.

The PERICARPIUM is wanting in this plant. But the common receptacle of the ſeeds which ſupplies the place of a pericarpium, is a roundiſh oval berry, plain at the baſe, pretty large, ſoft, pulpy, coloured, and deciduous, *i. e.* falls off before the ſeeds be ripe.

The SEEDS are ſmall, pointed, very numerous, and diſperſed through the ſuperficial part of the receptacle.

MONODELPHIA POLYANDRIA.

MALVA, or COMMON MALLOW.

The CALYX is a double perianthium: the exterior one conſiſts of three lanceolated, looſe, perſiſtent leaves; the interior has but one large, broad, perſiſtent leaf, divided into five ſegments.

The COROLLA has five plain leaves united at the baſe, heart-ſhaped, and premorſe, (fig. 18.)

The STAMINA conſiſt of numerous filaments, united into a cylindrical form below, looſe above, and inſerted into the corolla: the antheræ are kidney-ſhaped.

The PISTILLUM has an orbicular germen, a cylindrical ſhort ſtylus, and many briſtly ſtigmata of an equal length with the ſtylus.

The PERICARPIUM conſiſts of ſeveral diſtinct capſules joined by an articulation, reſembling a depreſſed globe, and opening from within when ripe: the receptaculum is a kind of column binding the capſules together.

The SEEDS are ſolitary and kidney-ſhaped.

GYNANDRIA PENTANDRIA.

PASSIFLORA, or PASSION-FLOWER.

The CALYX is a perianthium conſiſting of five plain coloured leaves, ſimilar to thoſe of the corolla.

The COROLLA conſiſts of five plain obtuſe ſemi-lanceolated leaves, of the ſame magnitude and figure with thoſe of the calyx.

The *nectarium* is a triple corona, the exterior of which is longeſt, ſurrounding the ſtylus within the petals, and ſtraitened above.

The STAMINA are five, ſubulated, open, and connected to the ſtylus at the baſe of the germen: the antheræ are oblong, obtuſe, and incumbent.

The PISTILLUM conſiſts of an erect cylindrical ſtylus, upon the top of which an oval germen is placed: the ſtyli are three, thicker and wider above: the ſtigmata are roundiſh knobs.

The PERICARPIUM is a fleſhy, ſuboval, one-celled berry, reſting upon the ſtylus.

The SEEDS are numerous, oval, and each of them incloſed in a ſmall membrane.

We ſhall here ſubjoin a complete deſcription of plants, reduced to their claſſes, orders, genera, and ſpecies, referring to the figures neceſſary for their explanation.

The genera include a great number of relative ſpecies diſtinguiſhed by the ſpecific difference of the root, the trunk, the branches, the leaves, &c. (yet all agreeing in the eſſential generic character); and are called by trivial names (expreſſive of the difference or ſome other circumſtance) added to the generic name. In order to inveſtigate the ſpecies, therefore, it is neceſſary to underſtand thoſe differences, and be acquainted with the names by which they are expreſſed. Several of theſe have been already incidentally explained; but for a complete enumeration, the reader muſt have recourſe to the preceding nomenclature. And to illuſtrate the manner in which thoſe terms are uſed, we ſhall here give a few examples; referring, by numbers, to the figures on the plates.

Claſs II. DIANDRIA.
Order, MONOGYNIA.
Genus, VERONICA, or SPEEDWELL.
Species, Veronica *arvenſis*, has ſolitary flowers; cut, ſeſſile, (fig. 94), and cordated, (fig. 10), leaves.
Veronica *agreſtis*, has ſolitary flowers; cut, cordated (fig. 10), and petiolated (fig. 93) leaves.

Claſs XVI. MONODELPHIA.
Order, POLYGYNIA.
Genus, MALVA, or MALLOW.
Species, Malva *ſpicata*, has tomentoſe (fig. 48), crenated (fig. 38), and cordated (fig. 10), leaves, and oblong hairy ſpicæ (fig. 165).
Malva *ſylveſtris*, has an erect (fig83) herbaceous ſtalk (fig. 112) with acute (fig. 42) ſeven-lobed (fig. 37) leaves, and hairy pedunculi and petioled (fig. 93).

Claſs XIX. SYNGENESIA.
Order, POLYGAMIA ÆQUALIS.
Genus, CARDUUS, or THISTLE.
Species, Carduus *helenioides*, or *melancholy thiſtle*, has lanceolated (fig. 6), teethed (fig. 30), amplexicaul (fig. 96) leaves; with unequal, ciliated (fig. 50) ſmall ſpines (fig. 121).

To theſe examples we ſhall add a deſcription of a plant, according to the natural character, from the Genera Plantarum; and according to the eſſential character, with the ſeveral ſpecies, from the Syſtema Vegetabilium, as tranſlated by the Litchfield Society.

PAPAVER.—POPPY.

Natural Character.

CALYX. A perianthium two-leaved, ovate, end-necked; *leaflets* ſubovate, concave, obtuſe, deciduous.

COROLLA. Petals four, roundiſh, flat, expanding, large, narrower at the baſe, leſs alternately.

STAMINA. Filaments numerous, capillary, much ſhorter than the corolla: *antheræ* oblong, compreſſed, erect, obtuſe.

PISTILLUM. Germ, roundiſh, large; *ſtylus* none; *ſtigma* pellated, flat, radiated.

PERICARPIUM. A capſule crown'd with the large flat ſtigma, unilocular, ſemi-multi-unilocular, gaping at the top under the crown with many apertures.

SEMINA. Seeds, numerous, very ſmall; *receptacles*, longitudinal folds, of equal number with the rays of the ſtigma adhering to the ſides of the pericarpium.

Eſſential Character.

PAPAVER. *Corolla* four-petalled, *calyx* two-leaved, *capſule* one-celled, gaping with pores under the permanent ſtigma. *Poppy. With hiſpid capſules.*

1 P. HYBRYDUM. Capſules ſubglobular, brawny, hiſpid, ſtem leafy, many flowered. *Mule.*

2 P. AROEMONE. Capſules clubbed, hiſpid, ſtem leafy, many-flowered.

3 P. ALPINUM. Capſules hiſpid, ſcape one-flowered, naked, hiſpid, leaves twice-feathered. *Alpine.*

4 P. NUDICAULE. Capſules hiſpid, ſcape one-flowered, naked hiſpid, leaves ſimple, feather ſinuous. *With ſmooth capſules.* *Naked ſtem.*

5 P. RHOEAS. Capſules ſmooth, globular, ſtem hairy, many-flowered, leaves feather-cleft, gaſhed.

6 P. DUBIUM. Capſules oblong, ſmooth, ſtem many-flowered, with briſtles appreſſed, leaves feather-cleft, gaſhed. *Dubious.*

7 P. SOMNIFERUM. Calyxes and capſules ſmooth, leaves ſtem-claſping, gaſhed. *Somniferous.*

8 P. CAMBRICUM. Capſules ſmooth, oblong, ſtem many-flowered, poliſhed, leaves feathered, gaſhed.

9 P. ORIENTALE. Capſules ſmooth, ſtem one-flowered, rugged, leafy, leaves feathered, ſawed. *Oriental.*

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SECTION III.
Of the SEXES of PLANTS.

As many philoſophers and botaniſts deny that ſuch a thing as the diſtinction of ſexes takes place in vegetables, it will be neceſſary to give a narration of the arguments employed by both parties on this ſubject. We ſhall begin with the arguments in favour of the ſexes.

I. Linnæus is at great pains in tracing the notion of the ſexes of plants to the remoteſt periods of antiquity. He informs us, that Empedocles, Anaxagoras, and other ancient philoſophers, not only attributed the diſtinction of ſexes to plants, but maintained that they were capable of perceiving pleaſure and pain.

Hippocrates and Theophraſtus are next introduced as diſtinguiſhing the conyza, the abies, the filix, &c. into male and female. The latter of theſe writers affirms that the fruit of the male palm will not germinate, unleſs the pollen of the male be ſhaken over the ſpatha of the female previous to the ripening of the ſeed.

Dioſcorides takes notice of a male and female mandragora, mercurialis, ciſtus, &c.

Pliny does not confine his views of ſex to animals, but exclaims that every thing this earth produces is characterized by the diſtinction of ſex.

From the days of Pliny to thoſe of Cæſalpinus, who lived in the 16th century, the analogy between the vegetable and animal ſeems to have been entirely neglected, Cæſalpinus tells us that the males of the oxycedrus, taxus mercurialis, urtica, and canabis, are barren; and that the females of theſe plants only bear fruit.

After Cæſalpinus, we find Dr. Grew and Sir Thomas Millington engaged in a converſation concerning the utility of the ſtamina and ſtyli of plants. The reſult of this converſation was the mutual agreement of theſe two eminent naturaliſts, that the ſtamina and ſtyli of vegetables were analogous to the organs of generation in animals, and that they were adapted by nature to anſwer the ſame purpoſes. Dr. Grew, in his anatomy of plants, after enumerating the analogies between plants and animals, concludes, that the pollen probably emits certain *vivific* effluvia, which may ſerve for the impregnation of the ſeeds.

Mr. Ray gave a further ſanction to the doctrine of ſexes, by concurring with Grew, and adding ſome further illuſtrations from analogy.

In the year 1695, Camerarius attempted to prove the ſexes of plants. But, as he truſted ſolely to the palm-tree, and withal ſeemed to be doubtful as to the authenticity of the fact, he cannot be conſidered as having done any thing in confirmation of the ſexual hypotheſis.

Mr. Morland, in the year 1703, adopted the ſame hypotheſis; but gave it a new modification, by ſuppoſing that the pollen contained the ſeminal plant in miniature, and conſequently that it behoved one pollen at leaſt to be conveyed into every ſeparate ſeed before it could be properly impregnated. Analogy and the ſtructure of the parts are the only arguments he employs.

Some years after this, Mr. Geoffroy wrote a treatiſe on the ſexes of plants: but as he advanced nothing new, we ſhall take no further notice of him.

Vaillant, in the year 1717, judiciouſly conſidering that the canal in the ſtylus of moſt plants was too narrow to admit the pollen itſelf, republiſhed Dr. Grew's theory of impregnation by means of a ſubtile ſeminal aura.

Theſe are the ſentiments of the principal botaniſts with regard to the generation of plants, till the celebrated Linnæus made his appearance as a botanical writer, who has extended the idea ſo far as to compoſe a complete ſyſtem upon it.

Although Linnæus can have no claim to the ſuppoſed diſcovery of the ſexual hypotheſis, his being preciſely the ſame with that of Dr. Grew; yet, as he is the chief ſupporter and improver of this doctrine, we ſhall give a ſuccinct narration of the arguments he makes uſe of, in order to prove that vegetables propagate their ſpecies by a regular commerce of ſexes.

In a treatiſe entitled, *Sponſalia Plantarum*, publiſhed as an inaugural diſſertation by Wahlbom, in the firſt volume of the *Amœnitates Academicæ*, all the arguments made uſe of by Linnæus in his *Fundamenta Botanica*, and other works, are collected and arranged in one view. But as Wahlbom honeſtly attributes all the merit of this diſſertation to his great maſter, we ſhall here drop his name altogether, and give the arguments as the property of Linnæus, by whom they were originally employed.

Linnæus, then, firſt attempts to ſhow, that vegetables are endowed with a certain degree of life; and, ſecondly, that they propagate their ſpecies in a manner ſimilar to that of animals.

"That vegetables are really living beings (ſays he), muſt be obvious at firſt ſight; becauſe they poſſeſs all the properties contained in that accurate definition of life laid down by the great Dr. Harvey, namely, *Vita eſt ſpontanea propulſio humorum*. But univerſal experience teaches, that vegetables propel humours or juices: hence it is plain that vegetables muſt be endowed with a certain degree of life."

Not truſting ſolely to a ſyllogiſm founded on a definition, Linnæus proceeds to ſupport the life of vegetables by arguments drawn from the following particulars in their œconomy; the firſt of which he intitles,

"1. *Nutritio*.—The very idea of nutrition implies a propulſion of humours, and of courſe the idea of life. But vegetables derive their nouriſhment from the earth, air, &c. and conſequently muſt be conſidered as living creatures.

"2. *Etas*.—Every animal muſt not only begin to exiſt, and have that exiſtence diſſolved by death, but muſt likewiſe paſs through a number of intermediate changes in its appearance and affections. *Infancy*, *youth*, *manhood*, *old age*, are characteriſed by *imbecility*, *beauty*, *fertility*, *dotage*. Are not all theſe viciſſitudes conſpicuous in the vegetable world? Weak and tender in *infancy*; beautiful and ſalacious in *youth*; grave, robuſt, and fruitful in *manhood*; and when *old age* approaches, the head droops, the ſprings of life dry up, and, in fine, the poor tottering vegetable returns to that *duſt* from whence it ſprung.

"3. *Motus*.—No inanimate body is capable of ſelf-motion. Whatever moves ſpontaneouſly, is endowed with a living principle: for motion depends on the ſpontaneous propulſion of humours; and wherever there is a ſpontaneous propulſion of humours, there alſo is life. That vegetables are capable of motion, is evident from the following facts: plants, when confined within doors, always bend towards the light, and ſome of them even attempt to make their eſcape by the windows. The flowers of many plants, eſpecially thoſe of the Syngeneſia claſs, purſue the ſun from eaſt to weſt, rejoicing in his beams. Who then can deny that vegetables are poſſeſſed of living and ſelf-moving powers?

"4. *Morbus*.—The term *diſeaſe* means nothing more than a certain corruption of life. It is well known, that vegetables are ſubject to diſeaſes as well as animals: when over-heated, they turn thirſty, languiſh, and fall to the ground: when too cold, they are tormented with the chilblain, and not unfrequently *expire*: they are ſometimes afflicted with cancers; and every plant is infeſted with lice peculiar to its ſpecies.

"5. *Mors*.—Death is oppoſed to life, the former being only a privation of the latter. Experience ſhows, that every living creature muſt die. But as vegetables are daily cut off by internal diſeaſes and external injuries; as they are ſubject to death from the attacks of hunger, thirſt, heat, cold, &c. with what propriety could vegetables be thus ſaid to *die*, unleſs we allow that they previouſly *lived*?

"6. *Anatomia*.—Under this article we are referred to Malpighius and Grew for the organic fibres, membranes, canals, veſicles, &c. of plants, as additional proofs of their living powers.

"7. *Organizatio*.—Vegetables not only propel humours, but alſo prepare and ſecrete a number of different juices for the fruit, the nectar, &c. analogous to the various ſecretions in animal bodies."

From theſe facts and obſervations, Linnæus concludes, that plants are unqueſtionably endowed with life as well as animals; and then proceeds in the following manner to ſhow how theſe animated vegetables propagate their ſpecies.

After diſcuſſing the long exploded doctrine of equivocal generation, he lays hold of another maxim of Dr. Harvey, viz. *Omne vivum ex ovo*.—"It being fully evident (ſays he), from the foregoing chain of reaſoning, that vegetables are endowed with life, it neceſſarily follows, agreeable to this maxim of Harvey's, that every vegetable muſt in like manner derive its exiſtence from an *egg*. But as vegetables proceed from eggs, and as it is the diſtinguiſhing property of an egg to give birth to a being ſimilar to that which produced it, the ſeeds muſt of courſe be the *eggs* of vegetables.

"Granting then that the ſeeds of vegetables are intended by nature to anſwer the ſame end as the eggs of animals, and conſidering at the ſame time that no egg can be fecundated without receiving an impregnation from the male, it follows, that the ſeed or eggs of vegetables cannot be fecundated by any other means. Hence alſo the neceſſity of vegetables being provided with organs of generation. But where are theſe organs ſituated? The anſwer is eaſy.—We have already found impregnated ſeeds within the flowers of plants; and it is natural to expect that the *genitalia* ſhould not be at a greater diſtance. Now, as *copulation* always precedes *birth*, and every *flower* precedes the *fruit*, the *generating faculty* muſt be aſcribed to the *flower*, and the *birth* to the *fruit*. Again, as the *antheræ* and *ſtigmata* are the only eſſential parts of flowers, theſe parts muſt neceſſarily be the *organs of generation*."

Being thus far advanced, Linnæus affirms, that the *antheræ* are the *teſtes*, and that the pollen performs the office of the male *ſemen*. Theſe affirmations he attempts to eſtabliſh by the following arguments; the firſt of which he terms,

"1. *Præcedentia*.—The antheræ, or vegetable teſtes, always precede the fruit; and as ſoon as the antheræ come to maturity, which conſtantly happens before the maturity of the fruit, they continue to throw out their pollen as long as the flower laſts; but decay and fall off whenever the fruit comes to perfection.

"2. *Situs*.—The antheræ of all plants are uniformly ſituated in ſuch a manner that the pollen may with the greateſt facility fall upon the ſtigma or female organ.

"3. *Tem-*

" 3. *Tempus.*—The antheræ and ſtigmata always flouriſh at the ſame time, whether the flowers be of the hermaphrodite or dioicous kind.

" 4. *Localumenta.*—When the antheræ are diſſected, they diſcover as great a variety or ſtructure as the pericarpia or ſeed capſules: for ſome of them have one cell, as the mercury; ſome two, as the hellebore, &c.

" 5. *Caſtratio.*—If all the antheræ be cut off from an hermaphrodite plant, juſt before the flowers begin to expand, taking care at the ſame time that no plant of the ſame ſpecies grow near it, the fruit will either prove entirely abortive, or produce barren ſeeds.

" 6. *Figura.*—When the pollen of different plants is examined by the microſcope, it exhibits as great a variety of figures as is diſcoverable in the ſeeds themſelves.

" The accumulated force of theſe arguments (concludes Linnæus) amounts to a full demonſtration that the antheræ are the teſtes, and that the pollen is the ſemen or genitura of vegetables.

" The male organ being thus inveſtigated, we hope (ſays Linnæus) that none will heſitate to pronouce the ſtigma to be the female organ, eſpecially when the following obſervations are ſufficiently attended to.

" The piſtillum is compoſed of the germen, ſtylus, and ſtigma. The germen, being only a kind of rudiment of the future fœtus or ſeed, ceaſes to exiſt as ſoon as the flower comes to maturity. Neither is the ſtylus an eſſential part, as many flowers have no ſtylus. But no fruit ever comes to maturity without the aſſiſtance of the ſtigma. It follows, that the ſtigma, muſt be the female organ adapted by nature for the reception of the pollen or impregnating ſubſtance. This will appear ſtill clearer from the following chain of reaſoning.

" 1. *Situs.*—The ſtigmata are always ſituated ſo that the pollen may with moſt eaſe fall upon them. Beſides, it is remarkable, that in moſt plants (though not in all) the number of the ſtigmata exactly correſponds with the loculamenta or cells of the pericarpium.

" 2. *Tempus.*—Here the obſervation, that the ſtigmata and antheræ conſtantly flouriſh at the ſame time, is repeated.

" 3. *Decidentia.*—The ſtigmata of moſt plants, like the antheræ, decay and fall off as ſoon as they have diſcharged their proper function; which evidently ſhows, that their office is not to ripen the fruit, but ſolely to anſwer the important purpoſe of impregnation.

" 4. *Abſciſſio.*—The argument here is preciſely the ſame with the caſtration of the antheræ; and the reſult is likewiſe the ſame, namely the deſtruction of the fruit.

" Theſe arguments (concludes Linnæus) are ſufficient to demonſtrate that the ſtigma is the female organ of generation, or that organ which is ſuited for the reception, and conveyance of the ſemen to the *vegetable eggs*. Hence plants may be ſaid to be *in actu veneris*, when the antheræ or teſticuli ſpread their pollen over the ſtigma or female *vulva*."

To ſhow how the *coitus* of vegetables is effected, is our author's next object of inveſtigation. He affirms, that the pollen is conveyed by means of the wind or inſects, to the moiſt ſtigma, where it remains until it diſcharges a ſubtile fluid, which being abſorbed by the veſſels of the ſtigma, is carried to the ſeeds or ova, and impregnates them. His proofs are taken from the following particulars.

" 1. *Oculus.*—When the flowers are in full blow, and the pollen flying about, every one may then ſee the pollen adhering to the ſtigma. This he illuſtrates by mentioning as examples the viola tricolor, iris, campanula, &c.

" 2. *Proportio.*—The ſtamina and piſtilla, in moſt plants, are of equal heights, that the pollen by the intervention of the wind, may, with the greater facility, fall upon the ſtigma.

" 3. *Locus.*—The ſtamina of moſt plants ſurround the piſtillum, to give the pollen an opportunity of falling upon the ſtigma at every breeze of wind. Even in the Monœcia claſs, the male flowers ſtand generally above the female ones, to afford an eaſier conveyance of the pollen to the ſtigma.

" 4. *Tempus.*—It is remarkable that the ſtamina and piſtilla conſtantly appear at the ſame time, even in plants belonging to the Monœcia claſs.

" 5. *Pluviæ.*—The flowers of moſt plants expand by the heat of the ſun, and ſhut themſelves up in the evening or in rainy weather. The final cauſe of this muſt be to keep the moiſture from the pollen, leſt it ſhould be thereby coagulated, and of courſe prevented from being blown upon the ſtigma.

" 6. *Palmicolæ.*—That the cultivators of palm-trees were in uſe to pull off the ſpadices from the males, and ſuſpend them over the ſpathæ of the females, is atteſted by Theophraſtus, Pliny, Proſper Alpinus, Kempfer, and many others. If this operation happened to be neglected, the dates were ſour and deſtitute of nuts. Kempfer adds this ſingular circumſtance, that the male ſpadix, after being thoroughly dried and kept till next ſeaſon, ſtill retained its impregnating virtue.

" 7. *Flores nutantes.*—As the pollen is ſpecifically heavier than air, ſuch flowers as have their piſtillum longer than the ſtamina, hang down, or incline to one ſide, *e. g.* the fritillaria, campanula, &c. An eaſy admiſſion of the pollen to the ſtigma is the final cauſe of this appearance.

" 8. *Submerſi.*—Many plants that grow below water, emerge when their flowers begin to blow, and ſwim upon the ſurface till they receive their impregnation, and then ſink down.

" 9. *Omnium florum genuina conſideratio.*"—Here a number of particulars are recited. We ſhall confine ourſelves to thoſe that are moſt ſtriking and applicable to the ſubject.

" When the flowers of the male hemp are pulled off before thoſe of the female are fully expanded, the females do not produce fertile ſeeds. But as a male flower is ſometimes found upon a female plant, this may be the reaſon why fertile ſeeds are ſometimes produced even after this precaution has been obſerved.

" The tulip affords another experiment to the ſame purpoſe. Cut off all the antheræ of a red tulip before the pollen is emitted; then take the ripe antheræ of a white tulip, and throw the pollen of the white one upon the ſtigma of the red; the ſeeds of the red tulip being thus impregnated by one of a different complexion, will next ſeaſon produce ſome red, ſome white, but moſt variegated flowers.

In the year 1744, Linnæus publiſhed a deſcription of a new genus, which he called *peloria*, on the ſuppoſition of its being a *hybrid* or *mule* plant, *i. e.* a plant produced by an unnatural commixture of two different genera. The root, leaves, caulis, &c. of this plant are exceedingly ſimilar to thoſe of the antirrhinum linaria, but the flower and other parts of the fructification are totally different. On account of its ſimilarity to the linaria in every part but the flower, Linnæus imagined it to have been produced by a fortuitous commixture of the linaria with ſome other plant, although he has never yet been able to point out the father. This doctrine of the production of *mule* plants has ſince been greatly prized and carefully propagated by Linnæus and the other ſupporters of the ſexual hypotheſis. In the third volume of the *Amœnitates Academicæ*, there is a complete diſſertation, entitled *Plantæ Hybridæ*, wherein the doctrine of *vegetable mules* is much improved and extended. This diſſertation contains a liſt of 47 mules, with their ſuppoſed fathers and mothers. For example,

The Veronica ſpuria is ſaid to be a *mule* plant *begot by* the Verbena officinalis *upon* the Veronica maritima.

The Delphinium hybridum, a *mule*, *begot* by the Aconitum napellus *upon* the Delphinium elatum.

The Arctotis calendula, a *mule*, *begot* by the Calendula pluvialis *upon* the Arctotis triſtis.

The Aſclepias nigra, a *mule begot* by the Cynanchum acutum *upon* the Aſclepias vincetoxicum, &c.

From the examples given in this diſſertation, Linnæus draws this concluſion, That only two ſpecies of each genus exiſted *ab origine*; and that all the variety of ſpecies which now appear have been produced by unnatural embraces betwixt ſpecies of different genera.

Under this head, Linnæus likewiſe quotes from Ray the ſtory of Richard Baal, gardener at Brentford. This Baal ſold a large quantity of the ſeeds of the braſſica florida to ſeveral gardeners in the ſuburbs of London. Theſe gardeners, after ſowing their ſeeds in the uſual manner, were ſurpriſed to find them turn out to be plants of a different ſpecies from that which Baal made them believe they had purchaſed; for, inſtead of the braſſica florida, the plants turned out to be the braſſica longifolia. The gardeners, upon making the diſcovery, commenced a proſecution of fraud againſt Baal in Weſtminſter-hall. The court found Baal guilty of fraud, and decreed him not only to reſtore the price of the ſeeds, but likewiſe to pay the gardeners for their loſt time, and the uſe of their ground. " Had theſe judges (ſays Linnæus) been acquainted with the ſexual hypotheſis, they would not have found Baal guilty of any crime, but would have aſcribed the accident to the fortuitous impregnation of the braſſica florida by the pollen of the braſſica longifolia.

Linnæus next proceeds to celebrate the utility of inſects, becauſe they convey the pollen of the male to the ſtigma of the female. " In this way (ſays he), it is reaſonable to think that many dioicous plants are impregnated. Nay, even the hermaphrodites themſelves are greatly obliged to the different tribes of inſects, which, by fluttering and treading in the corolla are conſtantly ſcattering the pollen about the ſtigma.

" Upon the whole then, (concludes Linnæus), the coitus of vegetables is evident to a demonſtration. This coitus is nothing more than the conveyance of the pollen to the ſtigma, to which it adheres till it burſts, and diſcharges a ſubtile elaſtic fluid. This fluid or aura is abſorbed by the veſſels of the ſtylus, and carried directly to the ovarium or germen, where the myſterious work of impregnation is fully completed."

Theſe are the arguments advanced by Linnæus and other advocates for the ſexual commerce of vegetables. Let us next attend to thoſe advanced by the oppoſers of this hypotheſis.

It is admitted by Pontedera, Dr. Alſton, &c. that ſome of the ancients applied the terms *male* and *female* to ſeveral plants. But then they deny that theſe terms conveyed the ſame ideas to the ancients that they do to the moderns. *Male* and *female*,

when applied to plants, were to the ancients mere terms of diſtinction, ſerving only as trivial names to diſtinguiſh one ſpecies or variety from another. The ancients were ignorant of the very characters which conſtitute the difference between what is called a *male* and *female* plant among the moderns. Theophraſtus, Dioſcorides, Pliny, and, in a word, the whole ancient botanical writers, confound the very notion of the modern ſexes: they call the real female, or ſeed bearing plant the *male*; and the male, or barren plant, the *female*. Nay, they have even applied the terms *male* and *female* to many plants which bear nothing but hermaphrodite flowers.

Such is the nature of this controverſy, that it cannot be determined with any degree of certainty, but by experiments made upon dioicous plants. If a female plant can produce fertile ſeeds without having any communication with the pollen of the male, the uſe of this pollen with reſpect to the impregnation of ſeeds muſt of neceſſity be entirely ſuperſeded.

Now, both Camerarius and Dr. Alſton tried theſe experiments with the ſame ſucceſs. Thoſe two eminent botaniſts took female plants of the mercury, ſpinage, and hemp; tranſplanted them at a great diſtance from any males of the ſame genus, and beſides had them incloſed by double rows of hedges. The reſult was, that each of theſe plants produced great quantities of fertile ſeeds. Tournefort made the ſame trial upon the lupulus, Miller upon the bryony, and Geoffroy upon the mays; and all of them declare that the ſeeds of theſe plants were as fertile as if they had been ſurrounded by a thouſand males.

Linnæus, in his firſt argument for the coitus of plants, refers every man to the evidence of his ſenſes.

"Do we not ſee (ſays he) the ſtigma of almoſt every hermaphrodite flower covered over with the pollen or impregnating ſubſtance? Do not we ſee the parietaria, the urtica, &c. by violent exploſions diſcharging their pollen in the open air, that it may be carried in that vehicle to the ſtigmata of their reſpective females?—All this is admitted by the oppoſers of the ſexes: but then they deny that theſe exploſions, &c. are intended to create any intercourſe between the male and the female; and further alledge, that this ejection of the pollen is intended by nature to throw off ſomething excrementitious, or at leaſt ſomething which, if retained, would prove noxious to the fructification.

Linnæus takes his ſecond argument from the proportion which the ſtamina bear to the ſtylus, alledging that they are generally of the ſame height.—This obſervation (ſay the anti-ſexualiſts) is not only contrary to experience, but, allowing it to be univerſal, no concluſion can be drawn from it either for or againſt the ſexual hypotheſis.

The third argument is taken from the *locus* or ſituation of the ſtamina with reſpect to the ſtylus: "and as the male flowers in the Monœcia claſs ſtand always above the female flowers, it muſt be concluded (ſays Linnæus), that the intention of nature, in this diſpoſition of the parts, is to allow a free and eaſy acceſs of the pollen to the ſtigma."—But the ſtamina cannot be ſaid to ſurround the piſtillum in the Monandria and Diandria claſſes: and the poſition of the male flowers, in the Monœcia claſs is a mere chimera; for in the ricinus, one of the examples which Linnæus mentions in confirmation of his doctrine, the female flowers ſtand uniformly ſome inches above the males.

That the ſtamina and piſtilla generally come to perfection at the ſame time, and that this happens even in the dioicous plants, is Linnæus's fourth argument. But, as it is acknowledged by Linnæus himſelf, that there are many exceptions with reſpect to this fact, the oppoſers of the ſexual hypotheſis alledge that it carries the beſt anſwer in its own boſom.

The fifth argument is founded on the circumſtance of ſome flowers ſhutting up their petals in rainy or moiſt evenings.—But many flowers do not ſhut themſelves up either in the night or moiſt weather, as the paſſion-flower, &c. the lychnis noctiflora, mirabilis peruvianæ, &c. open their flowers in the night, and ſhut them at the approach of the ſun. Hence this is another final cauſe (ſay the anti-ſexualiſts) perverted to ſupport a favourite hypotheſis.

We come now to the culture of the palm-tree, which is the ſixth and moſt plauſible argument employed by the ſexualiſts. Of this, the moſt authentic account we have is the following by Dr. Haſſelquiſt, in one of his letters to Linnæus, dated Alexandria May 18th, 1750. "The firſt thing I did after my arrival was to ſee the date-tree, the ornament and a great part of the riches of this country. It had already bloſſomed; but I had, nevertheleſs, the pleaſure of ſeeing how the Arabs aſſiſt its fecundation, and by that means ſecure to themſelves a plentiful harveſt of a vegetable which was ſo important to them, and known to them many centuries before any botaniſt dreamed of the difference of ſexes in vegetables. The gardener informed me of this before I had time to inquire; and would ſhow me, as a very curious thing, the male and female of the date or palm-trees: nor could he conceive how I, a Frank, lately arrived, could know it before; for, ſays he, all who have yet come from Europe to ſee this country, have regarded this relation either as a fable or miracle. The Arab ſeeing me inclined to be further informed, accompanied me and my French interpreter to a palm-tree, which was very full of young fruit, and had by him been wedded or fecundated with the male when both were in bloſſom. This the Arabs do in the following manner: When the ſpadix has female flowers, that come out of its ſpatha, they ſearch on a tree that has male flowers, which they know by experience, for a ſpadix which has not yet burſted out of its ſpatha: this they open, take out the ſpadix, and cut it lengthwiſe in ſeveral pieces, but take care not to hurt the flowers. A piece of this ſpadix with male flowers they put lengthwiſe between the ſmall branches of the ſpadix which hath female flowers, and then lay the leaf of a palm over the branches. In this ſituation I yet ſaw the greateſt part of the ſpadices which bore their young fruit; but the male flowers which were put between were withered. The Arab beſides gave me the following anecdotes: Firſt, unleſs they, in this manner, wed and fecundate the date-tree, it bears no fruit. Secondly, they always take the precaution to preſerve ſome unopened ſpathæ with male flowers from one year to another, to be applied for this purpoſe, in caſe the male flowers ſhould miſcarry or ſuffer damage. Thirdly, if they permit the ſpadix of the male flowers to burſt or come out, it becomes uſeleſs for fecundation: it muſt have its *maidenhead* (theſe were the words of the Arab), which is loſt in the ſame moment the bloſſoms burſt out of their caſe. Therefore the perſon who cultivates date-trees muſt be careful to hit the right time of aſſiſting their fecundation, which is almoſt the only article in their cultivation. Fourthly, on opening the ſpatha, he finds all the male flowers full of a liquid which reſembles the fineſt dew; it is of a ſweet and pleaſant taſte, reſembling much the taſte of freſh dates, but much more refined and aromatic: this was likewiſe confirmed by my interpreter, who hath lived thirty-two years in Egypt, and therefore had opportunities enough of taſting both the nectar of the bloſſoms and the freſh dates.

Now, though this account ſeems fully to confirm the fact, *viz*, that ſuch a practice obtains among the Arabs, and that they aſſert its efficacy in fecundating the trees, it is certain (ſays the oppoſers of this doctrine), that no intelligent perſon, who is not already wedded to an hypotheſis, will attempt to found an argument upon the aſſertions of a people ſo full of ridiculous ſuperſtitions. Before Dr. Haſſelquiſt, or any other perſon, can draw any argument from the above mentioned account, he ought to ſee the experiment ſeveral times repeated, with his own eyes, and not take it upon the word of a people who beſides their ſuperſtition, may very probably find it their intereſt to impoſe upon travellers.

Mr. Milne, author of the Botanical Dictionary, however, relates an experiment, near akin to the abovementioned, which merits ſome attention: "In the garden of M. de la Serre, of the Rue S. Jacques at Paris, was a female turpentine tree, which flowered every year, without furniſhing any fruit capable of vegetation. This was a ſenſible mortification to the owner, who greatly deſired to have the tree increaſed. Meſſieurs Duhamel and Jeſſieu very properly judged that they might procure him that pleaſure by the aſſiſtance of a male piſtachio tree. They ſent him one very much loaded with flowers. It was planted in the garden of M. de la Serre, very near the female turpentine tree, which the ſame year produced a great quantity of fruits, that were well-conditioned, and roſe with facility. The male plant was then removed; the conſequence of which was, that the turpentine-tree of M. de la Serre in none of the ſucceeding years bore any fruit that, upon examination, was found to germinate."

Upon this experiment it is obſerved by the anti-ſexualiſts, that, though it were a thouſand times repeated, it never could be deciſive. The nature of the controverſy, ſay they, is ſuch, that one experiment is more deciſive in favour of their opinion, than 10,000 can be againſt them. The reaſon is plain: If there is ſuch a thing as a ſexual intercourſe in vegetables, it is as wonderful that any ſeeds ſhould be perfected without that intercourſe, as that a virgin ſhould have a child: the laſt is not in the leaſt more extraordinary than the firſt. One experiment, therefore, which ſhews that ſeeds may be perfected without ſuch ſexual intercourſe, is either to be reſolved into a miracle, or muſt prove abſolutely deciſive againſt the ſexual ſyſtem; while numberleſs experiments ſuch as that above mentioned could prove nothing, becauſe we know not what effect vegetables may have by growing in each others neighbourhood, independent of any ſexual intercourſe.

In Milne's Botanical Dictionary, under the article *Sexus Plantarum*, the author quotes Dr. Alſton's experiments partially. The facts recorded by Dr. Alſton are as follow. 1. Three ſets of ſpinach, planted at a great diſtance from each other, proved all of them fertile, and ripened *plenty* of ſeeds, which were found to anſwer as well as other ſpinach ſeed. 2. A plant of hemp growing by itſelf, being taken care of, produced about 30 good ſeeds, though in a ſituation very much expoſed, and plucked up too ſoon, on account of bad weather, in the autumn. 3. This experiment, which is the moſt remarkable of the three, we ſhall give in the Doctor's own words. "In the ſpring of 1741, I carried two young ſeedling plants of the French mercury, long before there was any in, from the city phyſic garden, the only

place

place where it was then to be found in this country, to the king's garden at the Abbey; which are more than 700 yards diſtant from one another, with many high houſes, trees, hedges, and part of a high hill, between them: and planted one of them in one incloſure, where it was ſhaded from the ſun the greateſt part of the day; and the other in another, 25 yards diſtant, expoſed to the ſouth and weſt. Both plants ripened fertile ſeeds; and the laſt ſhed them ſo plentifully, that it proved a troubleſome weed for ſeveral years, though none of the ſpecies was to be found in that garden for more than 20 years preceding.

Of this experiment Mr. Milne hath not taken any notice; but upon the other two, has the following remark. "The reſult of theſe, and ſuch like experiments, can be accounted for, on the principle of the ſexes, in no other way than on the ſuppoſition that ſome male flowers have been intermixed with the female, and operated the fecundation in queſtion. This appears the more probable, as only *a part* of the ſeeds in the above experiments attained to perfect maturity, ſo as to be capable of vegetation."

The ſeventh argument of Linnæus is taken from the *flores nutantes*.—The piſtils of theſe flowers, according to Linnæus, are always longer than the ſtamina; and nature has aſſigned them this penſile poſture, that the pollen, which is ſpecifically heavier than air, may the more conveniently fall upon the ſtigma.—But the piſtils of the campanula, lilium, and many other *flores nutantes*, are not longer than the ſtamina. Beſides, granting this were uniformly the caſe; yet, as the pollen is heavier than air, this poſture muſt of neceſſity either make the pollen miſs the piſtillum altogether, or, at any rate, it can only fall upon the back part of the piſtil in place of the ſtigma; and, of courſe, ſuch a direction would rather tend to fruſtrate than promote the impregnation of the ſeed.

The eighth argument is taken from the *plantæ ſubmerſæ*, which are ſaid to emerge as ſoon as their flowers begin to blow, leſt the pollen ſhould be coagulated or waſhed off by the water.—But many ſubmarine and aquatic plants fructify entirely below water; and, ſuppoſing they did not, the ſame argument would equally prove it to be the intention of nature, that the pollen ſhould be blown away by the winds, as that it ſhould be ſubſervient to the impregnation of the ſeed.

The ninth and laſt argument is entitled *Omnium florum genuina conſideratio*; which (ſay the anti-ſexualiſts) is nothing more than a collection of vague obſervations upon the ſtructure and œconomy of particular plants, ſome of them true, others falſe, but all of them evidently thruſt in as ſupports to a favourite hypotheſis.

Thus the diſpute reſted ſome years ago; but of late there has appeared a tranſlation of one of Linnæus's works upon the ſubject, which, though publiſhed in 1759, was but little known in this country. A treatiſe on the Sexual Syſtem had alſo been publiſhed by the Abbé Spalanzani, in which he not only oppoſed the Linnæan doctrine, but treated it with ridicule, though without taking any notice of this laſt publication, which he ſeems to have been ignorant of. In this he mentions an experiment with hemp ſimilar to ſome of thoſe already related; but which was alſo tried by Linnæus, and in his hands turned out the very reverſe of what it did with Spalanzani. In the treatiſe alluded to, Linnæus mentions Sir Thomas Millington as the firſt among the moderns who thought of the diſtinction of ſexes in plants. He was Savilian profeſſor at Oxford; and Dr. Grew, in his anatomy of plants, relates, that in a converſation on the nature of the antheræ of flowers, Sir Thomas hinted, that thoſe parts might probably be analogous to the male organs of animals, and ſerve for the impregnation of the fruit. Grew improved on the idea, and purſued it. That the ſubject, however, may be properly underſtood, our author is of opinion, that we ſhould firſt accurately underſtand the nature of vegetable bodies; and in order to do this, we ought firſt to conſider the operations of nature in the human frame, and from thence continue our reſearches through the various tribes of inferior animals, till at laſt we arrive at the vegetable creation. In like manner, to illuſtrate the generation of plants, we muſt likewiſe take our firſt lights from the animal kingdom, and purſue the ſame chain till we come to vegetables. This ſubject, indeed, he owns to be ſo obſcure, that no naturaliſt has hitherto been able to ſay any thing ſatisfactory concerning it; he only mentions ſome remarkable facts concerning the production of mule animals, from the copulation of two individuals of different ſpecies. In the horſe-kind we ſee two different kinds of mules produced. "From the mare and male aſs, (ſays he) proceeds the mule properly ſo called, which in its nature, that is, in his medullary ſubſtance and nervous ſyſtem, agrees with its mother; but in its cortical ſubſtance and outward form, in its mane and tale; reſembles the aſs. Between the female aſs and the horſe, the other kind of mule is engendered, whoſe nature or medullary ſubſtance reſembles that of the aſs; but its cortical ſtructure that of the horſe. If the he-goat of Angora copulates with the common ſhe-goat, the kid, by that means procured, inherits the external ſtructure and valuable coat of its father; while, on the other hand, if the common he-goat impregnates the goat of Angora, the kid produced has the ſame external form, and bears the ſame worthleſs hair with its father. Hence it ſeems probable, that the medullary ſubſtance, with what Malpighi calls the keel *(carina)*, and the nervous ſyſtem, are latent in the egg of the mother; the cortical ſubſtance, or vaſcular ſyſtem, being derived from the father."

Theſe cortical and medullary ſubſtances are previouſly explained by our author to be thoſe of which both animal and vegetable bodies are compoſed. By the medullary ſubſtance in animal bodies, he means the ſpinal marrow ariſing from the organized brain, and ſending off the nerves; by the cortical ſubſtance the veſſels with the heart attached to them, by which the medullary part is nouriſhed. In vegetables, the cortical part nouriſhes the plant, not only by its root, but with its whole ſurface. For a ſmall branch torn from the parent ſtem, and placed in water, imbibes nouriſhment at its pores. Thus the *Fuci*, and other marine vegetables, are nouriſhed without a root, ſolely by the pores diſperſed through their whole ſubſtance. The bark of trees every year depoſits its gelatinous internal layer, which is added to the wood, and aſſimilates itſelf to it. The medullary, which is the other eſſential part of vegetables, is multiplied and extended without end; and whenever it is entirely loſt, the death of the plant neceſſarily follows. In examining this ſubſtance, we muſt be careful, in two caſes, that we be not miſled; firſt, by the ſtraws of graſſes, and by other hollow ſtems, where the medulla lines the inſide of the bark; and, ſecondly, by large trees, whoſe trunks become perfectly ſolid throughout, except in the very ſummits of the branches. The wood performs the office of bones, when there is no longer any occaſion for the medulla in that part; and trees, although become hollow, continue nevertheleſs to grow ſo long as this ſubſtance remains in the extreme branches. It is by no means neceſſary that the medulla ſhould have any connexion with the root, as it is only nouriſhed by the cortical ſubſtance of the plant, and is therefore increaſed at its upper extremity without end, if it meets with no reſiſtance. In thoſe animals whoſe ſpinal marrow is ſurrounded by a bony covering, as in the larger and more perfect kinds, this ſubſtance never comes out of its confinement; and the harder its caſe, the more abſolutely is its increaſe prevented: but in the ſmaller tribes of worms, where this covering is leſs rigid, a perpetual and unlimited increaſe of the animal takes place.

"The moſt important parts of the flower, and which are abſolutely eſſential to it, (our author proceeds to obſerve), are the ſtamina and piſtilla. So eſſential are they, that among the many thouſands of flowers with which we are acquainted, no one can be found not furniſhed with both theſe organs. The ſtamina derive their origin from the ſubſtance of the wood, which was originally formed from the inner bark, and they may therefore be ſaid to ſpring from the cortical ſubſtance of the vegetable.—This is perfectly evident in the Aſarum (Aſarabacca), whoſe twelve ſtamina proceed from twelve fibres in the inner bark.—Double flowers illuſtrate the ſame fact: in them, the ſtamina being weakened and diſſolved by exceſs of nouriſhment, the woody ſubſtance reaſſumes the ſoftneſs of the inner bark, of which it was originally formed. All ſtamina conſiſt of veſſels containing the pollen, or impregnating powder, which they diſcharge in due time, not without the ſtricteſt obſervance of certain natural laws. The form of theſe veſſels, like that of the capſules of the fruit, is accurately defined, as well as their cells, their particular manner of burſting, and the pollen which they contain; this pollen, likewiſe, is no leſs certain and uniform in its figure, ſize, and colour, than the ſeeds themſelves.

"The piſtillum is the only part which originates from the medullary ſubſtance, and is therefore invariably ſituated in the centre of the flower. It always contains the rudiments of the ſeed, which, in proceſs of time, ripen into fruit. The rudiments of the fruit are called the *germen*, or ſeed-bud; this has conſtantly another organ connected with it, named the *ſtigma*, which is in its higheſt degree of vigour and perfection during the time of flowering.

"Another circumſtance worthy of attention is, that the root, which the firſt year of its growth is large and filled with medullary pulp, the following ſeaſon becomes hollow, in producing the ſtem, flowers, and ſeed; all this pulp being conveyed to the flower, and ſeeming to be only deſtined to the formation of ſeed, ſo many new and diſtinct animations being formed from it as there are rudiments of new plants. This is particularly obſervable in the turnip.

"Thus vegetables, like inſects, are ſubject to a metamorphoſis; with this difference only, that their flowers are fixed to one ſpot, inſtead of being able, like inſects, to fly from place to place; and that their nouriſhment is not given them by means of peculiar organs for the formation of chyle. We have ſeen that the outer bark becomes calyx, the internal bark corolla, the wood ſtamina, and the medulla piſtillum; the fructification exhibiting the internal parts of a plant naked and unfolded. We have likewiſe ſeen, that the fructification puts an end to vegetation in the part from whence it ariſes, ſtopping the progreſs of the medulla, which would otherwiſe have extended itſelf without end

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by the branches, and occaſioning the diviſion of that medulla into a number of ſeeds, each endowed with a ſeparate living principle. But as the medulla exiſts naked in the germen, it cannot ſupport itſelf, or make any farther progreſs, without the aſſiſtance of the cortical ſubſtance which it has left; it muſt therefore receive this aſſiſtance by ſome means or other, and in fact does receive it from the ſtamina and their pollen, which owe their origin to the woody matter derived from the inner bark, and originally generated by the outer bark. But if it happens that the cortical ſubſtance is able to inveſt the medullary rudiments of the ſeed in the flower itſelf, the plant becomes viviparous, as in *feſtuca, aira*, and *poa vivipara*, in which nearly the ſame thing takes place as in the medulla of other plants, which remains in the branches, and is variouſly diſtributed, being at once both clothed and nouriſhed by the bark, and enabled to form new branches, juſt as it happens in the compound animals, or *ſertulariæ*.

"The organs common in general to all plants are, 1. The root, with its capillary veſſels, extracting nouriſhment from the ground. 2. The leaves, which may be called the *limbs*, and which, like the fect and wings of animals, are organs of motion; for being themſelves ſhaken by the external air, they ſhake and exerciſe the plant. 3. The trunk, containing the medullary ſubſtance, which is nouriſhed by the bark, and for the moſt part multiplied into ſeveral compound plants. 4. The fructification, which is the true body of the plant, ſet at liberty by a metamorphoſis, and conſiſts only of the organs of generation; it is often defended by a calyx, and furniſhed with petals, by means of which it in a manner flutters in the air.

"Many flowers have no calyx, as ſeveral of the lily tribe, the *hippuris*, &c. many want the corolla, as graſſes, and the plants called *apetalous;* but there are none deſtitute of ſtamina and piſtilla, thoſe important organs deſtined to the formation of fruit. We therefore infer from experience, that the ſtamina are the male organs of generation, and the piſtilla the female; and as many flowers are furniſhed with both at once, it follows that ſuch flowers are hermaphrodites. Nor is this ſo wonderful, as that there ſhould be any plants in which the different ſexes are in diſtinct individuals; for plants being immoveably fixed to one ſpot, cannot, like animals, travel in ſearch of a mate. There exiſts, however, in ſome plants, a real difference of ſex. From ſeeds of the ſame mother, ſome individuals ſhall be produced, whoſe flowers exhibit ſtamina without piſtilla, and may therefore be properly called *males;* while the reſt, being furniſhed with piſtilla without ſtamina, are therefore denominated *females:* and ſo uniformly does this take place, that no vegetable was ever found to produce female flowers, without flowers furniſhed with ſtamina being produced, either on the ſame individual, or on another plant of the ſame ſpecies, and *vice verſa*.

"As all ſeed-veſſels are deſtined to produce ſeeds, ſo are the ſtamina to bear the *pollen*, or fecundating powder. All ſeeds contain within their membranes a certain medullary ſubſtance, which ſwells when dipped into warm water. All pollen, likewiſe, contains in its membrane an elaſtic ſubſtance, which, although very ſubtile and almoſt inviſible, by means of warm water often explodes with great vehemence. While plants are in flower, the pollen falls from their antheræ, and is diſperſed abroad, as ſeeds are diſlodged from their ſituation when the fruit is ripe. At the ſame time that the pollen is ſcattered, the piſtillum preſents its ſtigma, which is then in its higheſt vigour, and, for a portion of the day at leaſt, is moiſtened with a fine dew. The ſtamina either ſurround this ſtigma, or, if the flowers are of the drooping kind, they are bent towards one ſide, ſo that the pollen can eaſily find acceſs to the ſtigma; where it not only adheres by means of the dew of that part, but the moiſture occaſions its burſting, by which means its contents are diſcharged. What iſſued from it, being mixed with the fluid of the ſtigma, is conveyed to the rudiments of the ſeed. Many evident inſtances of this preſent themſelves to our notice; but I have no where ſeen it more manifeſt than in the jacobean lily *(amarillis formoſiſſima)*, the piſtillum of which, when ſufficient heat is given the plant to make it flower in perfection, is bent downwards, and from its ſtigma iſſues a drop of limpid fluid, ſo large that one would think it in danger of falling to the ground. It is, however, gradually re-abſorbed into the ſtyle about three or four o'clock, and becomes inviſible till about ten the next morning, when it appears again; by noon it attains its largeſt dimenſions; and in the afternoon, by a gentle and ſcarcely perceptible decreaſe, it returns to its ſource. If we ſhake the antheræ over the ſtigma, ſo that the pollen may fall on this limpid drop, we ſee the fluid ſoon after become turbid, and aſſume a yellow colour; and we perceive little rivulets, or opake ſtreaks, running from the ſtigma towards the rudiments of the ſeed. Sometime afterwards, when the drop has totally diſappeared, the pollen may be obſerved adhering to the ſtigma, but of an irregular figure, having loſt its original form. No one, therefore, can aſſent to what Morland and others have aſſerted, that the pollen paſſes into the ſtigma, pervades the ſtyle, and enters the tender rudiments of the ſeed, as Leewenhoeck ſuppoſed his worms to enter the ova. A moſt evident proof of the falſhood of this opinion may be obtained from any ſpecies of *mirabilis* (marvel of Peru), whoſe pollen is ſo very large, that it almoſt exceeds the ſtyle itſelf in thickneſs, and, falling on the ſtigma, adheres firmly to it; that organ ſucking and exhauſting the pollen, as a cuttle-fiſh devours every thing that comes within its graſp. One evening in the month of Auguſt I removed all the ſtamina from three flowers of the *mirabilis longiflora*, at the ſame time deſtroying all the reſt of the flowers which were expanded; and ſprinkled theſe three flowers with the pollen of *mirabilis jalappa*; the ſeed-buds ſwelled, but did not ripen. Another evening I performed a ſimilar experiment, only ſprinkling the flowers with the pollen of the ſame ſpecies; all theſe flowers produced ripe ſeeds.

"Some writers have believed, that the ſtamina are parts of the fructification, which ſerve only to diſcharge an impure or excrementitious matter, and by no means formed for ſo important a work as generation. But it is very evident, that theſe authors have not ſufficiently examined the ſubject; for as, in many vegetables, ſome flowers are furniſhed with ſtamina only, and others only with piſtilla, it is altogether impoſſible, that ſtamina ſituated at ſo very great a diſtance from the fruit as on a different branch, or perhaps on a ſeparate plant, ſhould ſerve to convey any impurities from the embryo.

"No phyſiologiſt could demonſtrate, *à priori*, the neceſſity of the maſculine fluid to the rendering the eggs of animals prolific; but experience has eſtabiſhed it beyond a doubt. We therefore judge *à poſteriori* principally of the ſame effect in plants.

"In the month of January 1760, the *antholyza cunonia* flowered in a pot in my parlour, but produced no fruit, the air of the room not being ſufficiently agitated to waft the pollen to the ſtigma. One day, about noon, ſeeing the ſtigma very moiſt, I plucked off one of the antheræ, by means of a fine pair of forceps, and gently rubbed it on one of the expanded ſtigmata. The ſpike of flowers remained eight or ten days longer; when I obſerved, in gathering the branch for my herbarium, that the fruit of that flower only on which the experiment had been made had ſwelled to the ſize of a bean. I then diſſected this fruit, and diſcovered that one of the three cells contained ſeeds in conſiderable number, the other two being entirely withered.

"In the month of April I ſowed the ſeeds of hemp *(cannabis)* in two different pots. The young plants came up ſo plentifully, that each pot contained thirty or forty. I placed each by the light of a window, but in different and remote apartments. The hemp grew extremely well in both pots. In one of them I permitted the male and female plants to remain together, to flower and bear fruit, which ripened in July; and being macerated in water and committed to the earth, ſprung up in twelve days. From the other, however, I removed all the male plants as ſoon as they were old enough for me to diſtinguiſh them from the females. The remaining females grew very well, and preſented their long piſtilla in great abundance, theſe flowers continuing a very long time, as if in expectation of their mates; while the plants in the other pot had already ripened their fruit, their piſtils having, quite in a different manner, faded as ſoon as the males had diſcharged all their pollen. It was certainly a beautiful and truly admirable ſpectacle, to ſee the unimpregnated females preſerve their piſtils ſo long green and flouriſhing, not permitting them to begin to fade till they had been for a conſiderable time expoſed, in vain, to the acceſs of the male pollen. Afterwards, when theſe virgin plants began to decay through age, I examined all their calyxes in the preſence of ſeveral botaniſts, and found them large and flouriſhing, although every one of the ſeed-buds was brown, compreſſed, membranaceous, and dry, not exhibiting any appearance of cotyledons or pulp. Hence I am perfectly convinced, that the circumſtance which authors have recorded, of the female hemp having produced ſeeds, although deprived of the male, could only have happened by means of pollen brought by the wind from ſome diſtant place. No experiment can be more eaſily performed than the above; none more ſatisfactory in demonſtrating the generation of plants.

"The *Clutia tenella* was in like manner kept growing in my window through the months of June and July. The male plant was in one pot, the female in another. The latter abounded with fruit, not one of its flowers proved abortive. I removed the two pots into different windows of the ſame apartment, ſtill all the female flowers continued to become fruitful. At length I took away the male entirely, leaving the female alone, and cutting off all the flowers which it had already borne. Every day new ones appeared from the axilla of every leaf; each remained eight or ten days; after which their footſtalks turned yellow, they fell barren to the ground. A botanical friend, who had amuſed himſelf with obſerving this phenomenon with me, perſuaded me to bring from the ſtove in the garden a ſingle male flower, which he placed over one of the female ones, then in perfection, tying a piece of red ſilk round its piſtillum. The next day the male flower was taken away, and this ſingle ſeed-bud remained and bore fruit. Afterwards I took another male flower out of the ſame ſtove, and with a pair of ſlender forceps pinched off one of its antheræ, which I afterwards gently ſcratched with a feather, ſo that a very ſmall portion of its pollen was diſcharged upon one of the three ſtigmata of a female flower, the

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two other ſtigmata being covered with paper. This fruit likewiſe attained its due ſize; and, on being cut tranſverſely, exhibited one cell filled with a large ſeed, and the other two empty. The reſt of the flowers, being unimpregnated, faded and fell off. This experiment may be performed with as little trouble as the former.

"The *Datiſca cannabina* came up in my garden from ſeed ten years ago, and has every year been plentifully increaſed by means of its perennial root. Flowers in great number have been produced by it; but being all female, they proved abortive. Being deſirous of procuring male plants, I obtained more ſeeds from Paris. Some more plants were raiſed; but theſe likewiſe, to my great mortification, all proved females, and bore flowers, but no fruit. In the year 1757, I received another parcel of ſeeds. From theſe I obtained a few male plants, which flowered in 1758. Theſe were planted at a great diſtance from the females; and when their flowers were juſt ready to emit their pollen, holding a paper under them, I gently ſhook the ſpike or panicle with my finger, till the paper was almoſt covered with the yellow powder. I carried this to the females, which were flowering in another part of the garden, and placed it over them. The cold nights of the year in which this experiment was made, deſtroyed theſe datiſcas, with many other plants, much earlier than uſual. Nevertheleſs, when I examined the flowers of thoſe plants which I had ſprinkled with the fertilizing powder, I found the ſeeds of their due magnitude; while in the more remote datiſcas, which had not been impregnated with pollen, no traces of ſeeds were viſible.

"Several ſpecies of *Momordica*, cultivated with us, like other Indian vegetables in cloſe ſtoves, have frequently borne female flowers; which, although at firſt very vigorous, after a ſhort time have conſtantly faded and turned yellow, without perfecting any ſeed, till I inſtructed the gardener, as ſoon as he obſerved a female flower, to gather a male one and place it above the female. By this contrivance we are ſo certain of obtaining fruit, that we dare pledge ourſelves to make any female flowers fertile that ſhall be fixed on.

"The *Jatropha urens* has flowered every year in my hot-houſe; but the female flowers coming before the males, in a week's time dropped their petals, and faded before the latter were opened; from which cauſe no fruit has been produced, but the germina themſelves have fallen off. We have therefore never had any fruit of the jotrapha till the year 1752, when the male flowers were in vigour on a tall tree at the ſame time that the females began to appear on a ſmall jatropha which was growing in a garden-pot. I placed this pot under the other tree, by which means the female flowers bore ſeeds, which grow on being ſown. I have frequently ſince amuſed myſelf with taking the male flowers from one plant, and ſcattering them over the female flowers of another, and have always found the ſeeds of the latter impregnated by it.

"Two years ago I placed a piece of paper under ſome of theſe male flowers, and afterwards folded up the pollen which had fallen upon it, preſerving it ſo folded up, if I remember right, four or ſix weeks, at the end of which time another branch of the ſame jatropha was in flower. I then took the pollen, which I had ſo long preſerved in paper, and ſtrewed it over three female flowers, the only ones at that time expanded. Theſe three females proved fruitful, while all the reſt which grew in the ſame bunch fell off abortive.

The interior petals of the *Ornithogalum*, commonly, but improperly, called *Canadenſe*, cohere ſo cloſely together, that they only juſt admit the air to the germen, and will ſcarcely permit the pollen of another flower to paſs: this plant produced every day new flowers and fruit, the fructification never failing in any inſtance; I therefore, with the utmoſt care, extracted the antheræ from one of the flowers with a hooked needle; and, as I hoped, this ſingle flower proved barren. This experiment was repeated about a week after with the ſame ſucceſs.

"I removed all the antheræ out of a flower of *Chelidonium corniculatum* (ſcarlet horned poppy), which was growing in a remote part of the garden, upon the firſt opening of its petals, and ſtripped off all the reſt of the flowers: another day I treated another flower of the ſame plant in a ſimilar manner, but ſprinkled the piſtillum of this with the pollen borrowed from another plant of the ſame ſpecies: the reſult was, that the firſt flower produced no fruit, but the ſecond aſſurded very perfect ſeed. My deſign in this experiment was to prove, that the mere removal of the antheræ from a flower is not in itſelf ſufficient to render the germen abortive.

"Having the *Nicotiana fruticoſa* growing in a garden-pot, and producing plenty of flowers and ſeed, I extracted the antheræ from a newly-expanded flower before they had burſt, at the ſame time cutting away all the other flowers; this germen produced no fruit, nor did it even ſwell.

"I removed an urn, in which the *Aſphodelus fiſtuloſus* was growing, to one corner of the garden, and from one of the flowers which had lately opened I extracted its antheræ; this cauſed the impregnation to fail. Another day I treated another flower in the ſame manner: but bringing a flower from a plant in a different part of the garden, with which I ſprinkled the piſtillum of the mutilated one, its germen by that means became fruitful.

"*Ixia Chinenſis*, flowering in my ſtove, the windows of which were ſhut, all its flowers proved abortive. I therefore took ſome of its antheræ in a pair of pincers, and with them ſprinkled the ſtigmata of two flowers, and the next day one ſtigma only of a third flower; the ſeed-buds of theſe flowers remained, grew to a large ſize, and bore ſeed; the fruit of the third, however, contained ripe ſeed only in one of its cells.

"To relate more experiments would only be to fatigue the reader unneceſſarily. All nature proclaims the truth I have endeavoured to inculcate, and every flower bears witneſs to it. Any perſon may make the experiment for himſelf, with any plant he pleaſes, only taking care to place the pot in which it is growing in the window of a room ſufficiently out of the reach of other flowers; and I will venture to promiſe him, that he will obtain no perfect fruit, unleſs the pollen has acceſs to the piſtillum."

SECTION IV.

SEXUAL SYSTEM, REDUCED TO CLASSES, ORDERS, and GENERA.

ART. I. CLASSES.

The Sexual method of reducing plants to claſſes, genera, and ſpecies, is founded upon the ſuppoſition that vegetables propagate their ſpecies in a manner ſimilar to that of animals. Linnæus endeavours to ſupport this hypotheſis by the many analogies that ſubſiſt between plants and animals, which have been more particularly pointed out in the preceding ſection. It is from this circumſtance that Linnæus's ſyſtem of botany has got the name of the *ſexual ſyſtem*. The names of his claſſes, orders, &c. are all derived from this theory. He calls the ſtamina of flowers, as we have ſeen, the *males*, or the male parts of generation; the piſtils he calls *females*, or the female parts of generation; and plants whoſe flowers contain both male and female parts, are ſaid to be *hermaphrodites*. It is founded on the fructification of plants, which, in a perfect ſtate, conſiſts of the ſeven principal parts following, the *calyx*, the *corolla*, the *ſtamina*, the *piſtil*, the *pericarpium*, the *ſeeds*, and the *receptacle*, each of which is deſcribed in the ſyſtem under its reſpective head.

From the number, proportion, poſitions, and other circumſtances attending theſe parts of fructification, the claſſes, orders, and genera of vegetables are characteriſed. The number and diſpoſition of the filaments of the ſtamina generally ſhew the claſs of a plant, and the ſtyles of the piſtilla conſtitute, for the moſt part, the character of the order in which it is arranged under that claſs: for inſtance, if in any flower there be but one filament or ſtamen, it belongs to the firſt claſs, which is called the *Monandria*; and if it have only one ſtyle, it belongs to the firſt order under that claſs, which is called the *Monogynia*; if, with one filament, there be two ſtyles, it is one of the *Monandria* claſs, and of the ſecond order under that claſs, called the *Digynia*; and ſo on.

When we ſpeak of the STAMINA, it has been obſerved, that upon the filaments are fixed buttons, called *antheræ*, which are conſidered as the male organs of generation in plants; and the top of the ſtyle, which has been mentioned in treating of the piſtil, uſually ſwells or divides into a head, called its *ſtigma*, (Plate IV. Claſs II. Order I. fig. 7) which is the female part, and which receiving the duſt or pollen from the buttons of antheræ, affords it a paſſage down the ſtyle (fig. 6), to impregnate the germen (fig. 5). From this diſtinction of ſexes in plants, in like manner as in animals, the Linnæan ſyſtem of botany obtained the name of the Sexual ſyſtem.

The other parts of the fructification, viz. the calyx or cup (Plate IV. Claſs III. Order I. fig. 1), corolla (Plate IV. Claſs IV. Order I. fig. 4) pericarpium or germen of the piſtil enlarged ſeeds, and receptacle (Plate III. fig. 160, 161), are conſulted for eſtabliſhing the genera of plants. Hence, all vegetables that agree in theſe parts ſhould be ranked under one genus; and all ſuch as differ in them ſhould be ſeparated. The characteriſtic mark of each genus is, therefore, to be fixed from the number, figure, proportion, and ſituation of all the parts; but as there are few genera in which all the parts are conſtant in every one of the ſpecies, we ought, whenever it is poſſible, to fix upon ſome one circumſtance that is conſtant, and make it the eſſential character, which may be had in moſt genera. The more conſtant any part of the fructification is found through the ſeveral ſpecies of any genus, the more it may be relied on with certainty, as a characteriſtic mark of that genus. In ſome genera one part of fructification is found to be the moſt conſtant; and in others, another; but there is no part but is ſometimes liable to a variation.

As generic differences depend upon the form of the fructification, ſpecific diſtinctions take their riſe from any circumſtance in which plants of the ſame genus are found to diſagree, provided ſuch circumſtance is conſtant and not liable to alteration, by culture or other accidents. Hence Linnæus aſſerts the ſpecies to be as many as there were different forms of vegetables produced at the creation, and conſiders all caſual differences as varieties of the ſame ſpecies. The root often affords a real ſpecific difference, and is ſometimes the chief diſtinction; the trunk often

furniſhes a ſure mark of diſtinction; the leaves exhibit moſt natural and elegant ſpecific differences, and the flowers and other parts of the fructification have their influence likewiſe, in many caſes, in diſtinguiſhing the ſpecies.

Such differences as are only incidental to vegetables, and are not conſtant and unchangeable, conſtitute the ſeveral varieties of their reſpective ſpecies, which varieties are grounded chiefly on the following circumſtances, viz. magnitude, time of flowering, colour, ſcent, taſte, virtues and uſes, duration, multitude, puberſcence, oppoſition, and compoſition of leaves, the circumſtance of their being curled or bladdery, monſtrous flowers, which are to be conſidered only as a variety from luxuriance, and ſex in plants of the twenty-ſecond claſs. It is found that a change of ſoil occaſions many of the varieties in plants, as does likewiſe an improvement in, or neglect of, culture. The varieties may be generally explained, and eaſily reduced under their proper ſpecies, by comparing the variable mark of the variety with the natural plant.

The Sexual ſyſtem of botany being founded on the diſcovery of a diſtinction of ſexes in vegetables, the conſtruction and diſtribution of the ſyſtem are principally eſtabliſhed upon, and regulated by, the ſtamina, or male parts of the flower, repreſented in Plate IV. Claſs II. Order I. fig. 3 and 4; and piſtilla or female parts of the flower, repreſented on Plate IV. Claſs II. Order I. fig. 5, 6, 7. Such flowers as have ſtamina, but no piſtil, are called male flowers: ſuch as have a piſtil, but no ſtamina, female flowers: ſuch as have both ſtamina and piſtilla, hermaphrodite flowers: and ſuch as have neither, neuter. Hermaphrodite flowers are ſometimes diſtinguiſhable into male hermaphrodites, and female hermaphrodites, when, in a flower which contains the parts belonging to each ſex, one of the ſexes proves abortive; thus, if the defect be in the ſtamina, it is a female hermaphrodite; if in the piſtil, a male one.

The flowers of the generality of plants are hermaphrodite; but in the twenty-firſt and twenty-ſecond claſſes, the former diſtinguiſhed by the name of the Monoecia, and the latter by that of the Dioecia claſs, the ſexes are ſeparate and allotted to different flowers: and in the Dioecia, or twenty-ſecond claſs, in particular, the ſexes are found even on different plants; the male flowers growing all upon one plant, and the female flowers on another.

We ſhall here explain the *names* or *titles* of the ſeveral claſſes and orders, before we enter upon a particular account of each; becauſe an explanation of theſe names leads immediately to the knowledge of the proper characters of the ſeveral claſſes and orders, and the ſeveral diſtinctions on which they are founded.

The names and titles of the ſeveral claſſes and orders of this ſyſtem, as will be hereafter mentioned, are all compound terms, derived from the Greek language, and expreſſive, each of the principal circumſtance which obtains in the reſpective claſs or order that it ſerves to denominate; and which diſtinguiſhes it from every other claſs or order belonging to the ſyſtem.

The ten claſſes firſt in order, which conſiſt of hermaphrodite flowers, take their denominations from the *number* of ſtamina, or male parts, of the flower; and each denomination is a word compounded of the *numerical* term, which expreſſes the *number* of ſuch male parts, and the term ἀνὴρ, which ſignifies a *huſband*, the word uſed for the male part itſelf: thus,

I. *Monandria*, the title of the firſt claſs, is a word compounded of μόνος, *ſingle*, and ἀνὴρ, a *huſband*, and ſignifies a *ſingle huſband*, ſtamen, or male part.

II. *Diandria*, the title of the ſecond claſs, ſignifies two huſbands, or ſtamina.

III. *Triandria*, the title of the third claſs, ſignifies three huſbands, or ſtamina.

IV. *Tetrandria*, expreſſes four huſbands, or ſtamina.

V. *Pentandria*, five huſbands, or ſtamina.

VI. *Hexandria*, ſix huſbands.

VII. *Heptandria*, ſeven huſbands.

VIII. *Octandria*, eight huſbands.

IX. *Enneandria*, nine huſbands: and

X. *Decandria*, the title of the tenth claſs, ſignifies ten huſbands, ſtamina, or male parts.

It muſt be remembered, that in all theſe ten claſſes, the flowers are hermaphrodite: for ſhould the female part be wanting in any plant, containing the number of ſtamina which would otherwiſe refer it to one of theſe ten claſſes, the plant muſt be referred to ſome other ſucceeding claſs, not yet explained.

XI. *Dodecandria*, the title of the eleventh claſs, ſignifies twelve huſbands; and imports that the flowers have twelve ſtamina. The claſs is not, however, confined to this number, but includes all ſuch hermaphrodite flowers as are furniſhed with any number of ſtamina, from twelve to nineteen, both incluſive. No flowers have been yet found to have juſt eleven ſtamina, which is the reaſon no claſs has been allotted to that number.

XII. *Icoſandria*, the title of the twelfth claſs, is a word, compounded of εἴκοσι *twenty*, and ἀνὴρ, a *huſband*; and ſignifies twenty huſbands, or ſtamina: but here again, the title is to be underſtood with great latitude; for though the plants which belong to this claſs are rarely found with leſs than twenty ſtamina, yet they frequently have a greater number; and they are, therefore, not to be known with certainty from thoſe of the next claſs, without having recourſe to their claſſic character, which will be deſcribed in the ſubſequent arrangement.

XIII. *Polyandria*, the name of the thirteenth claſs, is a word formed of the two Greek words πολὺς *many*, and ἀνὴρ a *huſband*; and ſignifies that the flowers have many huſbands, or ſtamina.

XIV. *Didynamia*, the name of the fourteenth claſs, is compounded of δὶς, *twice*, or *two*, δύναμις *power*; and ſignifies the power or ſuperiority of two: becauſe the flowers of this claſs have four ſtamina, of which two are longer than the other two. This circumſtance alone is ſufficient to diſtinguiſh this claſs from the fourth, where the four ſtamina are equal: but the flowers of this claſs have alſo their particular character, beſides what is expreſſed in the title, as will be ſhewn in the following arrangement.

XV. *Tetradynamia*, the title of the fifteenth claſs, ſignifies the power or ſuperiority of four; becauſe the flowers of this claſs have ſix ſtamina, of which four are longer than the remaining two; which circumſtance diſtinguiſhes them from the flowers of the ſixth claſs, where the ſtamina are equal: but they have alſo their particular character.

XVI. *Monadelphia*, the title of the ſixteenth claſs, is a word compounded of μόνος, *ſingle*, and ἀδελφὸς, a *brother*; it ſignifies a *ſingle brotherhood*; which relation is employed to expreſs the union of the filaments of the ſtamina, which, in this claſs, do not ſtand ſeparate, but join at the baſe, and form one ſubſtance, out of which they proceed as from a common mother: this circumſtance diſtinguiſhes the claſs from the two following ones; the number of ſtamina belonging to it is not limited; the flowers have their particular character.

XVII. *Diadelphia*, the title of the ſeventeenth claſs, ſignifies a *double brotherhood*, or two ſets of ſtamina united in the manner explained in the ſixteenth claſs. The number of the ſtamina is not limited, and the flowers of the claſs have their peculiar character.

XVIII. *Polyadelphia*, the title of the eighteenth claſs, ſignifies many brotherhoods, or ſets of ſtamina; the flowers have no claſſic character, farther than is expreſſed in the title.

XIX. *Syngeneſia*, the title of the nineteenth claſs, is a word compounded of σὺν, *together*, or *in company*, and γένεσις *generation*; it ſignifies *congregation*, and alludes to the circumſtance of the ſtamina, in which, though the filaments ſtand ſeparate, yet the antheræ, which are the part more immediately ſubſervient to generation, are united in a cylinder, and perform their office together.

XX. *Gynandria*, the title of the twentieth claſs, is a term compounded of the two Greek words γυνὴ, a *wife*, and ἀνὴρ, a *huſband*, and alludes to the ſingular circumſtance of this claſs, in the flowers of which the ſtamina grow upon the piſtilla, ſo that the male and female parts are united, and do not ſtand ſeparate, as in other hermaphrodite flowers.

XXI. *Monoecia*, the name of the twenty-firſt claſs, is a word compounded of the numerical term μόνος *ſingle*, and οἶκος a *houſe*, or *habitation*; it therefore ſignifies a *ſingle houſe*; and to underſtand its application, it muſt be obſerved that the plants of this claſs are not hermaphrodite, but ſuch as upon the ſame root bear both male and female flowers, the flowers that have the ſtamina wanting the piſtilla, and thoſe that have the piſtilla wanting the ſtamina. Now the name alludes to this circumſtance, that in this claſs the male and female flowers are both found on the *ſame* plant, whereas in the next claſs they have *diſtinct* habitations.

XXII. *Dioecia*, the name of the twenty-ſecond claſs, ſignifies *two houſes*, or *habitations*; and is applied to this claſs, the plants of which are male and female, to expreſs the circumſtance of the male flowers being on one plant, and the female flowers on another; the contrary of which is the caſe of the Monoecia claſs, juſt preceding, which, upon the ſame roots bears both male and female flowers, and thoſe which have the ſtamina wanting the piſtilla, and ſuch as have the piſtilla wanting the ſtamina.

XXIII. *Polygamia*, the name of the twenty-third claſs, is a term compounded of πολὺς, *many*, and γάμος, a *marriage*; and ſignifies a *plurality of marriages*; the reaſon of which name is, that this claſs produces, either upon the ſame or different plants, hermaphrodite flowers, and alſo flowers of one ſex only, being male or female; or flowers of each ſex; and the latter receiving impregnation from, or giving it to, the hermaphrodites, as their

ſex

ſex may happen to be, the parts eſſential to generation in the hermaphrodite flowers do not confine themſelves to the correſponding parts within the ſame flower, but become of promiſcuous uſe.

XXIV. *Cryptogamia*, the name of the twenty-fourth claſs, is compounded of the two Greek words κρυπτὸς, *concealed*, and γάμος, a *marriage:* it therefore ſignifies concealed marriages, and was applied to this claſs becauſe the plants belonging to it either bear their flowers concealed within the fruit, or have them ſo ſmall as to be imperceptible.

Art. II. Orders.

As the ten firſt claſſes of the Linnæan ſyſtem of botany take their denominations from the number of ſtamina, or male parts of the flower, ſo the orders of the thirteen firſt claſſes take their denominations from the number of the piſtilla, or female parts of the flower; and as the denomination of each of the ten firſt claſſes is a word compounded of the *numerical term*, which expreſſes the *number* of ſuch male parts, as μόνος, *ſingle*, &c. and ἀνὴρ, a *huſband*, ſo the denomination of each order belonging to the thirteen firſt claſſes is a word compounded of the *numerical term*, which expreſſes the *number* of ſuch female parts, as *ſingle*, &c. and γυνὴ, a *wife*, thus as the terms *Monandria*, *Diandria*, &c. import, that the claſſes which they denominate have, the firſt a *ſingle huſband*, or ſtamen, the ſecond *two huſbands*, or ſtamina; ſo the terms *Monogynia*, *Digynia*, &c. import that the orders which they denominate have, the firſt a *ſingle wife*, or piſtil, the ſecond *two wives*, or piſtilla. In like manner, the order *Trigynia* ſignifies *three wives*, or piſtilla; the order *Tetragynia*, *four wives*, the order *Pentagynia*, *five wives*; the order *Hexagynia*, *ſix wives*; the order *Decagynia*, *ten wives*; and the order *Polygynia*, *many wives*. Theſe are the titles of the ſeveral orders of the thirteen firſt claſſes of this ſyſtem; and as from the *table* given of the claſſes and orders of the ſyſtem, the rank of each order will appear under its reſpective claſs, it now remains to offer ſome general explanation of the terms which denominate the ſeveral orders of the eleven following claſſes.

Of the three orders which conſtitute the *Didynamia*, or fourteenth claſs, *Gymnoſpermia*, the title of the firſt, ſignifies, that the plants of this order have *naked ſeeds*. *Angioſpermia*, the title of the ſecond order, ſignifies, that the plants belonging to the order have their *ſeeds covered* by a ſeed-veſſel, or pericarpium; and *Polypetala*, the title of the third order, ſignifies that ſuch plants as belong to this order have *many petals*.

The diſtinction of the two orders, which conſtitute the *Tetradynamia*, or fifteenth claſs, is founded in the pericarpium. In the firſt order *Siliculoſa*, the pericarpium is a *Silicula*, or little Siliqua, which differs from the Siliqua, in being round, and having the apex of the diſſepiment, which had been the ſtyle, prominent beyond the valves, often ſo far as to be equal in length to the Silicula. In the ſecond order *Siliquoſa*, the pericarpium is a Siliqua, which is long, and without any remarkable extenſion of the ſtyle.

The orders of the *Monadelphia*, *Diadelphia*, and *Polyadelphia*, or ſixteenth, ſeventeenth, and eighteenth claſſes, are each denominated from the number of ſtamina in each brotherhood, or diſtinct ſet of ſtamina: the titles of theſe orders are the *Pentandria*, the *Hexandria*, the *Octandria*, the *Decandria*, the *Icoſandria*, and the *Polyandria*, which, being the titles of the fifth, ſixth, eighth, tenth, twelfth, and thirteenth claſſes, have been already explained.

In order to underſtand the import of the titles given to the five ſeveral orders of the *Syngeneſia*, or nineteenth claſs, it is neceſſary to premiſe, that the flowers of the four firſt orders of this claſs, being compound, that is, comprehending many ſeſſile florets on a common receptacle, there ariſes an intercommunication of the ſeveral florets in one and the ſame flower, called *Polygamia*, which ſignifies Polygamy, or a *plurality of marriages*, as was obſerved in explaining the title of the twenty-third claſs, called *Polygamia*. This Polygamy of flowers affords four caſes, which are the foundations of the four firſt orders of the ſyngeneſia claſs. 1 *Polygamia Æqualis*, i. e. *equal Polygamy*, the denomination of the firſt order, is, when *all* the flowers are *hermaphrodite*. 2 *Polygamia Superflua*, *Superfluous Polygamy*, the title of the ſecond order, is when *ſome* of the florets are *hermaphrodite*, and *others female* only: for in this caſe, as the fructification is perfected in the hermaphrodites, the addition of the females is a *Superfluity*. 3 *Polygamia Fruſtranea*, *Fruſtraneous, or ineffectual Poligamy*, the title of the third order, is when ſome of the flowers are *hermaphrodite*, and others *neuter:* for in this caſe, the addition of the neuters is of no aſſiſtance to the Fructification. 4 *Polygamia Neceſſaria*, *Neceſſary Polygamy*, the title of the fourth order, is when ſome of the florets are *male*, and the reſt *female:* for in this caſe there being no hermaphrodites, the polygamy ariſing from the compoſition of the florets of different ſexes, is *neceſſary* to perfect the fructification. 5 *Monogamia*, the title of the fifth order, ſignifies a *ſingle marriage*, and is oppoſed to the Polygamia, or plurality of marriages, of the four other orders; for in this caſe, though the antheræ are united, which is the eſſential character of the flowers of this claſs, the flower is *ſimple*, and not compounded of *many* florets, as in the other orders.

The orders of the *Gynandria*, or twentieth claſs, are denominated each from the number of ſtamina: the titles of thoſe orders are, the *Diandria*, the *Triandria*, the *Tetrandria*, the *Pentandria*, the *Hexandria*, the *Decandria*, and the *Polyandria*, which, being the titles of the ſecond, third, fourth, fifth, ſixth, tenth, and thirteenth claſſes, have been already explained.

The *Monoecia* and *Dioecia*, or the twenty-firſt and twenty-ſecond claſſes, whoſe flowers have no fixed character, but that of not being hermaphrodite, take in the characters of almoſt every other claſs; and the orders have accordingly been diſpoſed under the titles of thoſe claſſes, to which their reſpective flowers would have belonged, if the ſtamina and piſtilla had been under the ſame covers. The orders of the *Monoecia*, or twenty-firſt claſs, are the *Monandria*, *Diandria*, *Triandria*, *Tetrandria*, *Pentandria*, *Hexandria*, *Heptandria*, *Polyandria*, *Monodelphia*, *Syngeneſia*, and *Gynandria*, which, being the titles of the firſt, ſecond, third, fourth, fifth, ſixth, ſeventh, thirteenth, ſixteenth, nineteenth, and twentieth claſſes, have been explained under the titles of thoſe claſſes; and the orders of the *Dioecia*, or twenty-ſecond claſs, are the *Monandria*, *Diandria*, *Triandria*, *Tetrandria*, *Pentandria*, *Hexandria*, *Octandria*, *Enneandria*, *Decandria*, *Polyandria*, *Monodelphia*, *Syngeneſia*, and *Gynandria*, which are the titles of the firſt, ſecond, third, fourth, fifth, ſixth, eighth, ninth, tenth, thirteenth, ſixteenth, nineteenth, and twentieth claſſes, already explained in explaining the names of theſe claſſes.

Of the orders of the *Polygamia*, or twenty-third claſs, the two firſt, *Monoecia* and *Dioecia*, are the ſame titles with thoſe of the twenty-firſt and twenty-ſecond claſſes, and are to be underſtood in the ſame manner; that is, *Monoecia*, when the polygamy is on the *ſame* plant, and *Dioecia*, when it is on *diſtinct* plants. *Trioecia*, the third and laſt order of this claſs, has been eſtabliſhed in favour of a ſingle genus, the *Ficus*, or *Fig-tree*, in which the polygamy is on three diſtinct plants, or producing male flowers, another female flowers, and a third hermaphrodite, or ſuch as upon the ſame root bear both male and female flowers.

The orders of the *Cryptogamia*, or twenty-fourth claſs, are the *Filices*, or *Ferns*, the *Muſci*, or *Moſſes*, the *Algæ*, or *Flags*, and the *Fungi*, or *Muſhrooms*.

The moſt general diviſion of vegetables, according to the ſyſtem of Linnæus, is into twenty-four *claſſes*, each claſs is ſubdivided into *orders*, each order into *genera*, each genus into *ſpecies*, and each ſpecies into *varieties:* for an explanation of the *claſſes* and *orders*, it is thought expedient to inſert the two following *tables*, which, at one view, exhibit the titles and arrangement of the ſeveral claſſes and orders of the ſyſtem; after which each claſs, with its reſpective orders, will be particularly treated of and explained.

Orders are taken from the females or piſtils, as Classes: from the males or ſtamens; but in the claſs of connected males, the Orders differ from others, as in

One female, two females, three females, &c. according to the number of piſtils.

The number of the piſtil is reckoned from the baſe of the ſtyle; but if there is no ſtyle, the calculation is made from the number of ſtigmas.

Equal Polygamy, conſiſts of many marriages, with promiſcuous intercourſe.

That is, *of many florets furniſhed with ſtamens and piſtils. The flowers of theſe are vulgarly called* Floſculous.

Spurious Polygamy, where the beds of the married occupy the diſk, and thoſe of the concubines the circumference.

That is, *the hermaphrodite florets occupy the diſk, and the female florets, without ſtamens, ſurround the border, and that in three manners.*

(a) Superfluous Poligamy, when the married females are fertile, and thence the concubines ſuperfluous.

That is, *when the hermaphrodite flowers of the diſk are furniſhed with ſtigmas, and produce ſeeds; and the female flowers alſo, which conſtitute the circumference, produce ſeeds likewiſe.*

(b) Fruſtraneous Poligamy, when the married females are fertile, and the concubines barren.

That is, *when the hermaphrodite flowers of the diſk are furniſhed with a ſtigma, and produce ſeeds; but the florets which conſtitute the circumference, having no ſtigma, produce no ſeeds.*

(c) Necessary Polygamy, when the married females are barren and the concubines fertile.

That is, *when the hermaphrodite flowers, from defect of the ſtigma of the piſtil, produce no ſeeds; but the female flowers in the circumference produce perfect ſeeds.*

(e) Separate Polygamy, when many beds are ſo united that they conſtitute one common bed.

That is, *when many flower-bearing calyxes are contained in one common calyx, ſo as to conſtitute one flower.*

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Article III.

KEY to the SEXUAL SYSTEM.

MARRIAGES of PLANTS.

Florescence.

PUBLIC MARRIAGES.

Flowers visible to every one.

In one Bed.

Husband and wife have the same bed.

All the flowers hermaphrodite: stamens and pistils in the same flower.

Without Affinity.

Husbands not related to each other.

Stamens not joined together in any part.

With Equality.

All the males of equal rank.

Stamens have no determinate proportion in length.

1 ONE MALE.
2 TWO MALES.
3 THREE MALES.
4 FOUR MALES.
5 FIVE MALES.
6 SIX MALES.
7 SEVEN MALES.
8 EIGHT MALES.
9 NINE MALES.
10 TEN MALES.
12 TWELVE MALES.
20 TWENTY MALES.
13 MANY MALES.

With Subordination.

Some males above others.

Two stamens are always lower than the others.

14 TWO POWERS. 15 FOUR POWERS.

With Affinity.

Husbands related to each other.

Stamens cohere with each other, or with the pistil.

16 ONE BROTHERHOOD.
17 TWO BROTHERHOODS.
18 MANY BROTHERHOODS.
19 CONFEDERATE MALES.
20 FEMININE MALES.

In Two Beds.

Husband and wife have separate beds.

Male flowers and female flowers in the same species.

21 ONE HOUSE. 22 TWO HOUSES.
23 POLYGAMIES.

Clandestine Marriages.

Flowers scarcely visible to the naked eye.

24 CLANDESTINE MARRIAGES.

Article IV.

TABLE OF THE CLASSES AND ORDERS.

Class I. MONANDRIA, or One Male.
One husband in marriage.
One stamen in the hermaphrodite flower.
This class comprehends two Orders:
1 Monogynia, 2 Dyginia.

Class II. DIANDRIA, or Two Males.
Two husbands in the same marriage.
Two stamens in an hermaphrodite flower.
This Class comprehends three Orders:
1 Monogynia, 2 Dygynia, 3 Tryginia.

Class III. TRIANDRIA, or Three Males.
Three husbands in the same marriage.
Three stamens in an hermaphrodite flower.
This Class comprehends three Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,

Class IV. TETRANDRIA, or Four Males.
Four husbands in the same marriage.
Four stamens in the same flower with the fruit.
(If the two nearest stamens are shorter it is referred to Class 14.)
This Class comprehends three Orders:
1 Monogynia, 2 Dyginia, 3 Tetragynia.

Class V. PENTANDRIA, or Five Males.
Five husbands in the same marriage.
Five stamens in an hermaphrodite flower.
This Class comprehends six Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,
4 Tetragynia, 5 Pentagynia, 6 Polygynia.

Class VI. HEXANDRIA, or Six Males.
Six husbands in the same marriage.
Six stamens in an hermaphrodite flower.
(If the two opposite stamens are shorter, it belongs to Class 15.)
This Class comprehends five Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,
4 Tetragynia, 5 Polygynia.

Class VII. HEPTANDRIA, or Seven Males.
Seven husbands in the same marriage.
Seven stamens in the same flower, with the pistil.
This Class has only one Order, viz. Monogynia.

Class VIII. OCTANDRIA, or Eight Males.
Eight husbands in the same marriage.
Eight stamens in the same flower, with the pistil.
This Class comprehends four Orders:
1 Monogynia, 2 Digynia, 3 Trigynia, 4 Tetragynia.

Class IX. ENNEANDRIA, or Nine Males.
Nine husbands in the same marriage.
Nine stamens in an hermaphrodite flower.
This Class comprehends three Orders:
1 Monogynia, 2 Trigynia, 3 Hexagynia.

Class X. DECANDRIA, or Ten Males.
Ten husbands in the same marriage.
This Class comprehends five Orders:
1 Monogynia, 2 Dyginia, 3 Trigynia,
4 Pentagynia, 5 Decagynia.

Class XI. DODECANDRIA, or Twelve Males.
Twelve husbands in the same marriage.
Twelve stamens to nineteen in an hermaphrodite flower
This Class comprehends five Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,
4 Pentagynia, 5 Polygynia.

Class XII. ICOSANDRIA, or Twenty Males.
Generally twenty husbands, often more.
Stamens inserted on the calyx (not on the receptacle) in an hermaphrodite.
This Class comprehends five Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,
4 Pentagynia, 5 Polygynia.

Class XIII. POLYANDRIA, or Many Males.
Twenty males or more in the same marriage.
Stamens inserted on the receptacle from 20 to 1000 in the same flower with pistil.
This Class comprehends seven Orders:
1 Monogynia, 2 Digynia, 3 Trigynia,
4 Tetragynia, 5 Pentagynia, 6 Hexagynia.
7 Polygynia.

Class XIV. DIDYNAMIA, or Two Powers.
Four husbands, two taller than the other two.
Four stamens, of which the two nearest are the longer.
This Class comprehends three Orders:
1 Gynospermia, 2 Angiospermia, 3 Polypetala.

Class XV. TETRADYNAMIA, or Four Powers.
Six husbands, of which four are taller.
Six stamens, of which four are longer, and the two opposite ones shorter.
This Class has two Orders: 1 Siliculosa, 2 Siliquosa.

Class XVI. MONODELPHIA, or One Brotherhood.
Husbands, like brothers, arise from one base.
Stamens are united by their filaments into one body.
This Class has three Orders:
1 Pentandria, 2 Decandria, 3 Polyandria.

Class XVII. DIADELPHIA, or Two Brotherhoods.
Husbands arise from two bases, as if from two mothers.
Stamens are united by their filaments into two bodies.
This Class comprehends three Orders:
1 Hexandria, 2 Octandria, 3 Decandria.

Class XVIII. POLYADELPHIA, or Many Brotherhoods.
Husbands arise from more than two mothers.
Stamens are united by their filaments into three or more bodies.
This Class comprehends three Orders:
1 Pentandria, 2 Icosandria, 3 Polyandria.

Class XIX. SYNGYNESIA, or Confederate Males.
Husbands jointed together at the top.
Stamens are connected by the antheræ, forming a cylinder (seldom by the filaments).
This Class comprehends six Orders:
1 Polygamia æqualis, 2 Polygamia superflua,
3 Polygamia frustranea, 4 Polygamia necessaria,
5 Polygamia segregata, 6 Monogamia.

Class

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CLASS XX. GYNANDRIA, or FEMININE MALES.
Huſbands and wives growing together.
Stamens are inſerted on the piſtils (not on the receptacle).
This Claſs comprehends ſeven Orders:
1 Diandria, 2 Triandria, 3 Tetrandria,
4 Pentandria, 5 Hexandria, 6 Decandria,
7 Polyandria.

CLASS XXI. MONOECIA, or ONE HOUSE.
Huſbands live with their wives in the ſame houſe, but have different beds.
Male flowers and female flowers are on the ſame plant.
This Claſs comprehends eleven Orders:
1 Monandria, 2 Diandria, 3 Triandria,
4 Tetrandria, 5 Pentandria, 6 Hexandria,
7 Heptandria, 8 Polyandria, 9 Monodelphia,
10 Syngyneſia, 11 Gynandria.

CLASS XXII. DIOECIA, or TWO HOUSES.
Huſbands and wives have different houſes.
Male flowers and female flowers are on different plants.
This CLASS comprehends fourteen Orders:
1 Monandria, 2 Diandria, 3 Triandria,
4 Tetrandria, 5 Pentandria, 6 Hexandria,
7 Octandria, 8 Enneandria, 9 Decandria,
10 Dodecandria, 11 Polyandria, 12 Monodelphia
13 Syngyneſia, 14 Gynandria.

CLASS XXIII. POLYGAMIA, or POLYGAMIES.
Huſbands live with wives and concubines.
Hermaphrodite flowers, and male ones, or female ones in the ſame ſpecies.
This Claſs comprehends three Orders:
1 Monoecia, 2 Dioecia, 3 Trioecia.

CLASS XXIV. CRYPTOGAMIA, or CLANDESTINE MARRIAGES.
Nuptials are celebrated privately.
Flowers concealed within the fruit in the ſame irregular manner.
This Claſs comprehends four orders:
1 Filices, 2 Muſci, 3 Algæ, 4 Fungi.

Having explained the names, or titles, of the ſeveral claſſes and orders of the Linnæan ſyſtem of botany, we ſhall now proceed to conſider theſe claſſes, with their reſpective orders, more particularly.

In order to illuſtrate the ſeveral Orders appertaining to each reſpective Claſs, we have ſelected one Genus in each reſpective Order throughout the whole twenty-four Claſſes; and to render our deſcriptions as plain as poſſible, we have introduced, independent of the three introductory Plates, three others, in which are diſplayed delineations of the reſpective Genera, as accurately as they could poſſibly be drawn, ſo that clear and eaſy reference may be made from the deſcriptions to the Plates, and from the Plates to the deſcriptions.

CLASS I. MONANDRIA.

The firſt claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with but one ſtamen. It has two orders. 1. MONYGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing eleven genera, diſtinguiſhed into, 1. *Trilocular*, or, ſuch as have the ſeed-veſſel divided into three loculaments, and, 2. *Monoſpermous*, or ſuch as have only a ſingle ſeed. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles and containing four genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 1. *Canna* (Indian flowering reed). The whole flower is repreſented in the firſt figure; the perianthium is triphillous, as 1; the corolla monopetalous, but divided into ſix ſegments, 2, 2; the nectarium is ſhaped like a petal, and divided into two ſegments, the upper aſcending archwiſe, the inferior rolled back, 3; the filament is wanting, but the anthera adheres to the margin of the ſuperior ſegment of the nectarium, 4; the parts of the piſtil are a roundiſh germen, 5; ſword-ſhaped ſtyle, 6, adhering to the nectarium; and a linear ſtigma, 7, growing to the margin of the ſtyle.

ORDER II. DIGYNIA. Genus 3. *Blightum* (virgate ſtrawberry blite). The perianthium is tripartite, 1; no corolla; the filament briſtly, 2; the antheræ is a twin, 3; the germen ovate, 4; the ſtyles two, 5, 5; and the ſtigma ſimple, 6, 6.

CLASS II. DIANDRIA.

The ſecond claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with two ſtamina. It has three orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing twenty-four genera, diſtinguiſhed into, 1. ſuch as have regular corollæ; 2. ſuch as have irregular corollæ, and the fruit angioſpermous, or the ſeeds included in a veſſel; 3. ſuch as have irregular corollæ, and the fruit gymnoſpermous, or the ſeeds naked. 2. DYGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing two genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing only one genus.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 24, *Monarda* (Oſwego tea). The perianthium of one leaf, 1; the corolla monopetalous, but divided into two lips, 2; the two filaments are ſetaceous, 3; the antheræ compreſſed, 4; the germen quadrifid, 5; the ſtyle filiform, 6; and the ſtigma bifid, 7.

ORDER II. DIGYNIA. Genus 1, *Anthoxanthum* (vernal graſs). The calyx is a bivalvular glume, with one flower, 1; the corolla is a uniflorous bivalvular glume, each valve having a dorſal ariſta, 2; the nectarium is diphillous, thin, cylindrical, embracing the germen, ſtamen, and ſtyle, 3, 3; the filaments like two hairs, 4, 4; the antheræ double forked, 5, 5; the germen oblong, 6; and the ſtyles thread-ſhaped, 7, 7.

ORDER III. TRIGYNIA. Genus 1, *Piper* (black pepper). The perianthium monophyllous, 1; no corolla, or filaments; the antheræ are two, placed at the root of the germen, 2; the germen is large, 3; there are no ſtyles, but there are briſtly ſtigmas, 4; a filiform ſpadix, covered with flowers, 5.

CLASS III. TRIANDRIA.

The third claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with three ſtamina. It has three orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing twenty-three genera, diſtinguiſhed into, 1. thoſe whoſe flowers have no ſpatha or amentum; 2. ſuch as have ſpathaceous flowers, and a trilocular capſule; 3. ſuch as have an imbricated amentum, and are gymnomonoſpermous, or have ſeeds ſingle and naked. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing twenty-nine genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing eight genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 14, *Crocus* (garden crocus). The calyx a ſpatha, 1; the corolla is monopetalous; its tube, 2, is long, and its limb divided in ſix parts, 3; the filaments are three and awl-ſhaped, 4; the antheræ are arrow-ſhaped, 5; the germen is roundiſh, 6; the ſtyle filiform, 7; the ſtigmas are three, 8, 8.

ORDER II. DIGYNIA. Genus 2, *Avena Fatua* (wild oats). The calyx is a bivalvular glume generally with many flowers; the valves without beards, 1; the wild oat, having a beard, 2; the corolla bivalvular, having a beard ſpirally wreathed, and growing out at its bark; the filaments are three, and like hairs, 3; the antheræ oblong and bifurcate, 4; the germen obtuſe, 5; the ſtyles are two, reflex, thread like, and feathered at the top, 6; but the ſtigmas undivided.

ORDER III. TRIGYNIA. Genus 8, *Mallugo* (Virticillute). The calyx a perianthium of five leaves, 1; no corolla; the filaments three, lying cloſe to the piſtil, 2; the antheræ ſimple, 3; the germen ovate and triſulcate, 4; the ſtyles are three and ſhort, 5.

CLASS IV. TETRANDRIA.

The fourth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with four ſtamina. The flowers of this claſs may be known from thoſe of the fourteenth claſs by this diſtinction, that the ſtamina are of equal length; whereas in thoſe of the fourteenth, which have four ſtamina likewiſe, there are two long and two ſhort. The orders of this claſs are three. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing fifty-one genera, diſtinguiſhed into, 1. ſuch as have aggregate flowers, with the ſeeds ſingle and naked; 2. ſuch as have their flowers monopetalous, or compoſed of a ſingle petal, on a double fruit, and the ſtyle bifid, or divided into two parts; 3. ſuch as have monopetalous flowers otherwiſe circumſtanced; 4. ſuch as have tetrapetalous flowers, or flowers compoſed of four petals, and complete; that is not wanting either calyx or corolla; 5. ſuch as are incomplete, or want the calyx or corolla. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing four genera. 3. TETRAGYNIA,

the third order, comprehending ſuch plants as have four ſtyles, and containing ſix genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 4, *Dipſacus* (laciniated teazel). The common perianthium of the calyx is multiflorous, 1; the proper perianthium ſcarce diſtinguiſhable to the naked eye, 2; the univerſal corolla equal, 3; the proper corolla monopetalous, 4; the filaments are four, 5; the antheræ incumbent, 6; the germen, 7; and the ſtyle filiform, 8.

ORDER II. DIGYNIA. Genus 4, *Hemamelis* (witch hazel). The involucrum is triphyllous, 1; the calyx a double perianthium, the exterior diphyllous, and the interior tetraphyllous, 2; the corolla has four long linear petals, 3; the nectarium four foliole, truncated, and grown to the corolla, 4; the filaments are four and linear, 5; the antheræ obovate like two together, with a ſmall elevated top, 6; the germen ovate and hairy, 7; the ſtyles two, 8; and the ſtigmas truncated, with an elevated top, 9.

ORDER III. TETRAGYNIA. Genus 3, *Potamogeton* (pond weed). The corolla hath four petals, 1; the filaments are four, but very ſhort, 2; the antheræ are twins, 3; the germina are four, 4; no ſtyle; the ſtigmas obtuſe, 5.

CLASS V. PENTANDRIA.

The fifth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with five ſtamina. It has ſix orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing one hundred and three genera, diſtinguiſhed into, 1. *Monopetalous tetraſpermous*, or a flower compoſed of a ſingle petal with four ſeeds. 2. *Monopetalous*, or a flower compoſed of a ſingle petal, with the capſule placed within the flower. 3. *Monopetalous*, or a flower compoſed of a ſingle petal, with the germen below the flower. 4. Such as have declining ſtamina. 5. *Monopetalous*, or a flower compoſed of a ſingle petal, with a berry above the receptacle. 6. *Polypetalous*, or a flower compoſed of many petals. 7. Incomplete flowers. 8. Such as have the lobes of the corollæ bent obliquely to the right. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing ſixty-four genera, diſtinguiſhed into, 1. Such as have the lobes of the corollæ bent obliquely to the right. 2. *Monoſpermous*, or ſuch as are ſingle-ſeeded. 3. *Polyſpermous*, or ſuch as have many ſeeds. 4. *Gymnodiſpermous*, or ſuch as have two naked ſeeds, with a ſimple umbel. 5. *Gymnodiſpermous*, or ſuch as have two naked ſeeds, with an univerſal and partial involucrum. 6. *Gymnodiſpermous*, or ſuch as have two naked ſeeds, with only a partial umbel. 7. *Gymnodiſpermous*, without any involucrum. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing fourteen genera. 4. TETRAGYNIA, the fourth order, comprehending ſuch plants as have four ſtyles; and containing but one genus. 5. PENTAGYNIA, the fifth order, comprehending ſuch plants as have five ſtyles, and containing nine genera. 6. POLYGYNIA, the ſixth order, comprehending ſuch plants as have many ſtyles, and containing but one genus.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 132, *Nerium* (roſe-bay). The perianthium monophyllous, and quinquepartite, 1; the corolla of one leaf, and funnel ſhaped, but divided at the upper part into five, 2; the filaments are five, and ſhort, 3; the antheræ arrow-ſhaped, inclining together, and terminating in a long thread, 4; the germen roundiſh and bifid, 5; the ſtyle cylindric, 6; and the ſtigma truncate, 7.

ORDER II. DIGYNIA. Genus 67, *Anethum* (common fennel). The univerſal umbel conſiſts of many partial umbels, 1; a partial umbel, 2; and univerſal involucrum none; a partial one none; the proper perianthium obſolete; the univerſal corolla uniform; the floſcules all fertile, and conſiſting of five petals, 3; the filaments and capillary, 4; the antheræ roundiſh, 5; the germen, 6; the ſtyles two, 7; and the ſtigmata obtuſe, 8.

ORDER III. TRIGYNIA. Genus 9, *Turnera*. The perianthium monophyllous, its tube cylindrical, the limb quinquepartite, 1; the petals five, 2; the filaments five, 3; the antheræ 4; the conic germen, 5; the ſtyles three, 6; a ſtyle magnified, 7; the ſtigmas are bundles of hairs, 8.

ORDER IV. TETRAGYNIA. Genus 1, *Parnaſſia* (graſs of Parnaſſus). The petals five, 1; the filaments five, 2; the antheræ, 3; the nectaria five, 4; the germen ovate, 5; no ſtyle; the ſtigmas four, 6.

ORDER V. PENTAGYNIA. Genus 7, *Craſſula* (navelwort). The perianthium pentaphyllous, 1; the petals five, united at their baſe, 2; the filaments five, 3; the antheræ oblong, 4; the germina five, 5; the nectaria five, 6; the ſtyles five, 7; the ſtigma obtuſe, 8.

ORDER VI. POLYGYNIA. Genus 1, *Myoſurus* (mouſe tail). The perianthium pentaphyllous, 1; no corolla; the nectaria five, 2; the filaments five, 3; the antheræ oblong, 4; the germina numerous, 5; each germen is conic and ſmooth, 6; no ſtyles: ſtigmas ſimple, 7.

CLASS VI. HEXANDRIA.

The ſixth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with ſix ſtamina. The flowers of this claſs may be known from thoſe of the fifteenth by this diſtinction, that the ſtamina are of equal length; whereas in thoſe of the fifteenth, which have ſix ſtamina likewiſe, there are four long, and two ſhort. The orders of this claſs are five. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing forty-ſeven genera, diſtinguiſhed into, 1. Such as have trifid corolla, and a calyx. 2. Such as have a monophyllous ſpatha, or a ſpatha conſiſting of a ſingle leaf. 3. Such as are hexapetalous, and naked, *i. e.* conſiſt of ſix petals, and have no calyx. 4. Such as are monopetalous and naked, *i. e.* conſiſting of a ſingle petal, and have no calyx. 5. Such as have a calyx, but the corolla not trifid. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing three genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing eleven genera. 4. TETRAGYNIA, the fourth order, comprehending ſuch plants as have four ſtyles, and containing but one genus. 5. POLYGYNIA, the fifth order, comprehending ſuch plants as have many ſtyles, and containing but one genus.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 13, *Amaryllis* (belladona). The corolla hexapetalous, bell-ſhaped with a hook on every other petal, 1; the filaments fix, 2; the antheræ, 3; the germen, 4; the ſtyles, 5; and the ſtigmas, 6.

ORDER II. DIGYNIA. Genus 1, *Oryza* (rice). The glume of the calyx, 1; the corolla is bivalve, 2; the nectaria are two, 3; the filaments fix, the capillary, 4; the antheræ bifid, 5; the germen ſhaped like a top, 6; the ſtyles two, 7; and the ſtigmas elevated, 8.

ORDER III. TRIGYNIA. Genus 2, *Rumex* (great curled dock). The perianthium triphyllous; the petals three, 1; the filaments ſix, 2; the antheræ, 3; the germen, 4; the ſtyles three, 5; the ſtigmas, 6.

ORDER IV. TETRAGYNIA. Genus 1, *Petiveria*. The perianthium monophyllous, but quadripartite, 1; no corolla, the filaments ſix, 2; the antheræ oblong, 3; the germen compreſſed, 4; the ſtyles four, 5; and the ſtigmas, 6.

ORDER V. POLYGYNIA. Genus 1, *Aliſma* (great water plantation). The petals three, 1; the filament ſix, 2; the antheræ roundiſh, 3; the germina more than five, 4; a ſingle germen, 5; the ſtyle, 6; and ſtigma, 7.

CLASS VII. HEPTANDRIA.

The ſeventh claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with ſeven ſtamina. It has but one order. 1. MONOGYNIA, comprehending ſuch plants as have but one ſtyle, and containing but two genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 2, *Æſculas* (horſe cheſnut). The perianthium monophyllous, tubelous, quinquefid, 1; corolla, five petals inſerted in the calyx, 2 *a*; the filaments ſeven inſerted in the receptacle, ſubulate, bending downwards, pilous, 4 *b*, 3 *a*; antheræ ovate, riſing upright, 2 *c*, 3 *b*; germen ovate and villous, 4 *a*, 5 *a*, ending in the ſubulate ſtyle, 5 *b*; ſtigma accuminate, 5 *c*.

ORDER III. TETRAGYNIA. Genus 1, *Saururus* (lizard's tail). The amentum (or catkin) oblong, covered with flowers, 1; the proper perianthium monophyllous, ovate, lateral, coloured, and hairy, 2, 3; corolla none; filaments ſeven, filiform, 3 *a*; antheræ oblong, erect, 3 *b*; germina four, ovate, 4 *a*; ſtyles thickiſh, ſubulate, 4 *b*; ſtigmas ſimple, acute, 4 *c*.

CLASS VIII. OCTANDRIA.

The eighth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with eight ſtamina. It has four orders, 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing twenty-two genera. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing two genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing four genera. 4. TETRAGYNIA, the fourth order, comprehending ſuch plants as have four ſtyles, and containing three genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 4, *Oenothera* (tree primroſe). The perianthium monophyllous, the tube cylindraceous, the limb quadripartite, 1; corolla, four petals, obcordate, 2 *a*; inſerted at the diviſures of the calyx, 3; filaments eight, ſubulate incurved, inſerted in the mouth of the calyx, ſhorter than the corolla, 2 *b*, 4 *a*; antheras oblong, incumbent, 2 *c*, 4 *b*; germen cylindraceous, ſtanding under the corolla, 5 *a*; ſtyle filiform, of the length of the ſtamina, 5 *b*; ſtigmas quadrifid, thick, obtuſe, reflexed, 5 *c*.

ORDER

Classes and Orders, according to Linnæus.
See System of Botany. Sect. 4. Class 11.

Class 11. Dodecandria
Order 3. Trigynia

Lathyris

Class 11. Dodecandria
Order 5. Polygynia

Houseleek

Class 12. Icosandria
Order 1. Monogynia

Pomegranate

Class 12. Icosandria
Order 2. Digynia

Beam Tree

Class 12. Icosandria
Order 3. Trigynia

Quicken Tree

Class 12. Icosandria
Order 4. Pentagynia

Cestlin Apple

Class 12. Icosandria
Order 5. Polygynia

Bramble

Class 13. Polyandria
Order 1. Monogynia

Sarracenia

Class 13. Polyandria
Order 2. Digynia

Plum

Class 13. Polyandria
Order 3. Trigynia

Wolfsbane

Class 13. Polyandria
Order 5. Pentagynia

Columbine

Class 13. Polyandria
Order 6. Hexagynia

Water Aloe

Class 13. Polyandria
Order 7. Polygynia

Crowfoot

Class 14. Didynamia
Order 1. Gymnospermia

Melittis

Class 14. Didynamia
Order 2. Angiospermia

Honey Flower

Class 15. Tetradynamia
Order 1. Siliculosa

Honesty

Class 15. Tetradynamia
Order 2. Siliquosa

Stock July flower

Class 16. Monadelphia
Order 1. Pentandria

Hermannia

Class 16. Monadelphia
Order 2. Decandria

African Cranes bill

Class 16. Monadelphia
Order 4. Dodecandria

Indian vervain Mallow

Class 16. Monadelphia
Order 5. Polyandria

Rose Mallow

Class 17. Diadelphia
Order 2. Hexandria

Fallow Fumitory

Class 17. Diadelphia
Order 3. Octandria

Milkwort

Class 17. Diadelphia
Order 4. Decandria

Everlasting Pea

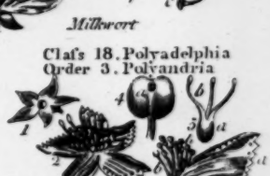
Class 18. Polyadelphia
Order 1. Pentandria

Theobroma

Class 18. Polyadelphia
Order 2. Icosandria

Orange

Class 18. Polyadelphia
Order 3. Polyandria



St. John's-wort

Class 19. Syngenesia
Order 1. Polygamia Æqualis

Dandelion

Class 19. Syngenesia
Order 2. Polygamia Superflua

Xeranthemum

Class 19. Syngenesia
Order 3. Polygamia Frustanea

Sun flower

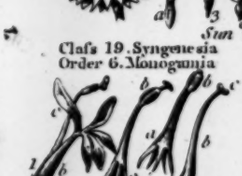
Class 19. Syngenesia
Order 4. Polygamia Necessaria

Marygold

Class 19. Syngenesia
Order 5. Polygamia Segregata

Globe Thistle

Class 19. Syngenesia
Order 6. Monogamia



Cardinal Flower

Class 20. Gynandria
Order 1. Diandria

Orchis

Class 20. Gynandria
Order 1. Triandria

Bermudiana

Class 20. Gynandria
Order 4. Pentandria

Passion Flower

Class 20. Gynandria
Order 5. Hexandria

Birthwort

Class 20. Gynandria
Order 7. Polyandria

Cuckow Pint

ORDER II. DIGYNIA. Genus 2, *Galenia*. The perianthium ſmall, quadrifid, and concave; 1; corolla none; filaments eight, like hairs, 2 *a*; antheræ divided into two lobes, 2 *b*, 3 *a*; germen nearly round, 2 *c*, 4 *a*; ſtyles two, ſimple, reflexed, 4 *b*; ſtigmas, ſimple, obtuſe, 4 *c*.

ORDER III. TRIGYNIA. Genus 1, *Polygonum* (buck wheat). The perianthium turbinate, on the outſide coloured, quinquepartite, 1 *a*, 2 *a*; corolla none, except the coloured calyx: filaments often eight, ſubulate, ſhort, 2 *b*, *a*; antheras ſubrotund, incumbent, 2 *c*, 3 *b*; the germen triquetrous, 2 *d*, 4 *a*; ſtyles often three, filiform, very ſhort, 4 *b*; ſtigmas ſimple, 4 *c*.

ORDER IV. TETRAGYNIA. Genus 2, *Adoxa* (tuberous muſchatel). The flowers terminating in a head, 1; perianthium below the flowers, bifid, ſpreading flat, 2; corolla monopetalous, quadrifid, ſpreading flat, 3 *a*; filaments eight, 3 *b*, 4 *a*; antheras ſubrotund, 3 *c*, 4 *b*; germen within the receptacle of the corolla, 3 *d*, 5 *a*; ſtyles four, ſimple, erect, 5 *b*; ſtigmas ſimple, 5 *c*.

CLASS IX. ENNEANDRIA.

The ninth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with nine ſtamina. It has three orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing but one genus. 2. TRIGYNIA, the ſecond order, comprehending ſuch plants as have three ſtyles, and containing two genera. 3. HEXAGYNIA, the third order, comprehending ſuch plants as have ſix ſtyles, and containing but one genus.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 4, *Caſſita* (berry bearing). The perianthium triphillous; the folioles acute, concave, a little ſpreading, 1 *a*, 2 *a*; petals three, their margins from the middle to their points convolute, 2 *b*; the nectarium is formed of three glands, coloured, truncate, the length of the germen, and ſtanding round it, 3 *a*, 4 *a*; filaments nine, 2 *c*, 4 *b*; antheras with three lobes, 4 *c*; germen ſtanding under the flower, 2 *d*, 4 *d*, 5 *a*; ſtyle, 5 *b*; ſtigma trilobate, 5 *c*.

ORDER II. TRYGYNIA. Genus 1, *Rheum* (palmated rhubarb). Calyx none; corolla monopetalous, the limb cut into ſix ſegments, 1 *a*; filaments nine inſerted into the corolla, 1 *b*; antheras twins, 1 *c*; germen three-cornered, 2 *a*; ſtyles ſcarce any, 2 *b*; ſtigmas three, reflex, plumoſe, 2 *c*.

ORDER III. HEXAGYNIA. Genus 1, *Butomus* (flowering ruſh). The involucrum ſimple, triphyllous, 1; petals ſix, 2 *a*; filaments nine, of which ſix are exterior, 3 *a*; antheras as if compoſed of two plates, 3 *b*; germen ſix, *a*; terminating in ſtyles, 4 *b*; ſtigmas ſimple, growing to the inſide of the ſtyles, 4 *c*.

CLASS X. DECANDRIA.

The tenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with ten ſtamina. It has five orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing thirty-five genera, diſtinguiſhed into, 1. Such as have declined ſtamina. 2. Such as have erect ſtamina. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing ten genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing ten genera. 4. PENTAGYNIA, the fourth order, comprehending ſuch plants as have five ſtyles, and containing nine genera. 5. DECAGYNIA, the fifth order, comprehending ſuch plants as have ten ſtyles, and containing two genera.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 39, *Kalmina* (narrow leaved kalmia). The perianthium quinquepartite, 1; corolla monopetalous partly hypocrateriform, and partly infundibuliform, cut into five ſegments, 2 *a*; ten nectariferous horn-ſhaped cavities, which before the flower is perfectly blown, contain the ſtamens and antheras like a ſheath, 2 *b*, 3 *a*; filaments ten, inſerted into the baſe of the corolla, 3 *b*; antheras ſimple, 3 *c*; germen roundiſh, 4 *a*; ſtyle filiform, 4 *b*; ſtigma obtuſe, 4 *c*.

ORDER II. DIGYNIA. Genus 5, *Saxifraga* (ſaxifrage). The perianthium monophyllous, quinquepartite, 1; petals five, 2 *a*; filaments ten, 3 *a*; antheras ſubrotund, 3 *b*; germen roundiſh, tapering upwards, 3 *c*, 4 *a*, ſo as to form two ſhort ſtyles, 4 *b*; ſtigmas obtuſe, 4 *c*.

ORDER III. TRIGYNIA. Genus 3, *Stellaria* (greater ſtitchwort). The perianthium pentaphyllous, 1; petals five, bipartite oblong, 2 *a*; filaments ten, every other ſhorter, 3 *a*; antheras heart-ſhaped, 3 *b*; ſtigmas obtuſe, 4 *c*.

ORDER IV. PENTAGYNIA. Genus 9, *Oxalis* (wood ſorrel). The perianthium quinquepartite, 1; corolla monopetalous, quinquepartite, the ungues joined together at their baſes, 2 *a*; filaments ten, capillary, the exterior ſhorter than the interior, 3 *a*; antheras ſubrotund, furrowed, 3 *b*; germen quinquangular, 4 *a*; ſtyles five, filiform, 4 *b*; ſtigmas obtuſe, 4 *c*.

ORDER V. DECAGYNIA. Genus 2, *Phytolacca* (American nightſhade). Calyx none (except the corolla is taken for a coloured calyx); petals five, 1 *a*, 2 *a*; filaments ten (eight or twenty), 2 *b*; antheras ſubrotund, 2 *c*; germen obicular, divided on the outſide by little bands or wreaths, 2 *d*, 3 *a*, terminating with ten (or eight) ſtyles, 3 *b*; ſtigmas ſimple, 3 *c*.

CLASS XI. DODECANDRIA.

The eleventh claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with any number of ſtamina, from twelve to nineteen, both incluſive. It has five orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing eleven genera. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing two genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing two genera. 4. PENTAGYNIA, the fourth order, comprehending ſuch plants as have three ſtyles, and containing but one genus. 5. POLYGYNIA, the fifth order, comprehending ſuch plants as have many ſtyles, and containing but one genus.

Explanation of Plate IV.

ORDER I. MONOGYNIA. Genus 1, *Aſarum* (aſarabacca). The perianthium monophyllous, bell-ſhaped, ſemitrifid, coriacious, coloured, villous, 1; corolla none; filaments twelve, ſubulate, inſerted on the top of the germen, 2 *a*, 3 *a*; antheras oblong, joined to the middle of the filaments, 2 *b*, 3 *b*; germen below the calyx, and hid within its ſubſtance, 3 *c*, 4 *a*; ſtyle, a cylindraceous cone, hexagonal, 3 *d*, 4 *b*; ſtigma ſtar-ſhaped, 3 *e*, 4 *c*.

ORDER II. DIGYNIA. Genus 2, *Agrimonia* (lizard's tail). The perianthium monophyllous, quinquefid, ſitting on the top of the germen, 1 *a*; ſurrounded by another calyx, 1 *b*; petals five, and inſerted in the calyx, 2 *a*; filaments capillary, inſerted into the calyx, 2 *b*; antheras twins, 2 *c*; germen ſitting under the calyx, 3 *a*; ſtyles two, ſimple, 3 *b*; ſtigmas, 3 *c*.

Explanation of Plate V.

ORDER III. TRIGYNIA. Genus 2, *Euphorbia* (ſpurge). Perianthium monophyllous, ventricoſe, having at the mouth four teeth, ſometimes five, 1 *a*, 2 *a*; petals four, ſome few five, turbinated gibbous ſwelled, truncated, 1 *b*, 2 *b*, with the calycine denticles alternate, 2 *c*; the ungues faſtened to the margin of the calyx, 2 *d*; filaments many, twelve or more, filiform, articulated, inſerted on the receptacle, 3 *a*; antheras didymous ſubrotund, 3 *b*; germen ſubrotund, triquetrous, with a foot ſtalk, 4 *a*; ſtyles three, bifid, 4 *b*; ſtigmas obtuſe, 4 *c*.

ORDER V. POLYGYNIA. Genus 1, *Sempervivum* (houſeleek). The perianthium divided into from ſix to twelve ſegments, with hairs round their margin, 1; petals, from ſix to twelve, a little larger than the calyx, 2 *a*; filaments from ſix to twelve, 2 *b*; antheras ſubrotund; before they diſcharge their pollen, ſubovate, 3 *a*; with four furrows, after the pollen is diſcharged, 3 *b*; germens from ſix to twelve, placed in a circle, erect, 4 *a*; terminating in as many ſtyles, 4 *b*; ſtigmas acute, villous, 4 *c*.

CLASS XII. ICOSANDRIA.

The twelfth claſs conſiſts of ſuch plants as bear hermaphrodite flowers of the following characters. 1. A calyx compoſed of a ſingle, concave leaf. 2. The corolla faſtened by its claws to the inner-ſide of the calyx. 3. The ſtamina twenty or more. As the number of ſtamina in this claſs is not limited, notwithſtanding its title, an attention muſt be had to the two firſt characters, to diſtinguiſh the flowers from thoſe of the next claſs, with which they might otherwiſe be confounded. It has five orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing eight genera. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing but one genus. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing but one genus. 4. PENTAGYNIA, the fourth order, comprehending ſuch plants as have five ſtyles, and containing ſeven genera. 5. POLYGYNIA, the fifth order, comprehending ſuch plants as have many ſtyles, and containing eight genera.

Explanation of Plate V.

ORDER I. MONOGYNIA. Genus 6, *Punica* (pomegranate). The perianthium monophyllous, bell-ſhaped, quinquefid, 1; petals five, inſerted into the calyx, 2 *a*; filaments numerous, capillary inſerted into the calyx, 3 *a*; antheras a little oblong, 3 *b*; germen placed below the calyx, 3 *c*, 4 *a*; ſtyle ſimple, 4 *b*; ſtigma headed, 4 *c*.

ORDER II. DIGYNIA. Genus 1, *Cratægus* (bean tree). The perianthium monophyllous, having five teeth, 1; petals five, inſerted in the calyx, 2 *a*; filaments twenty, inſerted in the calyx, 3 *a*; antheras ſubrotund, 3 *b*; germen below the flower, 4 *a*; ſtyles two, 4 *b*; ſtigmas, 4 *c*. Note, fig. 4 is a longitudinal ſection.

ORDER III. TRYGINIA. Genus 1, *Sorbus* (quicken tree). The perianthium monophylous, having five teeth, 1; petals five,

five, ſeſſile, inſerted into the calyx, 2 *a*; filaments twenty inſerted into the calyx, 2 *b*; antheras roundiſh, 2 *c*; germen ſtanding under the receptacle, 3 *a*; ſtyles three, 3 *b*; ſtigmas capitate, 3 *c*. Note, fig. 3 is a longitudinal ſection.

ORDER IV. PENTAGYNIA. Genus 2, *Pyrus* (apple). The perianthium monophyllous, ſemiquinquefid, 1; petals five, inſerted into the calyx, 2 *a*, 3 *a*; filaments twenty, inſerted into the calyx, 3 *b*; antheras ſimple, 3 *c*; germen placed below the calyx, 3 *d*; ſtyles five, 3 *e*; ſtigmas ſimple, 3 *f*. Note, fig. 3 is a longitudinal ſection.

ORDER V. POLYGINIA. Genus 2, *Rubus* (bramble, or briar). The perianthium monophyllous, quinquepartite, 1; petals five inſerted in the calyx, 2 *a*; filaments many, inſerted in the calyx, 2 *b*; antheras ſubrotund, compreſſed, 2 *c*, 3; germens numerous, 4 *a*; ſtyles filiform; coming out of the ſides of the germens, 4 *b*; ſtigmas ſimple, 4 *c*.

CLASS XIII. POLYANDRIA.

The thirteenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with many ſtamina, and is diſtinguiſhed from the twelfth claſs, by the characters deſcribed under that claſs. It has ſeven orders. 1. MONOGYNIA, the firſt order, comprehending ſuch plants as have but one ſtyle, and containing thirty-ſix genera, diſtinguiſhed into, 1. ſuch as have ſcarce any ſtyle; 2. ſuch as have a ſtyle of ſome length. 2. DIGYNIA, the ſecond order, comprehending ſuch plants as have two ſtyles, and containing two genera. 3. TRIGYNIA, the third order, comprehending ſuch plants as have three ſtyles, and containing two genera. 4. TETRAGYNIA, the fourth order, comprehending ſuch plants as have four ſtyles, and containing but one genus. 5. PENTAGYNIA, the fifth order, comprehending ſuch plants as have five ſtyles, and containing two genera. 6. HEXAGYNIA, the ſixth order, comprehending ſuch plants as have ſix ſtyles, and containing but one genus. 7. POLYGINIA, the ſeventh order, comprehending ſuch plants as have many ſtyles, and containing ſixteen genera.

Explanation of Plate V.

ORDER I. MONOGYNIA. Genus 22, *Sarracenia* (ſide ſaddle flower). The calyx is a double perianthium, the inferior with three ſmall leaves, 1 *a*, the ſuperior with five leaves, large and coloured, 1 *b*, 2 *a*; petals five, inflex, aſſurgent, betwixt the angles of the ſtigma, covering the ſtamens, embracing the top of the ſtigma, 2 *b*; filaments many, 3 *a*; antheras ſimple, 3 *b*; germen roundiſh, furrowed, 3 *c*; ſtyle cylindrical, growing thicker at the top, 3 *d*; ſtigma ſhield-ſhaped, the ſtyle inſerted in its middle, membranaceous, quinquangular, overſhading the ſtyle, germen, and ſtamens, like an umbrella, 2 *c*, 3 *e*.

ORDER II. DIGYNIA. Genus 1, *Pæonia* (piony). The perianthium pentaphyllous, the folioles ſubrotund, reflex, unequal in ſize and ſituation, 2; petals five, 2 *a*; filaments numerous, ſhort, about three hundred ſtanding in three circles round the germens, 3 *a*; antheras oblong, quadrangular, large and quadrilocular, 3 *b*; germens two, ovate and downy, 3 *c c*; ſtigmas recurvate, 3 *d d*.

ORDER III. TRIGYNIA. Genus 2, *Aconitum* (wolfsbane). Calyx none; petals five, unequal, the uppermoſt helmet ſhaped and tubulate, the two lateral ones are broad, ſubrotund, oppoſite, connivent, the two undermoſt are oblong, bending downwards, 1 *a b c*; nectaria two, covered by the helmet-ſhaped petal, 1 *d*; filaments many, ſhort, 1 *e*, 2 *a*; antheras heart-ſhaped, 2 *b*; the germens three, (ſometimes five), 3 *a*; terminating in a ſtyle, 3 *b*; ſtigma ſimple, acuminate, 3 *c*.

ORDER V. PENTAGYNIA. Genus 1, *Aquilegia* (columbine). Calyx none; petals five, 1 *a*, 2 *a*; the nectaria five, equal with the petals placed alternate, 1 *b*; each is horn-ſhaped, on the upper part gradually broad, aſcending obliquely on the outer ſide with an opening or mouth, fixed on the inner ſide to the receptacle, 4; the baſe advancing to a long tube, growing narrower, the apex obtuſe, incurved; filaments from thirty to forty, the outer ſhort, 1 *c*, 5 *a*; antheras oblong, 5 *b*; germens five, 6 *a*; terminating in ſubulated ſtyles, longer than the ſtamens, 5 *c*, 6 *b*; ſtigmas ſimple, 5 *d*, 6 *c*; the germens are each covered with two paleas, 5 *e*.

ORDER VI. HEXAGYNIA. Genus 1, *Stratiotes* (water aloe). The ſpatha dyphillous uniflorus, 1, 2 *a*, on both ſides carminated, the carinas jagged with ſhort ſpines; perianthium monophyllous, tripartite, 2 *b*, 3; petals three, obcordate, 2 *c*; filaments twenty, ſhort, inſerted in the receptacle, 4 *a*; antheras ſimple, fagittated, and lanceolated, 4 *b*; germen inferous, 5 *a*; ſtyles ſix, bipartite, 5 *b*, longer than the ſtamens; ſtigma ſimple, 5 *c*.

ORDER VII. POLYGINIA. Genus 23, *Ranunculus* (crowfoot). The perianthium pentaphyllous, 1; petals five, 2; the nectarium at the ungues of each petal hath a hollow or cavity, 3 *a*; the eſſential character conſiſts in the nectarium, the other parts being commonly inconſtant and indifferent, which when unknown, cauſes a great deal of confuſion; the nectarium is in ſome ſpecies only an open pore, in others ſurrounded with cylindraceous margin, and ſome few cloſed by an emarginated ſcale; filaments many, four in the magnified one, *b*; germens numerous, collected in a ſmall head, 5 *a*; ſtyles none; ſtigmas reflexed, very ſmall; a german magnified, 5 *b*; its ſtigma 5 *c*.

CLASS XIV. DIDYNAMIA.

The fourteenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with four ſtamina, two of which are longer than the other two; a circumſtance that would ſufficiently diſtinguiſh this from the fourth claſs, in which the four ſtamina are equal, if the flowers of this claſs had not the following peculiar characters. 1. The calyx is a perianthium, compoſed of a ſingle, erect, tubulate leaf, cut into five ſegments, for the moſt part unequal and permanent. 2. The corolla conſiſts of a ſingle erect petal, the baſe of which contains the honey, and does the office of a nectarium: the upper lip is ſtrait, the lower ones ſpreading and cut into three ſegments, the middle one of which is the broadeſt. 3. The ſtamina are four awl-ſhaped filaments, inſerted into the tube of the corolla, and inclined towards the back of it; the two inner ones are the ſhorteſt; they ſtand parallel one to another, and ſeldom exceed the length of the corolla; the antheræ are lodged under the upper lip of the corolla in pairs. 4. The characters of the piſtil are as follow: the germen is uſually above the receptacle; the ſtyle is ſingle thread ſhaped, bent in the manner of the filaments, generally placed within them, exceeding them ſomewhat in length, and ſlightly curved towards the ſummit; the ſtigma is, for the moſt part, emarginated. 5. The pericarpium is either wanting, or, if not, it is generally divided into two cells. 6. If there be no pericarpium, the ſeeds are four in number, and lodged within the hollow of the calyx, as in a capſule; but if there be a pericarpium, the ſeeds are more numerous, and are faſtened to a receptacle placed in the middle of the pericarpium.

The orders of this claſs are three. 1. GYMNOSPERMIA, the firſt order, comprehending ſuch plants as have naked ſeeds, and containing thirty-three genera, diſtinguiſhed into, 1. Such as have the calyx cut into five ſegments, nearly equal. 2. Such as have the calyx bilabiate, or divided into two lips. 2. ANGIOSPERMIA, the ſecond order, comprehending ſuch plants as have the ſeeds in a pericarpium, and containing fifty-five genera, diſtinguiſhed into, 1. Such as have a ſingle ſtigma, and perſonate corollæ. 2. Such as have a ſingle ſtigma, and ſpreading corollæ. 3. Such as have a double ſtigma. 3. POLYPETALA, the third order, comprehending ſuch plants as have many petals, and containing but one genus.

Explanation of Plate V.

ORDER I. GYMNOSPERMIA. Genus 27, *Melittis* (baſtard balm). The perianthium monophyllous, bell-ſhaped, villous, the mouth bilabiate, the upper lip higher, the inferior lip ſhorter and trifid, 1; corolla monopetalous, gaping, the tube long and narrow, the upper lip erect, the inferior, patent, trifid, 2; filaments four, the inner ones ſhorter than the outer, 3 *a*; antheras in pairs, croſs ways, bifid, 3 *b*; germen quadrifid, villous, 4 *a*; ſtyle filiform, 4 *b*; ſtigma bifid, 4 *c*.

ORDER II. ANGIOSPERMIA. Genus 62, *Melianthus* (honey flower). The perianthium large, quinqueparte; the ſuperior lacinias erect, oblong, 1 *a*; the under lacinia very ſhort, 1 *b*; ſhaped like a bag, downwards gibbous; the two middle lacinias lanceolate, 1 *c*; petals five, the upper one erect, 2 *a*; the other four on the upper ſide patent, reflexed at the apex, 2 *b*; the nectarium is in the undermoſt lacinia of the calyx; filaments four, 2 *c*; antheras cordate, oblong, on the fore part quadrilocular, 2 *d*; germen tetragonous, ending in four knobs, 3 *a*; ſtyle 3 *b*; ſtigma quadrifid, 3 *c*.

CLASS XV. TETRADINAMIA.

The fifteenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with ſix ſtamina, two of which are ſhorter than the reſt; a circumſtance that would ſufficiently diſtinguiſh this from the ſixth claſs, in which the ſix ſtamina are equal, if the flowers of this claſs had not the following peculiar characters. 1. The calyx is a four-leafed, oblong perianthium, the leaves of which are oval, oblong, concave, obtuſe, conniving gibbous downward at the baſe, and the oppoſite ones equal and deciduous: the calyx in theſe flowers is a nectarium, which makes the baſe gibbous. 2. The corolla conſiſts of four equal, cruciform petals, or petals placed croſſwiſe: the ungues, or claws, are plain awl-ſhaped, erect, and ſomewhat longer than the calyx; the limb is plain: the inſertion of the petals is in the ſame circle with the ſtamina. 3. The ſtamina are awl-ſhaped, two placed oppoſite are of the length of the calyx, the other four are ſomewhat longer, but not ſo long as the corolla: the antheræ are oblong, acuminate, thicker at the baſe, erect, with their tops leaning outwards: there is a nectariferous glandule, which, in the different genera, has various appearances: it is ſeated cloſe to the ſtamina, and particularly to the two ſhorter ones, to whoſe baſe it is faſtened; and theſe have a light curvature, to prevent their preſſing upon it, whereby thoſe filaments become ſhorter

than

than the reſt. 4. The characters of the piſtil are, that the germen above the receptacle is increaſing daily in height; the ſtyle is of the length of the longer ſtamina, or wanting: the ſtigma is obtuſe. 5. The pericarpium is a ſiliqua, compoſed of two valves, and often containing two cells, opening from the baſe to the top; the diſſepiment projecting at the top beyond the valves; the prominent part thereof having before ſerved as a ſtyle. 6. The ſeeds are roundiſh, inclining downwards, and alternately plunged lengthwiſe into the diſſepiment. The receptacle is linear, ſurrounding the diſſepiment, and immerſed in the ſutures of the pericarpium.

The orders of this claſs are two. 1. SILICULOSA, the firſt order, comprehending thoſe plants whoſe pericarpium is a ſilicula, or ſmall ſiliqua, and containing thirteen genera. 2. SILIQUOSA, the ſecond order, comprehending ſuch plants whoſe pericarpium is a ſiliqua, and containing fourteen genera.

Explanation of Plate V.

ORDER I. SILICULOSA. Genus 14, *Lunaria* (honeſty, moonwort, or ſatin-flower). The perianthium tetraphyllous, the folioles ſpread at their apex, two of them are gibbous at the baſe like a ſack, 1; corolla tetrapetalous, each petal terminating with an unguis, the length of the calyx, 2 *a*; filaments ſix, four longer and two ſhorter, 3 *a*; antheras, 3 *b*; germen on a pedicle, 3 *c*; ſtyle on a conic form, 3 *d*; ſtigma, 3 *e*.

ORDER II. SILIQUOSA. Genus 6, *Cheiranthus* (ſtock July flower). The perianthium tetraphyllous, the two exterior folioles are gibbous at their baſes, 1; corolla tetrapetalous, 2 *a*; filament ſix, four longer and two ſhorter, 3 *a*; antheras bifid at the baſe, 3 *b*; germen in ſhape of a priſm, tetragonous, 3 *c*; ſtyled ſhort, 3 *d*; ſtigma bipartite, 3 *e*.

CLASS XVI. MONADELPHIA.

The ſixteenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with one ſet of united ſtamina. The characters of the flowers are thoſe following. 1. The calyx is a permanent perianthium, double in moſt genera. 2. The corolla conſiſts of five heart-ſhaped petals, the ſides of which lap each one over the next, contrary to the motion of the ſun. 3. The filaments of the ſtamina are united below, but diſtinct upwards, if there be more than one. The exterior filaments are ſhorter than the interior; the antheræ are incumbent. 4. The characters of the piſtil are as follow; the receptacle of the fructification is prominent in the center of the flower. The germina are erect, ſurrounding the top of the receptacle, in a jointed ring. The ſtyles are all united below in one ſubſtance with the receptacle, but divided above into as many threads as there are germina. The ſtigmata are ſpreading and thin. 5. The pericarpium is a capſule divided into as many cells as there are piſtilla; its figure is various in different genera. 6. The ſeeds are kidney-ſhaped.

This claſs has three orders, 1. PENTANDRIA, the firſt order, comprehending ſuch plants as have five ſtamina, and containing three genera. 2. DECANDRIA, the ſecond order, comprehending ſuch plants as have ten ſtamina, and containing alſo three genera. 3. POLYANDRIA, the third order, comprehending ſuch plants as have many ſtamina, and containing thirteen genera.

Explanation of Plate V.

ORDER I. PENTANDRIA. Genus 3, *Hermannia* (Ethiopian alder). The perianthium monophyllous, quinquefid, 1; corolla pentapellous, 2 *a*, twiſting from the right to the left, 3 (Note, fig. 3 is magnified); the ungues of the petals on both ſides are provided with a nectariferous membrane, rolled up lengthway, and in form of a tube, 4; filaments five, joined together in one body at the baſe, 5 *a*; antheras, 5 *b*; germen ſubrotund, pentagonous, quinquangular, 6 *a*; ſtyles five, ſtanding near each other, 6 *b*; ſtigmas ſimple, 6 *c*.

ORDER II. DECANDRIA. Genus 3, *Geranium* (crane's bill). The perianthium monophyllous, quinquepartite, 1; petals five, 2 *d*; filaments ten, five longer, five ſhorter, alternately, 3 *a*; antheras turn on the apex of the filament like the needle of a compaſs, 3 *b*; germen quinquangular, having a beak like that of a crane, 4 *a*; ſtyle, 4 *b*; ſtigma five, reflexed, 4 *c*. Note, the African geraniums have commonly the calyx at the baſe, tubulous and monophyllous, the petals unequal, the filaments at their baſe ſlightly grown together, generally no more than ſeven antheras, their ſeeds uncovered, with long feathery beards. The European geraniums, &c. have a calyx conſiſting of ſix leaves.

ORDER IV. DODECANDRIA. Genus 1, *Pentapetes* (Indian vervain mallow). The involucrum uniflorous, triphyllous, 1 *a*, 2 *a*; the perianthium monophyllous, quinquepartite, 1 *b*, 2 *b*; corolla monopetalous, the tube ſhort, the limb quinquepartite, 3 *a*; filaments fifteen, connected at the baſe into a tube, 3 *b*, 4 *a*; five filaments long, without antheras or farina, between two or three filaments, with their antheræ, ſtand one of the longer ones, without their antheræ, 4 *b*; antheræ, 3 *c*, 4 *c*: germen ſubrotund, with five furrows, 5 *a*; ſtyle cylindraceous, 5 *b*; ſtigma, 5 *c*.

ORDER V. POLYANDRIA. Genus 6, *Alcea*, (roſe mallow). The perianthium double, the exterior monophyllous, divided into ſix ſegments, 1 *a*; the interior monophyllous, ſemiquinquefid, 1 *b*; petals five, joined together at their baſe, 2 *a*; filaments numerous, forming at the baſe a pentagonous cylinder, inſerted into the corolla, 2 *b*, 3 *a*; antheras reniform, 3 *b*; germen orbicular, 1 *c*; ſtyle cylindraceous, 1 *d*; ſtigmas numerous (twenty), 1 *e*.

CLASS XVII. DIADELPHIA.

The ſeventeenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with two ſets of united ſtamina. The characters of the fructification are as follow. 1. The calyx is a ſingle-leafed perianthium, bell-ſhaped, and withering: the baſe is gibbous, the lower part of it is faſtened to the pedunclc, the upper part is obtuſe and melliferous; the brim is divided into five acute, erect, oblique, and unequal denticles; the loweſt odd denticle is longer than the reſt; the upper pair ſhorter and farther aſunder; the bottom of the cavity is moiſt with a melleous liquor, including the receptacle. 2. The corolla is papilionaceous or of the butterfly-ſhaped kind and unequal; the petals are expreſſed by diſtinct names, viz. Vexillum, or the Standard, is a petal covering the reſt, incumbent, greater, plano-horizontal, inſerted by its claw in the upper margin of the receptacle, approaching to a circular figure when it leaves the calyx, and nearly entire; along it, and eſpecially towards its extremity, runs a line, or ridge, that riſes up as if the lower part of the petal had been compreſſed; the part of the petal next to the baſe approaching to a ſemi-cylindric figure, embraces the part that lies under it. The diſk of the petal is depreſſed on each ſide, but the ſides of it neareſt the margin are reflexed upwards. Where the halved tube ends, and the halved limb begins to unfold itſelf, are two concave impreſſions, prominent underneath, and compreſſing the wings that lie under them. Alæ, the wings, are two equal petals, one at each ſide of the flower, placed under the vexillum, or ſtandard; incumbent, with their margins parallel, roundiſh, or oblong, broader upwards, the upper margin ſtraighter, the lower ſpreading more into a roundneſs; the baſe of each wing is bifid, the lower diviſion ſtretching out into a claw, inſerted in the ſide of the receptacle, and about the length of the calyx: the upper is ſhorter, and inflexed. Carina, or the keel, is the loweſt petal, and is often divided into two parts; it is placed under the vexillum, and between the alæ, it is heart-ſhaped, concave, compreſſed on the ſides, ſet like a veſſel afloat, mutilate at the baſe, the lower part of which runs into a claw of the length of the calyx, and inſerted in the receptacle, but the upper and ſide laciniæ are interwoven with that part of the alæ that is of the ſame ſhape. The form of the ſides of the carina is much like that of the alæ; and ſo alſo is their ſituation, except that they are lower, and ſtand within them. The line that forms the carina, or keel, in this petal runs ſtraight as far as the middle, and then riſes gradually in the ſegment of a circle; but the marginal line runs ſtraight to the extremity, where, meeting the carinal, they terminate obtuſely.

3. The Stamina are called Diadelphia. The filaments are two, of different forms, viz. a lower one that involves the piſtillum, and an upper one incumbent on it. The former of theſe, from the middle downwards, is cylindraceous, membranaceous, and ſplit lengthwiſe on its upper ſide; but the upper half terminates in nine awl-ſhaped parts, that are of the ſame length with, and follow the flexure of the carina of the corolla, and of which the intermediate, or lower rays, or diviſions of the filaments, are longer by alternate pairs. The upper filament is awl-ſhaped and briſtly, covering the ſplitting of the former cylindraceous filament, incumbent on it, anſwering to it in ſituation, ſimple, and gradually ſhorter; its baſe is detached from the reſt, and prepares an outlet for the honey on each ſide. The antheræ, reckoned all together, are ten, one on the upper filament, and nine on the lower, each of the radii, or rays, being furniſhed with a ſingle one: they are ſmall, all of one ſize, and terminate the rays.

4. The characters of the piſtil are, that it is ſingle, growing out of the receptacle within the calyx; the germen is oblong, roundiſh, highly compreſſed, ſtraight, and of the length of the cylinder of the lower filament which involves it. The ſtyle is awl-ſhaped, thread-ſhaped, aſcending, having the ſame length and poſition as the radii, or rays, of the filament, among which it is placed, and withering. The ſtigma is downy, of the length of the ſtyle, from the part turned upwards, and placed immediately under the antheræ.

5. The pericarpium is an oblong, compreſſed, obtuſe legume, with two valves, and a longitudinal ſuture, both above and below; each ſuture ſtraight, though the upper one falls near the baſe, and the lower one riſes near the top; the legume opens at the upper ſuture.

6 The ſeeds are few, roundiſh, ſmooth, fleſhy, pendulous, and marked with an embryo that is a little prominent towards the point of inſertion.

7. The proper receptacles of the ſeed are very ſmall, very

The BINDER *is deſired that this Sheet* 6 A—2 *is to be placed after* 6 A—1, *it being a duplicate ſignature introduced in this* NEW EDITION *of the Work to enlarge on the* SYSTEM *of* BOTANY.

ſhort, thinner toward the baſe, obtuſe at the diſk that faſtens them, oblong, inſerted longitudinally in the upper ſuture of the legume only, but placed alternate; ſo that when the valvulæ have been parted, the ſeeds adhere alternately to each of the valves.

The orders of this genus are three. 1. HEXANDRIA, the firſt order, comprehending ſuch plants as have ſix ſtamina, and containing only one genus. 2. OCTANDRIA, the ſecond order, comprehending ſuch plants as have eight ſtamina, and containing only one genus. 3. DECANDRIA, the third order, comprehending ſuch plants as have ten ſtamina, and containing forty-four genera, diſtinguiſhed into, 1. Such as have Monadelphious filament, or one ſet, or brotherhood. 2. Such as have Diadelphious filaments, or two ſets, or brotherhoods, and downy ſtigmata. 3. Such as have Diadelphious filaments, cups with two lips, and the ſtigmata not downy. 4. Such as have diadelphious filaments, ſimple ſtigmata that are not downy, and cups not two lipped.

Explanation of Plate V.

ORDER I. HEXANDRIA. Genus 2, *Fumaria* (yellow fumitory). The perianthium diphyllous, 1, 2 *a*; corolla oblong, tubulated, gaping, 2 *b*; filaments two, each incloſed in its lip, 3 *a*; antheras three, terminating each filament, 3 *b*; germen oblong, 3 *c*, 4 *a*; ſtyle the length of the filaments in this ſpecies, 3 *d*, 4 *b*; ſtigma, 3 *c*, 4 *c*.

ORDER II. OCTANDRIA. Genus 1, *Polygala* (milkwort). The perianthium tripartite, 1; one of the folioles ſtands above the corolla, and two below it, 2 *a*; corolla butterfly-ſhaped, the number of petals undetermined, 3; the wings, 3 *a*; the vexillum (or ſtandard) 3 *b*; filaments diadelphious, eight in one body, 4 *a*; antheras, eight 4 *b*; germen oblong, 5 *a*; ſtyle, 5 *b*; ſtigma terminates with a navel, 5 *c*.

ORDER III. DECANDRIA. Genus 27, *Lathyrus* (everlaſting tea). The perianthium monophyllous, ſemiquinquefid, companulate, 1; corolla butterfly-ſhaped, 2, the carina (or keel), 2 *a*, opens in the middle internally; filaments diadelphious, one ſtamen ſtanding by itſelf, the others in one body divided into nine, 3 *a*; antheras, 3 *b*; ſtigma villous, 4 *c*.

CLASS XVIII. POLYADELPHIA.

The eighteenth claſs conſiſts of ſuch plants as bear hermaphrodite flowers, furniſhed with many ſets of united ſtamina. The flowers have no particular character, except that expreſſed by the title. It has three orders. 1. PENTANDRIA, the firſt order, comprehending ſuch plants as have five ſtamina in each ſet, and containing but one genus. 2. ICOSANDRIA, the ſecond order, comprehending ſuch plants as have twenty ſtamina in each ſet, and containing but one genus. 3. POLYANDRIA, the third order, comprehending ſuch plants as have many ſtamina in each ſet, and containing two genera.

Explanation of Plate V.

ORDER I. PENTANDRIA. Genus 1, *Theobroma*. The perianthium quinquepartite, the folioles plain with two nerves, 1; petals five, with five nerves, inſerted by the unguis into the ſquamas of the exterior nectarium under and within its apex, 2 *a*; filaments five, ſhort, between the ſquamas of the interior nectarium, as the antheras, which are from three to ſeven in each family, grow on the outſide of the nectarium; the antheras are didymous, divaricated, uniform, and yellow, 3 *a*; germen ſtanding above the flowers, cylindraceous, quinquangular, 4 *a*; ſtyles five, approximate, 4 *b*; ſtigma, 4 *c*.

ORDER. II. ICOSANDRIA. Genus 1, *Citrus* (orange). The perianthium monophyllous, quinquedentate, 1; petals five, 2 *a*; filaments about twenty, ſtanding in a circle, or cylinder, joined together in many or few ſmall bodies, 3; antheras, 3 *b*; germen, 4 *a*; ſtyle, 4 *b*; ſtigma globoſe, hath within nine loculaments, 4 *c*; the ſtigma magnified, 4 *d*.

ORDER III. POLYANDRIA. Genus 6, *Hypericum* (St. John's wort.) The perianthium quinquepartite, 1; petals five, having round the margin in this ſpecies, glandules, 2 *a*, 3 *a*; filaments numerous, grown together at the baſe in five or ſix phalanxes, 3 *b*; antheras ſmall, on both ſides caniculated; on the apex a black gland, 4 *a*; germen ovate, in this ſpecies, 5 *a*; ſtyles three, ſpreading, 5 *b*; ſtigma, 5 *c*.

CLASS XIX. SYNGENESIA.

The nineteenth claſs conſiſts of ſuch plants as bear compound flowers, or flowers which comprehend many ſeſſile florets on a common, entire receptacle, with a common perianthium, and antheræ growing together in the form of a cylinder. The characters of the flowers of this claſs are as follow. 1. The common calyx is a parianthium, which contains the florets and the receptacle. It is either ſimple, augmented, or imbricated, *i. e.* ſcaly. It contracts when the flowers are fallen, but expands and turns back when the ſeeds are ripe. 2. The common receptacle of the fructification receives many ſeſſile florets on its diſk, which is either concave, plain, convex, piramidal, or globoſe. The ſurface of the diſk is either naked, without any other inequality than that of being lightly dotted; villoſe, covered with upright hairs, or paleaceous, that is, covered with chaffs, or ſtraws, which are narrow, awl-ſhaped, compreſſed and erect, and ſerve to part the florets. 3. The calyx of the florets is a ſmall perianthium, often divided into five ſegments, ſeated on the germen permanent, and at length becoming the crown of the ſeed. 4. The corolla conſiſts of a ſingle leaf, with a long and very narrow tube. It is ſeated on the germen, and is either tubulate, with the limb bell-ſhaped, and cut into five ſegments; lingulate, or tongue-ſhaped, with the limb narrow, plain, turned outwards, and the top whole; divided into three denticles, or five denticles, or wanting, having no limb, and often no tube. 5. The filaments of the ſtamina are five, capillary, very ſhort, and inſerted in the neck of the corollulæ; the antheræ are five, narrow, and erect; and, by the union of their ſides, forming a cylinder, that is tubulate, divided into five denticles, and of the length of the limb. 6. The germen of the piſtil is oblong, placed under the receptacle of the flower; the ſtyle is thread-ſhaped, erect, of the length of the ſtamina, and perforating the cylinder of the antheræ; the ſtigma is bipartite, or divided into two parts. 7. There is no true pericarpium, though in ſome there is a leathery cruſt. 8. The ſeed is ſingle, oblong, often four-cornered, but commonly narrower at the baſe. It is often crowned, and in that caſe the crown is of two kinds, either a pappus, *i. e.* down, or a perianthium.

The orders of this claſs are five, viz. 1. POLYGAMIA ÆQUALIS, the firſt order, comprehending ſuch plants as have compound flowers, of which the florets are all hermaphrodite, and containing thirty-eight genera, diſtinguiſhed into, 1. Such as have tongue-ſhaped compound flowers. 2. Such as have tubuloſe compound flowers. 3. Such as have radiate compound flowers. 2. POLYGAMIA SUPERFLUA, the ſecond order, comprehending ſuch plants as have the florets of the diſk hermaphrodite, and thoſe of the radius female, and containing twenty-nine genera, diſtinguiſhed into, 1. Tubuloſe. 2. Radiate. 3. POLYGAMIA FRUSTRANEA, the third order, comprehending ſuch plants as have the florets of the diſk hermaphrodite, and thoſe of the radius neuter, and containing four genera, all radiate. 4. POLYGAMIA NECESSARIA, the fourth order, comprehending ſuch plants as have the flowers of the diſk male, and thoſe of the radius female, and containing thirteen genera, moſt of which are radiate. 5. MONOGAMIA, the fifth order, comprehending ſuch plants as have ſimple flowers, and containing ſix genera.

Explanation of Plate V.

ORDER I. POLYGAMIA ÆQUALIS. Genus 9, *Leontodon*, (dandelion). The common calyx, 1; the interior ſcales linear, 1 *a*; the exterior ſcales fewer, often reflexed, 1 *b*; the compound corolla, 2; the corollulas, of which it is compoſed, being hermaphrodite, 3; the proper corolla monopetalous, quinquedentate, 3; filaments five, 4 *a*; antheras cylindraceous, tubuloſe, 4 *b*; germen, 5 *a*; ſtyle, 5 *b*; ſtigmas two, revoluſe, 5 *c*.

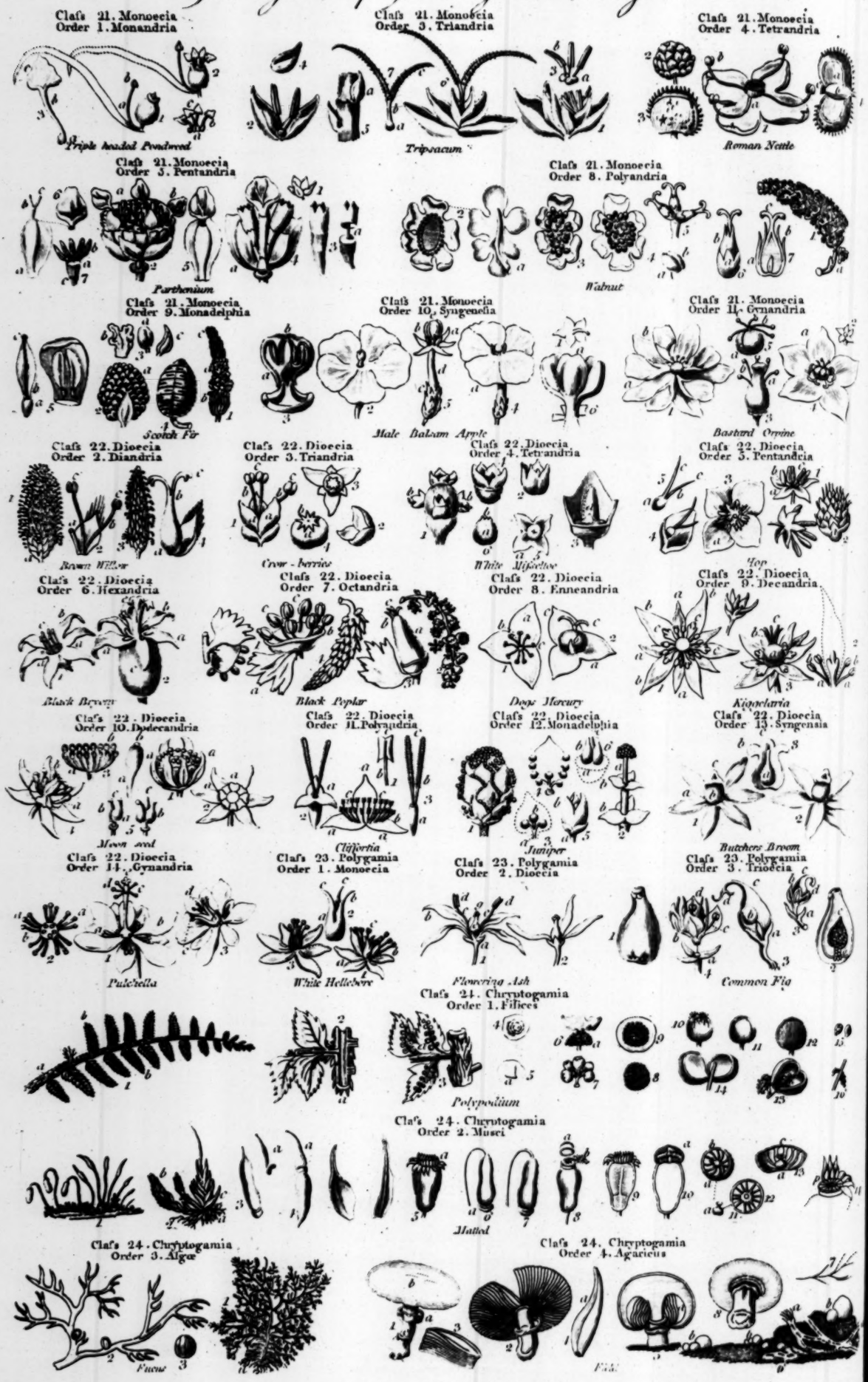
ORDER II. POLYGAMIA SUPERFLUA. Genus 5, *Xeranthemum* (eternal flower). The common calyx, 1; the compound corolla unequal, in which the hermaphrodite corollulas are very numerous, tubular, placed in the diſk, the female corollulas leſs numerous, tubular, placed in the circumference, 2 *a*, 3 *a*; the firſt being the proper corollas of the hermaphrodite floſcules, are funnel-ſhaped, much ſhorter than the calyx, the limb quinquefid, 4, 5; the ſecond being the proper corollas of the female floſcules, are tubular, 6 *a*; ſtamens of the hermaphrodite flowers, have five ſhort filaments, 5 *a*; antheras cylindraceous, tubular, 5 *b*; germen of the hermaphrodite ſhort, coronate, crowned in this ſpecies with a crown of five ſeteceous points, 4 *a*; the ſtyle filiform, 5 *c*; ſtigma bifid, 5 *d*; germen of the females as in the hermaphrodites, 6, 7; ſtyle, 7 *a*; ſtigma elevate, 7 *b*.

ORDER III. POLYGAMIA FRUSTRANEA. Genus 1, *Helianthus* (ſun-flower). The calyx, 1; the compound corolla radiate, its corollulas are either thoſe of hermaphrodite floſcules, numerous, and placed in the diſk, 2 *a*; or thoſe of the female floſcules, leſs numerous, much longer, and placed in the radius, 2 *b*; the proper corolla of the hermaphrodite floſcules are cylindraceous, 3; the proper corolla of the female floſcules in the form of a tongue, 4; filaments of the hermaphrodites, five, 5 *a*; antheras cylindraceous, 3 *a*, 5 *b*; germen of the hermaphrodite floſcules oblong, 5 *c*; ſtyle filiform, 5 *d*; ſtigma bipartite, reflex, 5 *e*; germen of the female floſcules ſmall, 4 *a*; ſtyle none, ſtigma none.

ORDER IV. POLYGAMIA NECESSARIA. Genus 7, *Calendula* (marygold). The common calyx ſimple, 1; the corolla a compound radiated flower, 2; the hermaphrodite corollulas many in the diſk, 3 *a*; the female corollulas many, 3 *b*; the proper hermaphrodites tubulous, 4; the limb quinquefid, 4 *a*; the female tongue-ſhaped, 5, with three teeth, 5; filaments of the hermaphrodite five, 6 *a*; antheras cylindraceous, tubulous, 6 *b*; germen of the hermaphrodite oblong, 6 *c*; ſtyle filiform, 6 *d*; ſtigma bifid, 6 *e*; germen of the female oblong, trigonous, 5 *b*; ſtyle filiform, 5 *c*; ſtigmas two, 5 *d*.

ORDER V. POLYGAMIA SEGREGATA. Genus 3, *Echinops* (globe thiſtle). The calyx a common one, containing many flowers, 1 *a*; the partial perianthium uniflorous, 2 *a*; corolla monopetalous, funnel-ſhaped, the border divided into five, reflex, ſpreading, 2 *b*; filaments five, like hairs, ſhort, 3 *a*; antheras

Classes and Orders, according to Linneus.
See System of Botany. Sect. 4. Class 21.


Class 21. Monoecia Order 1. Monandria
Triple headed Pondweed
Class 21. Monoecia Order 3. Triandria
Tripsacum
Class 21. Monoecia Order 4. Tetrandria
Roman Nettle
Class 21. Monoecia Order 5. Pentandria
Parthenium
Class 21. Monoecia Order 8. Polyandria
Walnut
Class 21. Monoecia Order 9. Monadelphia
Scotch Fir
Class 21. Monoecia Order 10. Syngenesia
Male Balsam Apple
Class 21. Monoecia Order 11. Gynandria
Bastard Orpine
Class 22. Dioecia Order 2. Diandria
Brown Willow
Class 22. Dioecia Order 3. Triandria
Crow-berries
Class 22. Dioecia Order 4. Tetrandria
White Misseltoe
Class 22. Dioecia Order 5. Pentandria
Hop
Class 22. Dioecia Order 6. Hexandria
Black Bryony
Class 22. Dioecia Order 7. Octandria
Black Poplar
Class 22. Dioecia Order 8. Enneandria
Dogs Mercury
Class 22. Dioecia Order 9. Decandria
Kiggelaria
Class 22. Dioecia Order 10. Dodecandria
Moon seed
Class 22. Dioecia Order 11. Polyandria
Clifortia
Class 22. Dioecia Order 12. Monadelphia
Juniper
Class 22. Dioecia Order 13. Syngensia
Butchers Broom
Class 22. Dioecia Order 14. Gynandria
Pulchella
Class 23. Polygamia Order 1. Monoecia
White Hellebore
Class 23. Polygamia Order 2. Dioecia
Flowering Ash
Class 23. Polygamia Order 3. Trioecia
Common Fig
Class 24. Chryptogamia Order 1. Filices
Polypodium
Class 24. Chryptogamia Order 2. Musci
Matted
Class 24. Chryptogamia Order 3. Algæ
Fucus
Class 24. Chryptogamia Order 4. Agaricus
Fild

antheras cylindraceous, with five teeth, 4 *b*; germen oblong, 4 *a*; ſtyle filiform, 4 *b*; ſtigma double, 4 *c*.

ORDER VI. MONOGAMIA. Genus 5, *Lobelia* (cardinal flower). The perianthium monophyllous, quinquedentate, growing round the germen, 1 *a*; corolla monopetalous, the tube cylindraceous, 1 *b*; the limb quinquepartite, 1 *c*; filaments five, 2 *a*; antheras growing together in the form of an oblong cylinder, 2 *b*; germen, 3 *a*; ſtyle cylindraceous, 3 *b*; ſtigma, 3 *c*.

CLASS XX. GYNANDRIA.

The twentieth claſs conſiſts of ſuch plants as have the ſtamina growing either upon the ſtyle itſelf, or upon a receptacle that ſtretches out into the form of a ſtyle, and ſupports both the ſtamina and piſtil. It has ſeven orders. 1. DIANDRIA, the firſt order, comprehending ſuch plants as have two ſtamina, and containing eight genera. The flowers of this order are very ſingular in their ſtructure, anſwering the following deſcription. The germen is always twiſted like a ſcrew: the petals are five; of which the two inner ones uſually approach one another, and form an helmet; the lower lip of which becomes a nectarium, and ſerves alſo for a piſtil and ſixth petal. The ſtyle grows to the inner margin of the nectarium, in ſuch a manner as to be with its ſtigma ſcarcely either of them diſtinguiſhable. The filaments are always two, ſupporting as many antheræ, which are narrower downwards, naked, or without a tunic, and diviſible like the pulp of a citrus. Theſe laſt are covered by little cells, that open underneath, and grow to the inner margin itſelf of the nectarium. The fruit is a capſule, containing only one cell, with three valves, and ſplits in the angles, under the keel-ſhaped ribs: the ſeeds are very ſmall, like ſaw-duſt, or filings, numerous, and affixed to a narrow receptacle in each valve. 2. TRIANDRIA, the ſecond order, comprehending ſuch plants as have three ſtamina, and containing but one genus. 3. TETRANDRIA, the third order, comprehending ſuch plants as have four ſtamina, and containing but one genus. 4. PENTANDRIA, the fourth order, comprehending ſuch plants as have five ſtamina, and containing but one genus. 5. HEXANDRIA, the fifth order, comprehending ſuch plants as have ſix ſtamina, and containing two genera. 6. DECANDRIA, the ſixth order, comprehending ſuch plants as have ten ſtamina, and containing but one genus. 7. POLYANDRIA, the ſeventh order, comprehending ſuch plants as have many ſtamina, and containing ſix genera.

Explanation of Plate V.

ORDER I. DIANDRIA. Genus 1, *Orchis*. The calyx, the ſpatha, 1 *a*; the ſpadix, 1 *b*; perianthium none; petals five, the two interior form a helmet, 2 *a*; filaments two, 2 *b*; antheras, 2 *c*; germen oblong, 2 *d*; ſtyle, 2 *e*; ſtigma, 2 *f*.

ORDER II. TRIANDRIA. Genus 1, *Siſyrinchium* (Bermudiana). Calyx an univerſal ſpatha, diphyllous, 1; petals ſix, 2 *a*; filaments three, iſſuing from the outward coat of the ſtyle, 3 *a*; antheras bifid at their lower end, fixed to the ſtyle at the bottom of the ſtigma, 3 *b*; germen, 3 *c*; ſtyle, 3 *d*; ſtigma trifid, 3 *e*.

ORDER IV. PENTANDRIA. Genus 3, *Paſſiflora* (paſſion flower). The involucrum three-leaved, placed ſo as to leave ſome place betwixt it and the flower, 2 *a*; calyx a perianthium monophyllous, quinquepartite, the keel ending in a hooked briſtle, 2 *b*, 3 *a*; petals five, 2 *b*, 3 *c*; nectarium a triple crown, ſurrounding the piſtillum, divided into rays, 4 *a*, *b*, *c*; filaments five, fixed to the column, growing together at the baſe, 5 *a*; antheras, 5 *b*; germen, 5 *c*; ſtyles three, 5 *d*; ſtigmas, 5 *e*.

ORDER V. HEXANDRIA. Genus 1, *Ariſtolochia* (birthwort). Calyx none; corolla monopetalous, tubulous, the limb dilated, 1; filaments none; antheras ſix, quadricular, at their baſe joined to the ſtigma, 2 *a*; germen oblong, ſtanding below the flower, angular, 2 *b*; ſtyle ſcarce any; ſtigma ſubgloboſe, ſex-partite, concave, 2 *c*.

ORDER VII. POLYANDRIA. Genus 4, *Arum* (cuckow point). The calyx and ſpatha monophyllous, 1; the ſpadix club-ſhaped, 2 *a*; below ſurrounded with germens, 2 *b*; corolla none; filaments none; otherwiſe than like nectarias, which are thickiſh at their baſe, 2 *c*; terminating in a filiform cirrhis or tendrils, 2 *d*; in a double order, coming out of the middle of the ſpadix; antheras many, ſeſſile, tetragonous, between the double order of the cirrhis or tendrils, 2 *e*; joined to the ſpadix; germens many, covering the baſe of the ſpadix, 2 *f*; ſtyles none; ſtigmas being a beard of little hairs, 2 *g*.

CLASS XXI. MONOECIA.

The twenty-firſt claſs conſiſts of ſuch plants as have no hermaphrodite flowers, but bear both male and female flowers on the ſame plant. Of this claſs there are eleven orders. 1. MONANDRIA. the firſt order, comprehending ſuch plants as have their male flowers furniſhed with one ſtamen, and containing three genera. 2. DIANDRIA, the ſecond order, comprehending ſuch plants as have their male flowers furniſhed with two ſtamina, and containing but one genus. 3. TRIANDRIA, the third order, comprehending ſuch plants as have their male flowers furniſhed with three ſtamina, and containing nine genera. 4. TETRANDRIA, the fourth order, comprehending ſuch plants as have their male flowers furniſhed with four ſtamina, and containing four genera. 5. PENTANDRIA, the fifth order, comprehending ſuch plants as have their male flowers furniſhed with five ſtamina, and containing five genera. 6. HEXANDRIA, the ſixth order, comprehending ſuch plants as have their male flowers furniſhed with ſix ſtamina, and containing but one genus. 7. HEPTANDRIA, the ſeventh order, comprehending ſuch plants as have their male flowers furniſhed with ſeven ſtamina, and containing but one genus. 8. POLYANDRIA, the eighth order, comprehending ſuch plants as have their male flowers furniſhed with many ſtamina, and containing twelve genera. 9. MONADELPHIA, the ninth order, comprehending ſuch plants as have their male flowers furniſhed with one ſet of united ſtamina, and containing ten genera. 10. SYNGENESIA, the tenth order, comprehending ſuch plants as have their male flowers furniſhed with ſtamina of which the antheræ are united, and containing ſeven genera. 11. GYNANDRIA, the eleventh order, comprehending ſuch plants as have their male flowers furniſhed with ſtamina that grow out of a kind of ſtyle, or imperfect piſtil, the perfect one being in the female flower, and containing but one genus.

Explanation of Plate VI.

ORDER I. MONANDRIA. Genus 1, *Zonichellia* (triple-headed pond-wort). Male flowers; the calyx monophyllous, tridentated at the mouth, 1; corolla none; filament one, 1 *a*; antheræ ſagittated, 1 *b*.

Female flower cloſe to the male; the calyx a monophyllous perianthium, ſcarcely viſible, 2; corolla none; germens four, 3 *a*; ſtyles four, 3 *b*; ſtigmas four, 3 *c*.

ORDER III. TRIANDRIA. Genus 4, *Tripſacum* (Americana). The male flowers; the calyx a glume or chaff, bearing on each ſide two flowers, having two valves, 1; corolla, the chaff, bivalve, 1, 2; filaments three, 3 *a*; antheras, 3 *b*.

The female flowers, the calyx, the chaff, divided into two or four, 4 *a*; at the baſe winding into a gaping hollow, 5 *a*; the corolla, the chaff, having three valves, 6; germen oblong, 7 *a*; ſtyles two, 7 *b*; ſtigmas hairy, 7 *c*.

ORDER IV. TETRANDRIA. Genus 7, *Urtica* (Roman nettle). The male flowers; the perianthium tetraphyllous; the folioles have a prickle at the apex, 1; petals none, filaments four, 1 *a*; antheras bilocular, 1 *b*.

Female flowers, 7; the perianthium two valves, 3, 4 *a*; corolla none; germen 4 *a*; ſtyles none; ſtigma, 4 *b*.

ORDER V. PENTANDRIA. Genus 4, *Parthenium* (Virginia flower). The common perianthium ſimple, pentaphyllous, 1; corolla compound and convex; the hermaphrodite corollules are many in the diſk, 2 *a*; the females ſtanding round the hermaphrodites, five in the radius, 2 *b*; the property of the hermaphrodite florets monopetalous, 3; tubulous, the mouth quinquefid, 3, 4; the female florets monopetalous, 5, 6; tubulous; the filaments of the hermaphrodites five, capillary, 7 *a*; antheras, 7 *b*; germen of the hermaphrodites within its proper receptacle, hardly to be obſerved, 4 *a*, 7 *c*; ſtyle capillary, 3 *a*; ſtigma none; germen of the females below the flower, 6 *a*; in form of a top, heart-ſhaped, compreſſed, large; ſtyle filiform, 6 *b*; ſtigma two filiform, 6 *c*.

ORDER VIII. POLYANDRIA. Genus 8, *Juglans* (wallnut.) The male flowers diſpoſed in an oblong amentum, 1; the calyx, the common amentum, all over looſely imbricated, in form of a cylinder, conſiſting of uniflorous ſcales, 2; each fixed in the centre of the outſide of the corolla, bending outwards, 3; corolla ſex-partite, with footſtalks, 2 *a*; inſerted both in the inner centre of the corolla and the rachis, 1 *a*; filaments many (eighteen), very ſhort, 4 *a*; antheras, 4 *b*.

The female flowers have no amentum, two or three are ſitting on the ſame plant, and are ſeſſile, 5; calyx is the perianthium, it is quadrifid, 6 *a*; corolla quadripartite, acute, erect, 6 *b*; germen oval, 7 *a*; ſtyles two, very ſhort, 7 *b*; ſtigma large, on the top lacerated, 7 *c*.

ORDER IX. MONODELPHIA. Genus 1, *Pinus* (Scotch fir). The male flowers growing in a ſpike, 1; calyx, the ſcales of the gem, open during the flowering time; thoſe near the baſe and apex ſteril, 1 *b*, *c*; corolla none, unleſs the little ſcales which adhere to the antheras may be ſo called, 2 *a*; filaments many, growing round a column, in little oval ſpikes, 1 *d*, 3 *a*; antheras oval, after the diſcharge of the pollen they become flexulous and lacerated, 3 *b*; endowed with dorſal ſcales, 3; theſe ſcales are oblong, tapering at both ends.

The female flowers on the ſame plant, 4; the calyx, the common catkin, ovate, conſiſting of ſcales, of which each contains two flowers, 5; corolla none, germen elevated, ſmall, 5 *a*; ſtyle, 5 *b*; ſtigma hairy, 5 *c*.

ORDER X. SYNGYNESIA, Genus 2, *Memordica* (male balſam apple). The male flowers; the perianthium monophyllous, concave, quinquefid, 1; corolla quinquepartite, 2; filaments three, 3 *a*; antheras in two of the filaments are bifid, having ears on both ſides, 3 *b*; the third having only on one ſide an ear.

Female flowers on the ſame plant with the male, 4; perianthium monophyllous, ſtanding above the germen, quinquepartite,

5 *a*;

5 *a*; corolla as in the male, 4 *a*; filaments three, very ſhort, without antheras, 5 *b*; germen ſtanding below the flowers, of a conic form, large, 5 *c*; ſtyle one, 5 *d*; ſtigmas three, 5 *e*, 6 *a*.

ORDER XI. GYNANDRIA. Genus 1, *Andrachmene* (baſtard alpine). The male flowers, 1; perianthium pentaphyllous, 2; petals five, 1 *a*; nectaria one within each petal, 1 *b*; filaments five inſerted at the baſe of the ſtyle, 3 *a*; antheras, 3 *b*.

The female flowers on the ſame plant with the males, 4; perianthium pentaphyllous, 4 *a*; petals none; nectaria the ſame as in the male flowers; germen globoſe, 5 *a*; ſtyles three, bipartite, 5 *b*; ſtigmas globoſe, 5 *c*.

CLASS XXII. DIOECIA.

The twenty-ſecond claſs conſiſts of ſuch plants as have no hermaphrodite flowers, but bear male and female flowers on diſtinct plants. Of this claſs there are thirteen orders. 1. MONANDRIA, the firſt order, comprehending ſuch plants as have their male flowers furniſhed with one ſtamina, and containing but one genus. 2. DIANDRIA, the ſecond order, comprehending ſuch plants as have their male flowers furniſhed with two ſtamina; and containing two genera. 3. TRIANDRIA, the third order, comprehending ſuch plants as have their male flowers furniſhed with three ſtamina, and containing two genera. 4. TETRANDRIA, the fourth order, comprehending ſuch plants as have their male flowers furniſhed with four ſtamina, and containing three genera. 5. PENTANDRIA, the fifth order, comprehending ſuch plants as have their male flowers furniſhed with five ſtamina, and containing nine genera. 6. HEXANDRIA, the ſixth order, comprehending ſuch plants as have their male flowers furniſhed with ſix ſtamina, and containing five genera. 7. OCTANDRIA, the ſeventh order, comprehending ſuch plants as have their male flowers furniſhed with eight ſtamina, and containing two genera. 8. ENNEANDRIA, the eighth order, comprehending ſuch plants as have their male flowers furniſhed with nine ſtamina, and containing two genera. 9. DECANDRIA, the ninth order, comprehending ſuch plants as have their male flowers furniſhed with ten ſtamina, and containing four genera. 10. POLYANDRIA, the tenth order, comprehending ſuch plants as have their male flowers furniſhed with many ſtamina, and containing but one genus. 11. MONADELPHIA, the eleventh order, comprehending ſuch plants as have their male flowers furniſhed with one ſet of united ſtamina, and containing three genera. 12. SYNGENESIA, the twelfth order, comprehending ſuch plants as have their male flowers furniſhed with ſtamina, of which the antheræ are united, and containing but one genus. 13. GYNANDRIA, the thirteenth order, comprehending ſuch plants as have their male flowers furniſhed with ſtamina that grow out of a kind of ſtyle, or imperfect piſtil, the perfect one being in the female flower, and containing but one genus.

Explanation of Plate VI.

ORDER II. DIANDRIA. Genus 3, *Salix* (brown willow). The male, 1; the calyx, the common amentum, oblong, with an involucrum formed of the gem, 1 *a*; conſiſting of ſquamas, having one flower, 2; petals none; nectarium a cylindraceous gland in the centre of the flowers, 2 *a*; filaments two, 2 *b*; antheras didymous, quadrilocular, 2 *c*.

The female, 3; the amentum and ſquamas the ſame as in the male; corolla none; germen ovate, 4 *a*; attenuated into a taper ſtyle, not very diſtinct, 4 *b*; ſtigmas two, bifid, revolute, 4 *c*.

ORDER III. TRIANDRIA. Genus 1, *Empetrum* (crow berries). The male, 1; perianthium tripartite, 2; petals three, 1 *a*; filaments three, 1 *b*; antheras bipartite, 1 *c*.

The female 3; perianthium and petals as in the male; germen depreſſed, 4 *a*; ſtyle ſcarce any; ſtigmas nine, 4 *b*.

ORDER IV. TETRANDRIA. Genus 3, *Viſcum* (white miſeltoe). The male 1; perianthium quadripartite, 2; corolla and filament one; antheras four, oblong, accuminate, one joined to each of the calycine folioles, 1 *b*, 3 *a*.

The female very often oppoſite to the male flowers, 4; perianthium tetraphyllous, fixed on the germen, 5 *a*; corolla none; germen oblong, trigonous, 6 *a*; ſtyles none; ſtigma obtuſe, 6 *b*.

ORDER V. PENTANDRIA. Genus 10, *Humulus* (hop). The male, 1; perianthium pentaphyllous, 1 *a*; corolla none; filaments five, 1 *b*; antheras with four furrows, 1 *c*.

The females 2; univerſal involucrum quadripartite, 2 *a*; the partial involucra tetraphyllous, 3 *a*; the folioles ſubrotund and ovate, having eight flowers, 3 *b*; each flower hath its perianthium monophyllous, 4; corolla none; germen, 5 *a*; ſtyles two, 5 *b*; ſtigmas, 5 *c*.

ORDER VI. HEXANDRIA. Genus 1, *Tamus* (black briony). The male, 1; perianthium ſexpartite, 1 *a*; corolla none; filaments ſix, 1 *b*; antheras, 1 *c*.

The female, 2; perianthium monophyllous. ſexpartite, ſitting on the apex of the germen, 2 *a*; petals none; nectarium an oblong point, adhering to the baſe of every ſingle ſegment of the perianthium, 2 *b*; germen ovately oblong, ſtanding under the calyx, 2; ſtyle cylindraceous, 2 *d*; ſtigmas three, 2 *e*.

ORDER VII. OCTANDRIA. Genus 1, *Populus* (black poplar). The male, 1; the common amentum oblong, conſiſting of uniflorous ſquamas, 1 *a*, 2; petals none; filaments eight, 1 *b*; antheras tetragonous, large, 1 *c*.

The female, 3; amentum and ſquamas as in the male, 4; germen ovate, narrow at each end, 3 *a*; ſtyle ſcarcely to be obſerved, 3 *b*; ſtigma quadrifid, 3 *c*.

ORDER VIII. ENNEANDRIA. Genus 1, *Mercurialis* (dog's mercury). The male, 2; perianthium tripartite, 1 *a*; corolla none; filaments nine or twelve, 1 *b*; antheras globoſe, didymous, 1 *c*.

The female, 2; perianthium as in the male; corolla none; nectaria two ſharp points, one on each ſide of the germen, 2 *a*; germen roundiſh, 2 *b*; ſtyles two, reflexed, 2 *c*; ſtigmas acute, reflexed, 2 *d*.

ORDER IX. DECANDRIA. Genus 2, *Kiggelaria*. Male, 1; perianthium monophyllous, quinquepartite, 1 *a*; petals five, longer than the calyx, 1 *b*; nectaria five, obtuſe, with three lobes, 1 *c*; filaments ten, 2 *a*; antheras, 2 *b*.

The female, 3; calyx and corolla the ſame as in the male; germen ſubrotund, 3 *a*; ſtyles five, 3 *b*; ſtigmas obtuſe, 3 *c*.

ORDER X. DODECANDRIA. Genus 2, *Meniſpermum* (moon ſeed). Male, 1; perianthium hexaphyllous, 1; petals eight, 2 *a*; filaments ſixteen, cylindric, 3 *a*; anthera, 3 *b*.

Female, 4; calyx and corolla the ſame as in the male; filaments eight, ſimilar to thoſe of the male, 4; antheras pellucid, ſterile, 4 *b*; germens two or three, ſtanding on a pedicle, 5 *a*; ſtyles, 5 *b*; ſtigmas, 5 *c*.

ORDER XI. POLYANDRIA. Genus 1, *Cliffertia* (Ethiopean holly). Male, 1; perianthium triphyllous, 1 *a*; corolla none; filaments about thirty, 1 *b*; anthera didymous, 1 *c*.

Female, 2; perianthium triphyllous, 2 *a*; corolla none; germen, 3 *a*; ſtyles two, feathery, 3 *b*; ſtigma, 3 *c*.

ORDER XII. MONODELPHIA. Genus 1, *Juniperus* (juniper). Male, 1; the amentum in form of a cone, having a common rachis, 2 *a*; to which there are three oppoſite flowers, 2 *b*; the tenth flower terminating the amentum, each flower ſerving for a baſe fixed to the pedicle of the column; corolla none; filaments (in the terminating flowers) three, at the baſe joined in one body, in the lateral flowers ſcarcely to be obſerved, 3 *a*; antheras three, ſeparate in the terminating flowers, 3 *b*; in the lateral ones fixed in the ſcales of the calyx, 4.

The female, 5; perianthium tripartite, joined with the germen, 5 *a*; petals three, 5 *b*; germen below the flower, 6 *a*; ſtyles three, 6 *b*; ſtigmas, 6 *c*.

ORDER XIII. SYNGENESIA. Genus 1, *Ruſcus* (butcher's broom). Male, 1; perianthium hexaphyllous, 1 *a*; petals none; nectarium, 1 *b*; filaments none; antheras three, inſerted on the apex of the nectarium, at their baſe coherent, 1 *c*.

Female 2; perianthium as in the male; petals as in the male; nectarium as in the male; germen hid within the nectarium, 3 *a*; ſtyle cylindraceous, 3 *b*; ſtigmas, 3 *c*.

ORDER XIV. GYNANDRIA. Genus 1, *Clutia* (pulchella). Male, 1; perianthium pentaphyllous, 1 *a*; petals five, ſhorter than the calyx, 1 *b*; the exterior nectaria tripartite, placed within the petals, 2 *a*; the interior nectaria, 2 *b*; filaments five, fixed in the middle of the ſtyle, ſpreading horizontally, 1 *c*; antheras ſubrotund, 1 *d*; germen none; ſtyle cylindraceous, club-ſhaped, 1 *e*

Female, 3; perianthium and petals as in the male; nectaria exterior none; the interior five, in pairs, ſituated as in the male, 3 *a*; germen ſtanding above the flower, 3 *b*; ſtyles three, bifid, 3 *c*; ſtigmas, 3 *d*.

CLASS XXIII. POLYGAMIA.

The twenty-third claſs conſiſts of ſuch plants as bear hermaphrodite flowers; and alſo either male, or female, or both. It has three orders, viz. 1. MONOECIA, the firſt order, comprehending ſuch plants as have the poligamy on the ſame plant, and containing fifteen genera, diſtinguiſhable into, 1. Such as are polygamous by male hermaphrodites and female hermaphrodites. 2. By hermaphrodites and males. 3. By hermaphrodites and females. DIOECIA, the ſecond order, comprehending ſuch plants as have the polygamy on two diſtinct plants, and containing ſeven genera, diſtinguiſhable into, 1. Such as are polygamous by hermaphrodites and females. 2. By hermaphrodites and males. 3. By hermaphrodites, males and females. 4. By male and female flowers upon the ſame root, and by males. 3. TRIOECIA, the third order, comprehending ſuch plants as have the polygamy on three diſtinct plants, and containing but one genus.

Explanation of Plate VI.

ORDER I. MONOECIA. Genus 4, *Veratrum* (white hellebore). Hermaphrodite flowers, 1; calyx none, except the corolla be taken for it, 1 *a*; which conſiſts of ſix petals; filaments ſix, 1 *b*; antheræ quadrangular, 1 *c*; germen three, 2 *a*; ſtyles three, 2 *b*; ſtigmas, 2 *c*.

The male flowers on the ſame plant, below the females, 2; calyx, corolla, and ſtamens the ſame as in the hermaphrodite.

ORDER II. DIOECIA. Genus 2, *Fraxinus* (flowering aſh). Hermaphrodite flower, 1; calyx none; ſometimes it hath a monophyllous perianthium, quadripartite, 1 *a*; corolla none; ſometimes it hath four petals, 1 *b*; filaments two, 1 *c*; antheras having four furrows, 1 *d*; germen ovate, 1 *e*; ſtyle cylindraceous, 1 *f*; ſtigma, 1 *g*.

The female 2; all as in the hermaphrodite. The common female aſh has very often ſome hermaphrodite flowers interſperſed; and the hermaphrodite female flowers have neither calyx nor corolla. The flowering aſh having both a corolla and a calyx, is always a true hermaphrodite, and without male flowers intermixt.

ORDER III. TRIOECIA. Genus 2, *Ficus* (common fig). Calyx a common one, obovate, large, fleſhy, concave, ſhut up with many ſcales, 1; the ſcales magnified, 2 *a*; whoſe interior ſurface is all over covered with florets, of which the uppermoſt approaching the calycine margin are hermaphrodite, and are few, 2 *b*; thoſe underneath are females, which are numerous, 2 *c*; the hermaphrodite flowers, each whereof ſitting on a pedunclé, 3; the proper perianthium, tripartite, 3 *a*; 4 *a*; corolla tetrapetalous, fixed at the baſe of the ſtamens, 4 *b*; filaments four, 4 *c*; antheras two in the middle of each filament, 4 *d*; germen oval, 3 *b*; ſtyle, 3 *c*; ſtigma, 3 *d*.

The female flowers, each whereof ſitting on a pedunclé, 5; the proper perianthium quinquepartite, 5 *a*; corolla none; germen oval, 5 *b*; ſtyle coming out on one ſide of the apex of the germen, 5 *c*; ſtigmas two, 5 *d*.

Note, The fructifications ſhould be examined a little before the maturity of the fruit. The fruit of a fig is not a pericarpium, but a receptacle, the interior ſides of which ſupport the flowers with the fructification.

CLASS XXIV. CRYPTOGAMIA.

The twenty-fourth claſs conſiſts of ſuch plants as conceal their fructification, having their flowers either within the fruit, or ſo ſmall as not to be perceptible to the naked eye. The fructification in theſe is alſo of an uncommon ſtructure. The orders are four. 1. FILICES, Ferns, the firſt order, comprehending ſuch plants as are dorſiferous, or bear their fruit on the back of the leaf. Thoſe following are the few known characters of this order. The calyx is a ſquama growing out of the leaf, opening on one of its ſides; and under which there are pedunculate globules; each globule is girt with an elaſtic ring, which breaks elaſtically, and ſheds a duſt. This order contains ſixteen genera, which, not admitting of any certain diſtinction from their fructification, have been ranged by Linnæus according to their ſituation under their covers. 2. MUSCI, Moſſes, the ſecond order, comprehending ſuch plants as anſwer the following characters: the antheræ are without filaments; the female flowers are diſtinct, and without any piſtil; the ſeeds conſiſt only of a naked corculum (being the firſt principle of the new plant within the ſeed) without cotyledon or tunic. The genera of this order have been diſtinguiſhed by Linnæus according to the following circumſtances; the antheræ, with or without a calyptra, or veil, placed on the ſame plant as the female floret, or on a diſtinct one; and the female aggregate, or ſingle. This order contains ten genera. 3. ALGÆ, Flags, the third order, comprehending ſuch plants as have their root, ſtem, and leaf all in one; the characters of the fructification being yet unknown, and containing fifteen genera. 4. FUNGI, Muſhrooms, the fourth order containing ten genera, for which no characters can be aſſigned, the fructification being but imperfectly known.

N. B. To theſe twenty-four claſſes already explained, Linnæus, in his Genera Plantarum, has annexed an APPENDIX, which in the Ordo Generum, prefixed to that work, he diſtinguiſhes by the title of the twenty-fifth claſs, and divides into two orders. 1. PALMÆ, the firſt order, comprehending ſuch plants as have a ſpadix and a ſpatha, and containing nine genera. 2. PLANTS, the ſecond order, comprehending ſuch as have been imperfectly deſcribed, and whoſe fructification is not ſufficiently known to aſcertain the ſeveral claſſes to which they may belong. To this order thirteen genera are now referred.

Explanation of Plate VI.

ORDER I. FILICES. Genus 8, *Polypodium*. The ſtipes on the forepart channelled, 1 *a*, 2 A; on the hind part rounded, covered with chaffy ſcales; the front is oblong, acute, bipinnate, branches alternate, 1 *b*, ſpreading lanceolate, pinnate; the pinnæ for the moſt part alternate, ſeſſile, grown together at the baſe; the fructification in rows, 3 *a*; one row on each ſide of the mid-rib; the clypei (or ſhields) membranaceous, 4, orbiculate, peltate, 5, pedunculated, is at the time of flowering, flat, covering the fructifications, 4; after the flowering reflexed, 6, lacerated, deciduous; the capſular globules roundiſh, 6 *a*, numerous faſciculated, on ſmall footſtalks, 7; the upper ſide of the clypeus (or ſhield) magnified, 4; the under ſide 5; the clypeus after the flowering reflexed, with mature globules, 6; the whole cluſter of globules diſengaged from the pinna and the clypeus, 8; the ſame diſengaged from the pinna, and ſtill adhering to the clypeus, 9; a few globules with their foot-ſtalks, 7; a ſingle globule in the ſtate of flowering, rough on the upper part, half-way down, with ſmall tubercles, and four ſhallow wrinkles, 10; the ſame nearly ripe, 11; the ſame ripe, the roughneſs and wrinkles being then vaniſhed, 12; the ſame burſt in two, throwing out the ſeeds, 13; the ſame empty, 14; the ſeeds, 15; the conceptacle of the ſeeds, 16. Note, the frons is a ſpecies of trunk, whoſe branches and leaves are blended together, and generally united with the fructification, which is only applicable to ferns and palms; and the ſtipes is the baſe of this trunk in palms, ferns, and muſhrooms.

ORDER II. MUSCI. Genus 8, *Bryum* (matted). Calyx, the calyptra, 1, 2, 3, 4 *a*; anthera, ſubrotund or oblong, 5 *a*; the mouth with a little ciliated ring, covered with a conic operculum, 6 *a*; receptacle, no apophyſis; perichetium none, but a tubercle for the baſe of the peduncle root fibrous, 2 *a*; trunk erect, ſomewhat branched, 2 *b*; leaves, 2 *c*; capſule, at firſt erect, 2 green, afterwards pendulous, 7, and reddiſh; the operculum magnified, 8 *a*; fig. 2, the moſs in its early ſtate with its calyptra, *a*; fig. 3 *a*; the calyptra taken off; fig. 4, as the moſs increaſes, the calyptra, *a*, withers; fig. 6, as the calyptra increaſes it becomes pendulous; fig. 8, the operculum *a* taken off to diſcharge the ſeeds *b*; fig. 10, a longitudinal ſection, to ſhew how the petals or ſetæ are placed within, and how the anthera is fixed to the operculum *a*; fig. 11, 5, when the operculum (*a*) is taken off, the outer row of petals or ſetæ ſpring back, but the inner remain erect; each row contains ſixteen petals, but in leſs than ſix or ten ſeconds, fold themſelves up, as in fig. 8 and 14; fig. 9, a longitudinal ſection of the ſame; fig. 11, the operculum on the inner ſide with the anthera *a*; fig. 12, the anthera taken out of the operculum, *a c*; fig. 13, a horizontal ſection of the operculum with the anthera, much magnified *a c*; fig. 14, the ſituation of the petals or ſetæ greatly magnified *p*; fig. 15, two leaves, the outſide *e*, the inſide *i*.

ORDER III. ALGÆ. Genus 11, *Fucus* (ſcarlet fruit). Root fibrous, 1 *a*; leaves linear, cartilaginous, ſmooth, without joints, very branched, the branches alternate, the little branches many on each ſide alternately, 1, 2; in fig. 2 the branches are magnified, the fruit, the veſicles lateral, ſcattered without order, ſeſſile, globous, black, the ſize of poppy ſeeds; fig. 3 is a vaſcle magnified.

ORDER IV. FUNGI. Genus 1, *Agaricus* (muſhroom). The fungus horizontal, with thin plates underneath, 2; the ſtem erect, cylindraceous, ſtriated, white, ſolid, bulbous at the baſe, 1 *c*, 2 *c*; the volva or calyx growing in the middle 1 *a*, 2 *a*; the cap convex, white, ſomewhat lacerated and ſquamated, 1 *b*; the lamellas or thin plates, 2, 3, 4, a little convex, entire, a ſingle lamella, 4 *a*, at firſt reddiſh 5 *a*, afterwards a brown black, 2, 3, 4; a ſection, fig. 3, a maſs of old horſe dung, collected by the gardeners, wherein are lodged white ſhreds or filaments, 6 *a*, which contain the ſeeds or cauſes of muſhrooms; a ſingle ſhred or filament 7; the manner in which the fungi firſt appear 6 *b*; a fungus on its under ſide, before it expands itſelf, to ſhew how the pileus and the volva are connected, 8; a vertical ſection of the ſame, 5.

SECTION V.

PHILOSOPHICAL REMARKS.

Vegetable MECHANISM conſiſts of two contrary ſubſtances. The CORPOREAL external one, including, nouriſhing, deſcending, adhering to the earth, carefully ſurrounding the pith, hardiſh, growing with a very tender point.

The internal PITH, or MEDULLA, included, vivifying, deliqueſcent at the baſe, aſcending at the point, infinite in multiplication, in diviſibility, and in termination, enlivened at its creation, ſecretly and gradually from its beginning extends itſelf where there is leaſt reſiſtance to its final exit; where the more feebly it is confined by the corporeal part, the ſooner it breaks its priſon, about to undergo its metamorphoſis; and, eſcaping, joins itſelf with the corporeal part, that, diſperſing itſelf into new lives, the circle of vegetation may be perennial.

GERMINATION is produced from the *ſeeds* being diſperſed and abſorbing water; whence the membranes are burſt by the bibulous ſwelling *cotyledons*; which give nouriſhment to the *heart*; till the *beak* of the fœtus puts out rootlets; by which the *plume* is elevated, growing into an annual *herb*, terminating in a decompounded *bud*. See GERMINATION.

VEGETATION is produced by the *rootlets* ſucking up the aqueous tincture of the ſoil; which by daily addition of heat, is gently driven through the veſſels of the external corporeal part; whence the nutrition of the exterior and interior plant, the ſuperfluous moiſture exhaling, the *bark* depoſiting the *rind* on its interior ſurface, which annually changes itſelf into a *woody* ſubſtance, (in annual ringlets interſperſed with the Alburnum, which at length almoſt oſſifies as the lower branches decay.) This woody ſubſtance afterwards ſuſtains the aſcending ſtock, in the ſummits of which the living *pith* advances.

We conceive the MEDULLA, or PITH, to conſiſt of a bundle of equally diverging nervous fibres; in which medulla the protruſive vital power breaks the ultimate nerves; which there diverging, penetrate the bark, as yet gelatinous; where theſe medullary nerves at the ſummit are in like manner multiplied in the bud. From the veſſel aſcending through this nerve being divided, and the aſcent of the propelled fluid being impeded beneath, the bark is extended into a *leaf*. See VEGETATION.

This LEAF, which is agitated by the paſſing wind, attracts and prepares the fluids (except thoſe of the Paraſite-Plants,

which are previouſly prepared), inhales electric matter from the light with its upper ſurface, perſpires a dew from under its ſurface, and periſhes never to be renewed.

But the larva of the herb is DISPLAYED, when the protruſion of the medulla, is greater than the retention of the including body; when the ſubſtance of the *bark* is expanded in the calyx, that of the *rind* in the corol, that of the *wood* in the ſtamens, that of the *medulla* in the piſtil; the vegetation thus terminates in new life, the threads of life being collected into the ultimate ſeeds of the medulla.

The PROLEPSIS exhibits the myſtery of the metamorphoſis of plants, in which the *larva* of the herb is changed into a *diſplayed* fructification; for it is the office of a plant to produce either a leafy *herb* or a *fructification*.

A genuine LEAF always nouriſhes in its boſom the principle of a multiplying branch, either ſuch actually or potentially; and ſince the leaf is produced for this cauſe, and no other, a leaf cannot exiſt, unleſs this principle has previouſly perforated the bark from which it aroſe, altho' the effect appears before its cauſe.

A genuine BUD is the compendium of a future *branch*, into which it is at length unfolded. A bud always conſiſts of *ſcales*, which are ſo many rudiments of leaves, and are preſſed together till the future branchlet becomes elongated. *And ſince* the leaf cannot exiſt without the bud, it follows that buds lie concealed in the boſom of every bud-ſcale, and this is evident to the eye, whence every bud can be nothing more than a body compoſed of leaves and budlets. It follows, therefore, that every bud conſiſts of leaves with their budlets, and theſe budlets in like manner of leſs ſcales or budlets, and ſo forward even unto the fifth generation, (as in the Volvox) nor further, as appears from the metamorphoſis. Therefore a leafy branch of the preſent year is pregnant with all the branchlets to be produced through *five years*, new ones always ſucceeding at the extreme ſummits, in the place, at the baſe, of thoſe fallen off, that the five ſeries may be perpetual. This happens in *trees*, where the medulla is delayed by the harder woody ſubſtance; but in annual *plants*, where the reſiſtance of the leſs compact body againſt the medulla is leſs, it can ſooner paſs into flower without the delay in the bud; for whatever increaſes the protruſion of the medulla, and weakens the power of the including body, promotes the floreſcence.

When a tree produces a FLOWER, nature anticipates the progenies of five years, then all coming forth together; in forming from the bud-leaves, the *bractes* of the next year, the *calyx* of the following one, the *corol* of that ſucceeding it, the *ſtamens* of the fourth, and *piſtil* of the fifth; which is filled with the granulated medulla of *the ſeed*, the termination of vegetable life.

FLORESCENCE exhibits *eſpouſals* of plants in the flower, and their *nuptials* in the antheſis.

The FLOWER, the unclad larva of the herb, comes forth from the diſplayed, internal plant, naked and perfect, like the above mentioned flying *inſect: wing-ſheathed* in reſpect to the calyx, *winged* in reſpect to the corol, conſiſting alone of the *organs* of reproduction; in the *males* the ſtamens have their anthers replete with the prolific *powder* containing the vivifying *fovilla:* in the *females* the piſtils have their *ovarium* terminated with a tubular and *moiſt ſtigma*.

The ANTHESIS takes place, when the burſt anthers ſcatter their bags of *duſt* upon the *ſtigma*, when this duſt gives out the included male *fovilla*, to be abſorbed by the prolific *lymph* of the *ſtigma;* ſo that the male corporeal part and the female medullary one, produce the ſeed, or *egg*, which is nouriſhed in the ovary to its due maturity.

The PRINCIPLE of fructification, the foundation of botany, ſhould be traced higher.

PROBLEM: we may ſuppoſe GOD at the beginning to have proceeded from ſimple to compound, from few to many! and therefore at the beginning of vegetation to have created juſt ſo many different plants, as there are *natural orders*. That HE then ſo intermixed the plants of theſe orders by their marriages with each other; that as many plants were produced as there are now diſtinct *genera*. That nature then intermixed theſe generic plants by reciprocal marriages (which did not change the ſtructure of the flower), and multiplied them into all poſſible exiſting *ſpecies;* excluding however from the number of ſpecies, the *mule-plants* produced from theſe marriages, as being barren.

Each GENUS therefore is natural, nature aſſenting to it, if not making it.

The CHARACTER therefore never conſtitutes the genius, but is itſelf diligently to be conſtructed according to the genus of nature.

Kindred PLANTS of the ſame mother are to be known in reſpect to the genus by the flower, or diſplayed plant, when the reciprocal unadulterated marriage leaves the fructification entire; but in the ſpecies are to be diſtinguiſhed from their ſiſter-companions, produced by a different father, according to the herb.

Thus the DIAGNOSIS of a plant conſiſts in the affinity of the *genus*, and in the difference of the *ſpecies*.

The NAME of a plant, therefore, that it may refer to each diagnoſis, is double: the *generic* family name, and the *ſpecific* trivial name, under which latter are the vague *ſynonimies* of authors.

The BOTANIST, in following the *Claſſifications*, is led to the named *genus* by the *characters* of the diſplayed plant or flower; to the appellation of the *ſpecies* by the *differences* of the larva or herb; and thence to it *ſynonimies;* from theſe to *authors*, and thence to *every thing*, which is come to us from our anceſtors on the ſubject. Thus the plant itſelf tells its name, and its hiſtory amid ſuch a multitude of ſpecies, and of individuals: this is the great purpoſe of botany, the invention of the preſent age, to the completion of which all true botaniſts will contribute their labour.

TRUE BOTANISTS will labour to increaſe this lovely Science: will conſtruct fundamental DESCRIPTIONS in characteriſtic words, particularly of obſcure, rare, and new plants, according to the rule of delineation of a plant: will add FIGURES, if they are able, which repreſent the perfect plant, ſuch as are given by *Vaillant, Dillenius, Ehret, Jacquin, Trew, Schmiedel, &c.* will diſcover the moſt compendious and moſt proper ſpecific DIFFERENCES: will enquire the SYNONYMIES of authors, particularly the beſt; as *Haller:* will always prefix the natural GENUS to the ſpecies; and when new, will define it by its natural *character* from the ſituation, figure, number, proportion, of all the parts of fructification: will refer the vague and new SPECIES to certain genera; as *Tournefort, Plumier, Brown, Jacquin:* will point out the natural *order*, where it appears: will mark the native STATIONS of each plant, and will therefore produce more *floras*, where there is opportunity, particularly *ſouthern or exotic ones:* will obſerve their PROPERTIES, as their *Duration, Semination, Gemmation, Vernation, Aeſtivation, Nuptials, Frondeſcence, Calendar, Horologe, Sleep, Qualities:* will add their USES: whatever uſes of *nature* (of the Pan and Pandora) the *Phyſician*, the *Oeconomiſt*, *&c.* have diſcovered, and of theſe whatever contributes moſt to the glory of the Author of all, and to the advantage of human life; that at length out poſterity may enjoy the meridian light of the ſcience.

FALSE BOTANISTS proclaim the laws of the art before they have learned them: extol abſurd authors, and are jealous of the excellent ones: ſteal from others, producing nothing of their own: boaſt much of a little knowledge: pretend they have diſcovered a natural method: aſſert the genera to be arbitrary.

ANATOMY OF PLANTS.

The obvious parts of a plant are five, viz. 1. Root, 2. Stem, 3. Branches, 4. Leaves, 5. Flowers. By the microſcope we diſcover the conſtituent parts to be, 1. A thin membrane, or outer ſkin.—2. An inner rind thicker than the former.—3. A blea of ſpongy texture.—4. A vaſcular ſeries.—5. A fleſhy ſubſtance.—6. Pyramidal veſſels.—7. A pith. The root has a deſcending fibre and aſcending ſtalk, which reduces the vegetable to one body compoſed of the above extremities.—Trees, ſhrubs, and herbs, are organized in the ſame manner; the thickneſs and colour of the component parts are the differences.—1. The outer bark conſiſts of two membranes, with a ſeries of veſſels between them. The fine meſhes ſerve the purpoſes of inhalent or exhalent pores.—2. The inner bark conſiſts of two membranes, incloſing a ſeries of veſſels that communicate with the blea.—3. The blea lies like cells or beds, and are reſervoirs for the liquid juices.—4. The vaſcular ſeries are greeniſh veſſels lodged between two membranes, and are the venal veſſels for the juices to riſe and fall as circulation requires.—5. The fleſh is the life of the vegetable, and is made up of ſtrong fibres, through it there are arterial veſſels, and are filled with elaſtic air, which arterial ſyſtem ſupplies the place of a heart, as the alternate changes of heat and cold verify.—6. Pyramidal veſſels ſpread through the whole ſubſtance of the fleſh, and as they advance upwards, their ramifications inoſculate, ſo as to prevent any poſſible obſtruction of the ſap.—7. The pith occupies the centre, and has a number of veſicles of uniform ſtructure. The veſſels of the fleſh communicate with it, and it forms the receptacle for the fat of the plant. The fibres of the root are capillary tubes, which abſorb the nutritive juices from the earth, and are analogous to lacteals in animals.

The Syſtem of Botany in the firſt Edition of this work, was found inadequate, and too conciſe to convey a competent knowledge of the Science; to ſupply the deficiency of the former, we have therefore, in the preſent edition, given eight additional pages, and, to render it yet more perfect, we have rejected the natural method of Claſſification, which occupied, in the former edition, eight pages, and have introduced the Linnean method of Claſſification, which is now univerſally adopted throughout all Europe by the moſt eminent Botaniſts. We have alſo introduced a copious explanation of the various Botanical terms; for without a perfect knowledge of theſe, it is impoſſible that the Syſtem can be clearly underſtood: we have likewiſe introduced a Key to the Sexual Syſtem, and an accurate Syſtematic arrangement, and illuſtration of the ſeveral Claſſes, Orders, and Genera, with their relative connexions, and ſubjoined ſeveral Philoſophical Remarks, with a variety of other additions equally important, ſo as to exhibit a comprehenſive diſplay of the Theory of Botany, and convey, in this ſmall ſpace, a conciſe though perfect Syſtem of this exhauſtleſs and entertaining Science.

BOTTLE, a ſmall veſſel proper to contain liquors, made of leather, glaſs, or ſtone. The ancient Jewiſh bottles were cags made of goats or other wild beaſts ſkins, with the hair on the inſide, well ſewed and pitched together; an aperture in one of the animals paws ſerving for the mouth of the veſſel.

Dr. Percival cautions againſt the practice of cleaning of wine-bottles with leaden ſhot. It frequently happens (he thinks) through inattention, that ſome of the little pellets are left behind; and when wine or beer is again poured into the bottles, this mineral poiſon will ſlowly diſſolve, and impregnate thoſe vinous liquors with its deleterious qualities. The ſweetneſs which is ſometimes perceived in red port wine may ariſe from this cauſe, when ſuch an adulteration is neither deſigned nor ſuſpected.—Potaſh is recommended for cleanſing bottles: a ſmall quantity in the water will clean two groſs.

BOTTLING, the operation of putting up liquors in bottles, corked, to keep, ripen, and improve.

The writers on huſbandry give divers rules concerning the bottling of beer, cyder, and the like. The virtues of Spa, Pyrmont, Scarborough, and other waters, depend on their being well bottled and corked, otherwiſe they loſe both their taſte and ſmell. To preſerve them it is neceſſary the bottles be filled up to the mouth, that all the air may be excluded, which is the great enemy of bottled liquors. The cork is alſo farther ſecured by a cement. Some improve their bottled beer, by putting cryſtals of tartar and wine or malt ſpirits; and others, by putting ſugar boiled up with the eſſence of ſome herbs and cloves into each bottle.

Cyder requires ſpecial precautions in the bottling; being more apt to fly and burſt the bottle than any other liquors. The beſt way to ſecure them, is to have the liquor thoroughly fine before it be bottled. For want of this, ſome leave the bottles open a while, or open them after two or three days bottling, to give them vent. If one bottle break, through fermentation, it is beſt to give them all vent, and cork them up again. Weak cyder is apter to break the bottles than rich. Some ſoak the corks in ſcalding water to render them more pliant and ſerviceable.

BOTTOM, uſed to denote a whole ſhip, or rather veſſel. In this ſenſe we ſay, Engliſh bottoms; foreign bottoms. By the act of navigation, certain commodities imported in foreign bottoms, pay a duty called petty cuſtoms; from which they are exempt if imported in Engliſh bottoms.

BOTTS, *in Vermeology*, a ſpecies of worms which can be produced and nouriſhed only in the inteſtines of a horſe. It is there alone they can enjoy the proper temperature of heat, and receive the nouriſhment neceſſary for them. Beſides the long worms which have been obſerved in the bodies of horſes, there are alſo ſhort ones. By theſe are to be underſtood what we call botts.

All authors, both ancient and modern, who have treated of the diſeaſes of horſes, have taken notice of theſe worms; but M. Vallifnieri is the firſt who has traced them to the laſt ſtage of their transformation, and has ſeen them change into a hairy kind of fly, like the drone. The flies from which theſe botts are produced inhabit the country, and do not come near houſes, at leaſt not near thoſe of great towns; and therefore horſes are never liable to have theſe worms (*i. e.* botts) in their bodies, if they have been kept in the houſe, eſpecially in a town, during the ſummer and autumn. It is in the former of theſe ſeaſons, and perhaps too in the beginning of the latter, that the females of theſe flies apply themſelves to the anus of horſes, and endeavour to gain admittance, in order there to depoſit their eggs, or perhaps their worms.

The preciſe inſtant of their entrance will ſcarce admit of an eye-witneſs, but by the mereſt chance; yet M. Vallifnieri ſays, that Dr. Gaſpari had attained this very uncommon ſight. "The Doctor (he tells us) was one day looking at his mares in the field; and from being very quiet, he obſerved that on a ſudden they became very reſtleſs, and ran about in great agitation, prancing, plunging, and kicking, with violent motions of their tails. He concluded, that theſe extraordinary effects were produced by ſome fly buzzing about them, and endeavouring to ſettle upon the anus of one of them; but the fly not being able to ſucceed, he obſerved it to go off, with leſs noiſe than before, towards a mare that was feeding at a diſtance from the reſt; and now the fly, taking a more effectual method to obtain its deſign, paſſed under the tail of the mare, and ſo made its way to the anus. Here at firſt it occaſioned only an itching, by which the inteſtine was protruded with an increaſing aperture of the anus; the fly taking the advantage of this, penetrated further, and ſecured itſelf in the fold of the inteſtine:—this effected, it was in a ſituation proper for laying its eggs. Soon after this, the mare became very violent, running about, prancing, and kicking, and throwing herſelf on the ground; in ſhort, was not quiet, nor returned to feeding, till after a quarter of an hour.

The fly then, we ſee, can find means of depoſiting its eggs, or perhaps its worms (*i. e.* botts), in the fundament of the horſe; which once effected, it has done all that is neceſſary for them. If theſe bott-worms are not hatched when firſt depoſited in the horſe, but are then only eggs, it will not be long before, it happens, from the nutritive heat they there receive. Theſe bott-worms ſoon make their way into the inteſtines of the horſe; they occupy ſuch parts of this region as are to them moſt convenient; and ſometimes (as we ſhall ſee preſently) they penetrate even to the ſtomach. All the hazard they ſeem to be expoſed to, is that of being carried away from the places they have fixed on by the excrement, which may ſeem likely to drive all before it. But nature has provided for all things; and when we ſhall have further deſcribed theſe bott-worms, it will ſeem that they are able to maintain their ſituation, and to remain in the body of the horſe, as long as they pleaſe.

There is a time when theſe bott-worms are of themſelves deſirous to leave this their habitation, it being no longer convenient for them after the purpoſes of their growth are anſwered. Their transformation to a fly muſt be performed out of the horſe's body: and, accordingly, when the time of their transformation draws near, they approach towards the anus of the horſe; and then leave him of their own accord, or with the excrement, with which they then ſuffer themſelves to be carried along.

According to M. de Reaumur's obſervations, the bott-worms have two unequal claws, by which they are enabled to remain in the inteſtines of the horſe in oppoſition to all efforts of the excrement to force them out.—Theſe claws are a ſort of anchor, differently diſpoſed from thoſe of common anchors, but contrived to produce the ſame effect. Beſides theſe two claws nature has given them a very great number of triangular ſpines or briſtles, very ſufficient to arm them againſt the coats of the inteſtines, and to reſiſt the force employed to drive them towards the anus, provided the head be directed towards the ſtomach of the horſe.

It will be aſked, no doubt, if theſe bott-worms are not dangerous to horſes?—The mares which afforded M. de Reaumur, for ſeveral years, thoſe on which he made his obſervations, did not appear to be leſs in health than thoſe which had none; but it may ſometimes happen, that they are in ſo great a quantity in the body of the horſe as to prove fatal to him. M. Vallifnieri ſuppoſes theſe bott-worms to have been the cauſe of an epidemical diſeaſe that deſtroyed a great many horſes about Verona and Mantua in the year 1713.—The obſervations communicated to him by Dr. Gaſpari ſufficiently confirm his ſuppoſition. This gentleman, upon diſſecting ſome horſes that died of the diſtemper, found in their ſtomachs a ſurpriſing quantity of ſhort worms; of which to give us ſome idea, he compares them to the kernels of a pomegranate opened: each of theſe, by gnawing on the coat of the ſtomach, had made for itſelf a kind of cellule therein, each of which would eaſily contain a grain of Indian wheat. It is eaſy to imagine by this means the ſtomach muſt be reduced to a wretched condition; the outer membranes were inflamed, and the inner ones ulcerated and corrupted, a very ſmall quantity of theſe worms were found in the ſmall inteſtines, and only a few in the larger, to which laſt they were found affixed, but had not corroded them. It is only perhaps when theſe bott-worms are in great numbers, and thereby incommode each other in the inteſtines of the horſe, that they make their way towards the ſtomach; and indeed a very few flies muſt be enough to overſtock the inſide of a horſe, provided they ſhould depoſit all their eggs, and ſuch ſhould all be animated, M. Vallifnieri having counted 700 and odd in the body of one ſingle fly.

When one of theſe botts has left the anus of the horſe, it falls on the ground; and immediately ſeeks out for ſome place of ſafety, where it may retire, to prepare for the laſt ſtage of its transformation, by which it is to become a fly. And now by degrees the ſkin hardens and thickens; and at length forms a ſolid ſhell or cod, the form of which ſcarce differs from that of the worm. It is firſt of a pale red colour, which changes into cheſtnut; and, at length, by the addition of gradual and ſucceſſive ſhades of brown, the ſhell is rendered black. The worm, or bott, before it paſſes into a nymph, is of the form of an oblong ball; it remains in this form much longer than worms of the fleſh-fly kind. M. de Reaumur met with worms that retained this figure five or ſix days; as yet, one can perceive no traces of the legs, wings, and head of the nymph. Hence he firſt learned, that thoſe bott-worms do not become nymphs immediately upon their firſt change; but that, in order to become flies, they muſt undergo one change more than caterpillars ordinarily do to become butterflies.—For the cure of horſes troubled with botts, ſee the Syſtem of FARRIERY, Sect. XXII.

BOUGIE. In the French language it ſignifies a wax candle, and is applied to a machine which (as the wax candle formerly was) is introduced into the urethra for removing obſtructions principally ariſing from Gonorrhæas.—There was no occaſion for bougies till towards the middle of the ſixteenth century, when the gonorrhæa virulenta appeared as a ſymptom of the lues venerea. Monſ. Daran, a French ſurgeon, lately boaſted of his introducing them as an improvement in his art, and acquired conſiderable profit by making and ſelling them. Sculteſtus, about the middle of the 17th century, uſed bougies in diſeaſes of the urethra, and Monſ. Daran probably took the hint from him. Different compoſitions have been uſed, and generally mercury was a part of them. Riverius made a plaſter as follows; R. ol. oliv. lb. iv. cerae citrin. lb ii. minii & ceruſſ.

āā lb. iſs tereb. venet. & rez. alb. āā oz. iii m. Whether the bougies are made up of this or any other compoſition, they muſt be of different ſizes, from the bigneſs of a knitting needle to that of a gooſe quill. They are made of linen rags, ſpread with a proper matter, and then rolled up as follows. Having ſpread any quantity of the linen rag with the compoſition that is choſen for the purpoſe, cut it into ſlips from ſix to ten inches long, and from half an inch to an inch broad: then dexterouſly roll them on a glazed tile, into the form of a wax candle; and as the end of the bougie that is to be entered firſt into the urethra ſhould be ſomewhat ſmaller than the reſt, it would be as well to cut the ſlips a little tapering. It ſhould alſo be obſerved that when the bougies are rolled up, that ſide muſt be outward on which the plaſter is ſpread.

Monſ. Daran, and ſome others, attributed the action of their bougies to the compoſition they made uſe of in forming them. Mr. Sharp apprehended, that as much of their efficacy was owing to the compreſſion they made on the affected part, as to any other principle; and Mr. Aiken, very juſtly ſays, As it is evident that bougies of very different compoſitions ſucceed equally well in curing the ſame diſorders in the urethra, it is plain that they do not act by means of any peculiar qualities in their compoſition, but by means of ſome property common to them all. This muſt be their mechanical form and texture, therefore their mode of action muſt be ſimple compreſſion. The efficacy of mere compreſſion in many caſes of conſtriction is well known, from the uſe of ſponge tents for widening parts that are ſtraitened by cicatrices; and admitting obſtructions in the urethra to be from a conſtriction formed by cicatrized ulcers, or a projection of the ſpungy ſubſtance of the urethra into the canal, we may eaſily conceive, that a gentle continued claſtic compreſſion will in time overcome the diſeaſe. We may alſo readily account for the inferior efficacy of metallic and whale-bone bougies from their not having the property of ſwelling with moiſture, and therefore not making ſo equal a compreſſion. As to bougies procuring a diſcharge of matter, there is no doubt but the mechanical ſtimulous of a foreign body in ſuch a tender part, though free from diſeaſe, muſt produce it in ſome degree; and that this will be varied according to the chymically irritating quality of the compoſition, and the irritable ſtate of the urethra; but it ſeems an abſurdity to apply a topic, made uniform throughout, to the whole length of a canal, with a view of producing extraordinary effects upon a particular part of it, by means of ſome powerful quality in the ingredients. As to that part of the bougie which was in contact with the diſeaſed part, being particularly covered with matter; this circumſtance is probably owing to the greater irritation of that part of the urethra where the diſorder is, than any other.

The properties requiſite in the bougie are a ſufficient degree of firmneſs, that it may be introduced with ſome force; a ſuppleneſs and tenacity, that it may conform to the motions of the body without breaking; a lenient, ſuppurative diſpoſition, to bring on a diſcharge without pain; and, laſtly, a ſmoothneſs of ſurface, that it may not only be introduced with more eaſe, but that it may lie eaſy in the paſſage.

BOUNTY, in *Commerce*, denotes a premium paid by the government to the exporters of certain commodities on their taking oath, or, in ſome caſes, giving bond, not to reland the ſame in England. There are divers bounties ſettled by act of parliament, as a bounty of one penny per ell on the exportation of Britiſh ſail-cloth; and the like on ſilk ribbands and ſtuffs, on ſilk ſtockings, on fiſh and fleſh, on gold and ſilver lace of Britiſh manufacture; and on ſeveral ſpecies of corn, when not exceeding certain prices, at the port of exportation.

The happy influence which bounties have on trade and manufactures is well known: nor can there be a more convincing proof of the good intentions of the government under which we live, than the great care that is taken to give all poſſible encouragement to thoſe who ſhall eſtabliſh or improve any hazardous branch of trade.

All undertakings, in reſpect either to mercantile enterprizes, or in the eſtabliſhment of manufactures, are weak and feeble in their beginnings; and if unſucceſsful, either ſink entirely, or at leaſt are ſeldom revived in the ſame age. Accidents of this nature are not only deſtructive to private perſons, but exceedingly detrimental to the public intereſt. On this principle, more eſpecially ſince trade, for which Providence deſigned us, hath been attended to, ſuch attempts have been thought deſerving, and have been favoured with public ſupport. This, in former times, uſually flowed from the crown, in the form of letters-patent, charters, or other grants of privileges, which, however requiſite they might be, were notwithſtanding very frequently objects of cenſure. If ſuch as obtained them failed in their endeavours, they were reputed *projectors*; if, on the other hand, they ſucceeded, they were conſidered as *monopolizers*. Corporations, which imply the uniting certain individuals into a body, that they may thereby become more uſeful to the community, are created by the crown. Many of theſe were formed for promoting trades; and according to the old ſyſtem of our government, were neceſſary and uſeful. On the ſame principle, privileges were granted to private perſons on a ſuggeſtion, that what was immediately of uſe to them would terminate in public utility. Theſe alſo did good in bringing in many arts and manufactures; though, in ſome caſes, tending to private intereſt more than public emolument, they were liable to legal correction. In later times, and in concerns of moment, a much better method has been adopted, as often as it has been found practicable, by rejecting private or particular intereſt, and propoſing the deſigned advantages to ſuch as ſhould perform the ſtipulations on which they are granted. Theſe bounties, as they are paid by the public, ſo they are ſolely calculated for the benefit of the public. They are ſometimes given to encourage induſtry and application in raiſing a neceſſary commodity; which was intended by the bounty on exporting corn. The intention of this bounty was to encourage agriculture; and the conſequence hath been, that we now grow more than twice as much as we did at the eſtabliſhment of the bounty; we even conſume twice as much bread as we then grew; yet in A. D. 1697, we exported a fifteenth part of what we grew, of late years a twenty-ninth part only. The bounty on this twenty-ninth part amounted to ſomewhat more than £50,000, and the produce more than £400,000. It is evident that all this is ſo much clear gain to the nation. But this is far from being all that we have annually gained. For if our cultivation is doubled, as indeed it is, that the rent of lands, the ſubſiſtence of working hands, the profits of the tradeſmen ſupplying them with utenſils, clothes, the value of horſes employed, &c. muſt all be taken into the account. Beſides this we muſt add the freight (amounting to half the bounty), to make the idea of the advantages complete.

Sometimes bounties are given with a view to promote manufacturers, as in the caſe of thoſe made of ſilk. Many laws are to be found in our ſtatute books in favour of the ſilk manufacture made with great wiſdom and propriety, for the encouragement and ſupport of many thouſands of induſtrious perſons employed therein. By ſtatute 8 Geo. I. cap. 15. § 1. a bounty was given on the due exportation of ribbons and ſtuffs, of ſilk only, of three ſhillings upon a pound weight; ſilks, and ribbons of ſilk, mixed with gold and ſilver, four ſhillings a pound; on ſilk gloves, ſilk ſtockings, ſilk fringes, ſilk laces, and ſewing ſilk, one ſhilling and three pence a pound; on ſtuffs of ſilk and grogram yarn, eight pence a pound; on ſilks mixed with incle or cotton, one ſhilling; on ſtuffs of ſilk, mixed with worſted, ſix pence a pound; for three years: and, from experience of their utility, theſe were continued by ſubſequent ſtatutes.

Sometimes bounties are given to ſupport a new manufacture againſt foreigners already in poſſeſſion of it, as in making linen and ſail-cloth. The promoting of the manufacture of Britiſh ſail-cloth was undoubtedly a very important national object, as the conſumption was very large, and of conſequence the purchaſe of it from foreigners an heavy expence on the public. Many methods were therefore deviſed, and countenanced by law, both here and in Ireland, for introducing and encouraging our own in preference to that of ſtrangers, more eſpecially to the royal navy. By ſtat. 12. *Annæ*, cap. 16. § 2. a bounty was given of one penny per ell on all that was exported for a term, and continued by ſubſequent ſtatutes. By 4 Geo. II. cap. 27. § 4. an additional bounty of another penny an ell is granted. Theſe bounties were to be paid out of an additional duty on imported ſail-cloth. By the ſame ſtatute every ſhip built in Britain, or in the plantations belonging to Britain, is, under the penalty of £50, to be furniſhed with a complete ſuit of ſails of Britiſh manufacture. The amount of theſe bounties mark the progreſs of the manufacture, which is alſo aſſiſted by the fund on which the payment is aſſigned.

Theſe aſſiſtances, however, are never beſtowed but on mature deliberation, in virtue of ſtrong proofs, and with a moral certainty of a national benefit. The great intention of bounties is to place the Britiſh trader on ſuch grounds as to render his commerce beneficial to his country. In order to this, ſome profit muſt accrue to himſelf, otherwiſe he would not embark therein; but this, whatever it be, muſt prove inconſiderable in compariſon of what reſults to the public. For if, by the help of ſuch a bounty, one or many traders export to the value of 1000, 10,000, or 100,000 pounds worth of commodities or manufactures, whatever his or their profit or loſs (for the latter, through avidity and over loading the market, ſometimes happens) may be, the nation gains the £1000, £10,000, or £100,000: which was the object of the legiſlature in granting the bounty. Upon this conſideration, that the entire produce of what is exported accrues to the nation, the legiſlature, when an alteration of circumſtances required it, have made no ſcruple of augmenting a bounty; as in the caſe of refined ſugar exported, from three to nine ſhillings per hundred weight. In like manner, the original bounty of one pound per ton in favour of veſſels employed in the whale-fiſhing hath been doubled, and many new regulations made, in order to render this fiſhery more advantageous to the public. As a bounty is given on malt when allowed to be exported, ſo an equivalent of 30 ſhillings per ton hath been granted on all Britiſh made malt ſpirits when exported, which is a common benefit to land, manufacture, and commerce.

It is indeed true, that on whatever account, or to whatever amount, this reward is given, the public ſeem to pay, and private perſons ſeem to receive. But theſe private perſons receive it as the hire from the public, for performing a ſervice which otherwiſe they would not perform, the benefit of which accrues to the public, and who can therefore very well afford to pay that reward in reality, which, as we have ſtated it, it only ſeems to do. For, looking a little cloſer, we cannot help obſerving, that the bounty is paid to individuals, who, as ſuch, make a part of the public. But the commodities or manufactures exported are ſold to foreigners; and the whole produce of them, be it what it will, comes into the purſe of the public. By attending to this ſelf-evident doctrine, every reaſonable and public-ſpirited man will be eaſily reconciled to bounties; and the three following conſiderations will be ſufficient to obviate the moſt common objections that have been made to the practice of giving them. 1. That no bounty can be deſired but on the plea of national utility, which always deſerves notice, and cannot be miſtaken. It muſt likewiſe be alleged and proved that this is the only means whereby the national benefit can be attained. 2. The ſums iſſued on this account not only ſhew the clear expence of the bounty, but alſo indicate the profit gained by the public; for as the one cannot exiſt without the other, that amount muſt be the inconteſtable index of both. 3. It muſt be remembered (and of this too ſome inſtances might be given) that if bounties ſhould be improperly beſtowed, they will of courſe prove ineffectual, and after a few fruitleſs trials will remain unclaimed, and conſequently produce no expence. There is indeed another objection which hath been made againſt the giving of bounties. This is grounded on the frauds to which they are ſuppoſed to be liable; and particularly the relanding of the goods on which the bounty hath been paid, and thereby deceiving and cheating the public. But whoever peruſes the laws made on this head, and attentively conſiders the numerous precautions taken to fix every circumſtance relative to the obtaining the bounty, the checks on the ſhipping of goods, the ſecurities taken for their due exportation, the certificates required to aſcertain their being actually delivered and ſold in a foreign market, muſt be convinced, that to diſcharge all thoſe ſecurities, in caſe of an intended fraud, is a thing very difficult, if not impoſſible.

To theſe remarks we may add, that bounties are uſually granted only for a limited time, and then expire; are always liable to be ſuſpended; and of courſe can never be the cauſe of any great national loſs. There is no doubt that, excluſive of frauds, the immoderate thirſt of gain may tempt intereſted men to aim at converting what was calculated for public benefit to its detriment for their own private advantage. Thus on a proſpect of ſhort crops in other countries, men may take meaſures within the letter, but directly againſt the ſpirit, of the law, to ſend ſo much of our corn abroad as to endanger a famine at home. For this the wiſdom of parliament provides, not barely by ſuſpending the bounty, but by prohibiting exportation, and opening the ports for foreign ſupplies. We cannot with any ſhadow of juſtice aſcribe ſcarcity to the bounty on the exportation. If this was the caſe, ſuſpenſions would be frequent, whereas there have been but five in a courſe of ſeventy years. If the bounty had any ſhare, the larger the exportation, the greater would be the ſcarcity. In A.D. 1750, we exported more than one-fifth of our growth of wheat, which was notwithſtanding but at four ſhillings per buſhel; whereas a century before, A.D. 1650, when we had neither bounty nor exportation, wheat was at nine ſhillings and ſixpence per buſhel. The cauſes of ſcarcity are unkindly ſeaſons; which though human policy cannot prevent, yet their ſad effects have been evidently leſſened by our increaſed growth, ſince the taking place of bounty and exportation.

Queen Anne's BOUNTY, for augmenting the poor livings under 50*l. per annum*, conſiſts of the produce of the firſt-fruits and tenths, after the charges and penſions payable out of the ſame are defrayed. A corporation for management of the ſame was ſettled, &c. in 1704.

BOW, *Arcus*, a weapon of offence, made of wood, horn, or other elaſtic matter, which, after being ſtrongly bent by means of a ſtring faſtened to its two ends, in returning to its natural ſtate, throws out an arrow with great force. It is alſo called the long-bow; by way of diſtinction from the croſs-bow, or arbalet. The bow is the moſt ancient, and the moſt univerſal, of all weapons. It has been found to obtain among the moſt barbarous and remote people, and who had the leaſt communication with the reſt of mankind. The long-bow was formerly in great vogue in England; moſt of our victories in France were acquired by it; and many laws were made to regulate and encourage its uſe. The parliament under Henry VIII. complain "of the diſuſe of "the long-bow, heretofore the ſafeguard and defence of this "kingdom, and the dread and terror of its enemies." 33 Hen. VIII. cap. 6. By this act, all men, under ſixty years of age, are commanded to exerciſe ſhooting with long-bows, and to have a bow and arrows always ready. Children from ſeven years old to ſeventeen, are alſo enjoined to be bred up in ſhooting. Servants were not excuſed, but to be ſupplied with a bow by their maſters, and the price to be deducted out of their wages. Aliens were forbidden the uſe of the long-bow, without a ſpecial licence from the king.

The art of uſing bows is called ARCHERY, and thoſe practiſed therein, ARCHERS, or *bowmen*. For a very copious account of the riſe, progreſs, and preſent ſtate of the Art of Archery, ſee the Article ARCHERY. The ſtrength of a bow may be calculated on this principle, that its SPRING, i. e. the power whereby it reſtores itſelf to its natural poſition, is always proportionate to the diſtance or ſpace it is removed therefrom. The moſt barbarous nations often excel in the fabric of the particular things which they have the greateſt neceſſity for in the common offices of life. The Laplanders, who ſupport themſelves moſt entirely by hunting, have an art of making bows, which we, in theſe improved parts of the world, have never arrived at. Their bow is made of two pieces of tough and ſtrong wood, ſhaved down to the ſame ſize, and flatted on each ſide: the two flat ſides of the pieces are brought cloſely and evenly together, and then joined by means of a glue made of the ſkins of pearch, which they have in great plenty, and of which they make a glue ſuperior in ſtrength to any which we have. The two pieces, when once united in this manner, will never ſeparate, and the bow is of much more force to expel the arrow than it could poſſibly have been under the ſame dimenſions, if made of only one piece. The Indians ſtill retain the bow. In the repoſitory of the Royal Society, we ſee a Weſt-Indian bow two yards long.

Croſs Bow, is alſo called ARBALET; which word is derived from *arbaliſta*, i. e. *arcubaliſta*; a bow with a ſling. The arbalet conſiſts of a ſteel-bow, ſet in a ſhaft of wood, furniſhed with a ſtring and a trigger; and is bent with a piece of iron fitted for that purpoſe.—It ſerves to throw bullets, large arrows, darts, &c. The ancients had large machines uſed for throwing many arrows at once called arbalets, or BALLISTÆ.

BOX, in Botany; there are three ſpecies; the box-tree with oval leaves, the narrow-leaved box, and the dwarf, or Dutch box. The ſeaſons for planting this are the autumn, and very early in the ſpring. And the beſt ſpecies for this purpoſe, is the dwarf Dutch box.

Box is cultivated for the ornament of gardens, chiefly for hedges and borders, the ſmallneſs of its leaf making it cut very cloſe and even, ſee the Treatiſe on GARDENING, Part I. Ar. 3. Month of September. Its wood is yellow, hard, and cloſe, even, very heavy, and eaſily taking a poliſh: whence its uſe in making muſical inſtruments, combs, ſpoons, tooth-pick-caſes, and other Tunbridge ware. It does not ſwim in water, nor is it liable to rot or to be worm eaten. It yields a chymical oil and ſpirit by diſtillation, of ſome uſe in medicine, and its decoction is by ſome held equal in virtue to *guaiacum*.

BOXERS, a kind of *athletæ*, who combat or contend for victory with their fiſts. Boxers amount to the ſame with what, among the Romans, were called *pugiles*. The ſtrange diſfigurements theſe boxers underwent were ſuch, that frequently they could not be known, and rendered them the object of many railleries. In the Greek anthology, there are four epigrams of the poet Lucilius, and one of Lucian, wherein their diſfigurements are pleaſantly expoſed.

BOXING, the exerciſe of fighting with the fiſts, either naked or with a ſtone or a leaden ball graſpad in them: in which ſenſe, boxing coincides with the *pugillatus* of the Romans, and what on our amphitheatres is ſometimes called trial of manhood. When the champions had *σθαιραι*, or balls, whether of lead or ſtone, it was properly denominated *σθαιρομαχια*. The ancient boxing differed from the *pugna ceſtuum*, in which the combatants had leathern thongs on their hands, and balls to offend their antagoniſts: though this diſtinction is frequently overlooked, and fighting with the *ceſtus* ranked as a part of the buſineſs of *pugiles*. We may diſtinguiſh three ſpecies of boxing; viz. where both the head and hands were naked; where the hands were armed and the head naked; and where the head was covered with a kind of a cap called amphotides, and the hands alſo furniſhed with the *ceſtus*.

In modern times this art has been in a manner appropriated by the Engliſh. About half a century ago it formed as regular an exhibition as we now ſee at any of the places of public amuſement, the theatres alone excepted. It was encouraged by the firſt ranks of the nobility, patroniſed by the firſt ſubject in the realm, and tolerated by the magiſtrates. Before the eſtabliſhment of Broughton's amphitheatre, a booth was erected at Tottenham Court, in which the proprietor, George Taylor, invited the profeſſors of the art to diſplay their ſkill, and the public to be preſent at its exhibition. The bruiſers then had the reward due to their proweſs in a diviſion of the entrance-money, which ſometimes was 100, or 150l. The general mode of ſharing was for two thirds to go to the winning champion, while the remaining third was the right of the loſer; though ſometimes by an expreſs agreement of the parties, the conqueror and the vanquiſhed ſhared alike. The nobility and gentry having complained of the inconveniences ſuſtained at Taylor's booth, prevailed on Mr. Broughton, who was then riſing into note as the firſt bruiſer in London, to build a place better adapted for ſuch exhibitions. This was accordingly done in 1742, principally by ſubſcription, behind Oxford-Road. The building was called Broughton's New Amphitheatre; and, beſides the ſtage for the combatants, had ſeats correſponding to the boxes, pit, and galleries, much in the ſame manner with thoſe at

Aſtley's. After a courſe of years, however, theſe exhibitions became gradually leſs patroniſed and frequented, owing probably to the refinement of our manners. Lately, indeed, they ſeemed to be revived, and for ſome time conſiderably engaged the attention of the public; but a fatal iſſue which attended one of them, brought the practice again into diſrepute. One of the combatants was killed on the ſpot. His royal highneſs the Prince of Wales was preſent, and declared that he would have ſome ſettlement made on the neareſt relation of the deceaſed, but that on account of the dreadful example he had then witneſſed, he would never more either ſee or patroniſe another ſtage-fight.

BRACELET, an ornament uſually worn round the wriſt. The word is French, *bracelet*. Bracelets were at firſt properly military ornaments or rewards, frequently conferred among the ancients, by generals and princes, on thoſe who behaved gallantly in fight. They became afterwards arbitrary decorations aſſumed at pleaſure; and are ſometimes ſaid to have been worn for health as well as ornament. Bracelets are much worn by the ſavages of Africa, who are ſo exceſſively fond of them, as to give the richeſt commodities, and even their fathers, wives, and children, in exchange for thoſe made of no richer materials than ſhells, glaſs-beads, and the like. They form alſo, in modern civilized countries, a very common part of the ornaments of the ladies.

BRACHIÆUS, or BRACHIALIS, a name given to two muſcles of the arm, the one external, the other internal muſcle of the arm, now generally known under the names of *brachialis*, or *brachiæus internus* and *externus*. For their origin, inſertion and uſes, ſee the Syſtem of ANATOMY, Table of Muſcles, Art. 20.

BRACHMINS, or BRACHMANS, a branch of the ancient Gymnoſophiſts, or philoſophers of India, remarkable for the ſeverity of their lives and manners. See the article GYMNOSOPHISTS.

Some ſay they derive their name from the patriarch Abraham, whom they call in their language *Brachma*, or *Bräma*. Others deduce it from the name of their god *Brachma*; which ſome again take to be the ſame with Abraham: whence Poſtel calls them *Abrachmanes*. There appear ſtill ſome remains of the ancient brachmans in the eaſt, under the denomination of Bramins. See BRAMINS.

BRADYPUS, or SLOTH, a genus of quadrupeds, belonging to the order of Bruta in the ſyſtem of mammalia. There are only two ſpecies of bradypus, viz.

1. The tridactylus, or American ſloth, has a ſhort tail, and only three toes on each foot. For repreſentation, ſee Plate II. Genus 7. It is the moſt ſluggiſh and moſt ſlow of all animals, and ſeems to move with the utmoſt pain. Its food is fruit, or the leaves of trees. If it cannot find fruit on the ground, it looks out for a tree well loaded, and with great pains climbs up: to ſave the trouble of deſcending, it flings off the fruit; and, forming itſelf into a ball, drops from the branches, continues at the foot till it has devoured all, nor ever ſtirs till compelled by hunger. It never drinks, and is terrified at rain.

The following wonderful account of this animal, from Kircher's Muſurgia, is quoted by Mr. Stillingfleet in his miſcellaneous tracts. "The deſcription (ſays Kircher) I had from father Torus, who reſided in America, who had animals of this kind in his poſſeſſion, and made many experiments in relation to their nature and qualities. Its figure is extraordinary; it is about the bigneſs of a cat, of very ugly countenance, and has claws extended like fingers. The hinder part of the head and neck are covered with hair. It ſweeps the ground with its fat belly, never riſes upon its feet, and moves ſo ſlowly, that it would ſcarce go the length of a bow-ſhot in 15 days, though conſtantly moving, and it is therefore called the ſloth. It lives generally upon the tops of trees, and employs two days to crawl up, and as many to get down again. Nature has doubly guarded this animal againſt its enemies. Firſt, by giving it ſuch ſtrength in its feet, that whatever it ſeizes, it holds ſo faſt, that it never can be freed from its claws, but muſt there die of hunger: ſecondly, in giving it ſuch a moving aſpect, when it looks at any man who ſhould be tempted to hurt it, that it is impoſſible not to be touched with compaſſion; beſides, that at the ſame time it ſheds tears, and upon the whole perſuades one, that a creature ſo defenceleſs, and of ſo unhappy a body, ought not to be tormented. To make an experiment of this, the above-mentioned father procured one of theſe animals to be brought to our college at Carthagena, he put a long pole under its feet, which it ſeized upon very firmly, and would not let go again. The animal therefore thus voluntarily ſuſpended, was placed between two beams along with the pole, and there it remained without meat, drink, or ſleep, 40 days; its eyes being always fixed on people that looked at it, who were ſo touched, that they could not forbear pitying it. At laſt being taken down, they let looſe a dog on it, which after a little while the ſloth ſeized with his feet, and held him four days, till he died of hunger. This was taken from the mouth of the father. They add (continues Kircher) that this creature makes no noiſe but at night, but that very extraordinarily. For by interruptions, that laſt about the length of a ſigh or ſemi-paſe, it goes through the ſix vulgar intervals of muſic, Ut, re, mi, fa, ſol, La, ſol, fa, mi, re, ut, aſcending and deſcending, and theſe perfectly in tune. So that the Spaniards, when they firſt got poſſeſſion of this coaſt, and heard theſe notes, imagined that ſome people brought up to our muſic were ſinging. This animal is called by the natives haut; certainly becauſe, going through theſe muſical intervals, it repeats, Ha, ha, ha, ha, ha, &c." To this account Linnæus ſeems, in his *Syſtema Naturæ*, to give credit. For he ſays, in his ſhort way of deſcription, among other things, "It utters an aſcending hexachord: its noiſe is horrible; its tears are piteous." He quotes Muſgrave, Cluſius, Geſner, &c.

2. The didactylus has two toes on each foot, and no tail: The head is round; the ears are large; and it has two mammæ on the breaſt: the body is covered with aſh-coloured hair. It is a native of Ceylon.

BRAIN, in a general ſenſe, is that large, ſoft, whitiſh maſs, incloſed in the *cranium*, or ſkull; wherein all the organs of ſenſe terminate, and the ſoul is ſuppoſed principally to reſide. The brain is encompaſſed with two meninges, or membranes, called *dura* and *pia mater*. Its figure is the ſame with that of the bones that contain it, viz. roundiſh, oblong, and flat on the ſides: it is divided into three principal parts; viz. the cerebrum, or brain ſtrictly ſo called, the CEREBELLUM, and the MEDULLA OBLONGATA; to which ſome add a fourth, viz. the MEDULLA *ſpinalis*, which is a continuation of the latter. For a copious anatomical deſcription of the brain, as referring to the human ſyſtem, ſee the Syſtem of ANATOMY, Part I. Sect. II. and Part VI. Sect. I. throughout. For repreſentation of the ſeveral parts, ſee Plate XI. Fig. 1 to 5.

For the great bulk of the brain, this reaſon may be aſſigned; viz. that on account of the exceeding ſubtilty and fineneſs of the animal ſpirits, and the ſlowneſs in which their ſecretion muſt be effected; together with the great quantity of them required in diſcharging the animal functions; there muſt of neceſſity be an infinite number of glands to ſeparate and prepare them. From the ſame principle, we ſee why the brain is much bigger in men, than in other animals: and in other animals, why, *cæteris paribus*, it is generally biggeſt in thoſe which diſcover the greateſt ſhare of ſagacity, e. gr. in monkeys; becauſe a conſiderable ſtock of animal ſpirits is to be employed in the affairs of cogitation, memory, &c. Accordingly, anatomiſts obſerve, that in fools the brain is ſmaller (*cæteris paribus*) than in men of ſenſe: this ſome may account for, by ſuppoſing it the cauſe of the folly, a ſufficient ſtock of ſpirits being wanting to reaſon ſtrongly: and others from the economy of nature, which proportioned the ſtock of ſpirits to the expence that would be required.

From the texture, diſpoſition, and tone of the fibres of the brain, philoſophers ordinarily account for the phenomena of ſenſation and imagination. Dr. Aſtruc goes farther, and from the analogy between the fibres of the brain, and thoſe of muſical inſtruments, ſolves the phenomena of judgment and reaſoning, and the defects and perfections of both. He lays it down as an axiom, that every ſimple idea is produced by the oſcillation of one determinate fibre; and every compound idea from cotemporary vibrations of ſeveral fibres; that the greater or leſs degree of evidence follows the greater or leſs force where the fibre oſcillates.

He takes occaſion to obſerve, that the fibres of the brain, from their natural analogy to thoſe of muſical inſtruments, may be perverted ſeveral ways; viz. by being rendered too dry or too moiſt, too ſtiff, or too lax, &c. In a phrenſy, he thinks the fibres too dry, and too much diſtended by the heat of the blood, &c. In a *mania*, theſe fibres he thinks too rigid, as well as too dry and diſtended. In a lethargy, they are too much ſoftened by phlegm; in idiocy, or fooliſhneſs, they are ſometimes too ſoft, and ſometimes too hard. Laſtly, he thinks that in melancholy, by the repeated ſucceſſive vibrations which the attentive meditation of a thing induces, two or more fibres, which of themſelves exhibit diſſimilar and unequal ideas, are (the other parts remaining ſound) ſenſibly brought to an iſochroniſm, that the ſoul, judging well in other reſpects, yet in this always makes a falſe judgment.

Through the whole bird kind, the cortical part of the brain is extremely over-proportioned to the medullary; ten times more in proportion than in men: add, that it is uſually alſo ſmooth, and without ſinuoſities. Dr. Willis, who diſſected a great variety of brains, obſerved a near reſemblance between the brains of men and quadrupeds, and between thoſe of birds and fiſhes: though M. Steno obſerves, that the brains of birds and fiſhes are not at all like thoſe of men.

The brain is ſubject to divers diſorders, as wounds, contuſions, depreſſions, conſtipations, inflammations, petrifactions, diſruptions, &c. Phil. Tranſ. No. 228. Med. Eſſ. Edinb. tom. II. p. 245. Hiſt. Acad. Scienc. an. 1703. 1710. 1725.

A watery brain appears to be the cauſe of the epilepſy; and an extremely dry or rigid one, of the phrenzy; and theſe have been found to be the ſtates of the brain, in diſſections of perſons affected with thoſe diſeaſes. Paracelſus even attributes leproſies, conſumptions, and jaundices, to diſorders of the brain. Hiſt. Ac. Sc. an. 1705, 1706. Curt. Lex. Med. 139.

The brain does not appear abſolutely neceſſary to animal life. We have ſeveral inſtances in authors, of children brought forth alive, and ſurviving their birth for ſome time, without any brain; and there are ſome anatomical inſtances of animals ſurviving the loſs of their brain. To which may be added, many inſtances given

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by Mr. Boyle, not only of animals living a long time after the ſeparation of the head from the body, but even of the copulation and impregnation of ſome inſects under thoſe circumſtances: whence it appears, that the ſpinal marrow is ſufficient, on occaſion, for the buſineſs of ſenſation, motion, ſecretion of animal ſpirits, &c.

The accurate Mr. Lewenhoeck examined, on ſeveral occaſions, the brains of different creatures by his microſcope; as that of the Indian hen, the ſheep, the ox, the ſparrow, &c. He could there always diſtinguiſh multitudes of veſſels ſo extremely ſmall, that if a globule of blood (a million whereof exceed not a grain of ſand in bigneſs) were divided into five hundred parts, thoſe parts would be too large to paſs into ſuch veſſels. He obſerved alſo, that theſe veſſels in the brain of a ſparrow, were as large as in that of an ox; and argues from hence, that there is really no other difference between the brain of a large animal and that of a ſmall one, but only that the one contains a much greater number of theſe veſſels than the others, and that the globules of the fluid paſſing through them, are in all animals of the ſame ſize.

In examining the brain of ſeveral ſorts of fowls, particularly the turkey, which is commonly called the cortical part of the brain, conſiſts of a very clear and tranſparent oily matter, which would be much better denoted by the term vitreous than cortical, but a great number of ſmall blood-veſſels are found ſpread through every part of this; and where a ſmall parcel of it is cut for a microſcopic examination, there flows a ſmall globule of a pellucid fluid from it. And Mr. Lewenhoeck thinks, that notwithſtanding the minuteneſs of theſe veſſels, there is a circulation carried on through them, and that of a red fluid; for wherever they lie three or four together, without any intervening matter, the congeries of them always appear red.

The medullary part of the brain of the ſame animal appears like a fiſher's net, between all the meſhes of which there is placed a very pliable ball-like ſubſtance, which changes its figure into a round or oval, according as the meſhes happen to be pulled or relaxed: theſe balls ſeemed to conſiſt of a clear and watery fluid, contained in a caſe or capſule of a membraneous matter. Phil. Tranſ. No. 168, page 884. See further concerning the brain in anatomical and medicinal writers, particularly Steno, Ridley, Willis, and Vieuſſens, who have treatiſes on the ſubject. Phil. Tranſ. No. 215. p. 1034.

BRAMINS, the name of the prieſts among the idolatrous Indians; the ſucceſſors of the ancient Brachmans. See BRACHMANS.

Their name is formed from *Brama*, their particular deity. They are found in Siam, Malabar, China, Coromandel, and moſt other eaſtern nations any wiſe civilized; but their chief ſeat is in Indoſtan, or the Mogul's country. They have a language peculiar to themſelves, which they call *Shanſchrit*; in which they have ſeveral ancient books, written, as is alleged, by their great prophet Brahma; as the *ſhaſtram*, which is their bible; and *porane*, a hiſtory which they eſteem ſacred, and pretend to have been dictated by God himſelf.

There are ſeveral orders of Bramins. Thoſe who mix in ſociety are for the moſt part very corrupt in their morals; they believe that the water of the Ganges will waſh away all their crimes; and, as they are not ſubject to any civil juriſdiction, live without either reſtraint or virtue, excepting that character of compaſſion and charity which is ſo commonly found in the mild climate of India. The others, who live abſtracted from the world, are either weak-minded men or enthuſiaſts; and abandon themſelves to lazineſs, ſuperſtition, and the dreams of metaphyſics. We find in their diſputes the very ſame ideas that occur in the writings of our moſt celebrated metaphyſicians; ſuch as, ſubſtance, accident, priority, poſteriority, immutability, indiviſibility, &c.

Their religion, which was anciently of the allegorical and moral kind, hath degenerated into a heap of extravagant and obſcene ſuperſtitions, owing to their having realized thoſe fictions which were intended merely as ſo many ſymbols and emblems. Were it poſſible to obtain a ſight of their ſacred books, the only remains there are of the Indian antiquities, we might in ſome meaſure be enabled to remove the veil that envelopes thoſe numerous myſteries; but the following ſtory will ſhow how little reaſon there is to hope that we ſhall ever be intruſted with ſuch a communication.

The emperor Mahmoud Akbar had an inclination to make himſelf acquainted with the principles of all the religious ſects throughout his extenſive provinces. Having diſcarded the ſuperſtitious notions with which he had been prepoſſeſſed by his education in the Mahometan faith, he reſolved to judge for himſelf. It was eaſy for him to be acquainted with the nature of thoſe ſyſtems that are formed upon the plan of making proſelytes; but he found himſelf diſappointed in his deſign when he came to treat with the Indians, who will not admit any perſon whatever to the participation of their myſteries. Neither the authority nor promiſes of Akbar could prevail with the Bramins to diſcloſe the tenets of their religion; he was therefore obliged to have recourſe to artifice. The ſtratagem he made uſe of was to cauſe a boy, of the name of Feizi, to be committed to the care of their prieſts, as a poor orphan of the ſacerdotal line, who alone could be initiated into the ſacred rites of their theology. Feizi, having received the proper inſtructions for the part he was to act, was conveyed privately to Benares, the ſeat of knowledge in Indoſtan; he was received into the houſe of the learned Bramin, who educated him with the ſame care as if he had been his own ſon. After the youth had ſpent ten years in ſtudy, Akbar was deſirous of recalling him: but he was ſtruck with the charms of the daughter of his preceptor. The women of the ſacerdotal tribe are looked upon as the greateſt beauties in Indoſtan. The old Bramin laid no reſtraint upon that growing paſſion of the two lovers; he was fond of Feizi, who had gained his affection by his addreſs and docility; and offered him his daughter in marriage. The young man, divided between love and gratitude, reſoved to conceal the fraud no longer; and falling at the feet of the Bramin, diſcovered the impoſture, and aſked pardon for the offence. The prieſt, without reproaching him in the leaſt, ſeized a poniard which hung at his girdle, and was going to plunge it in his breaſt, if Feizi had not prevented him by taking hold of his arm. The young man uſed every means to pacify him, and declare himſelf ready to do any thing to expiate his treachery. The Bramin, burſting into tears, promiſed to pardon him on condition that he ſhould ſwear never to tranſlate the *Bedas* or ſacred volumes, or diſcloſe to any perſon whatever the ſymbol of the Bramin creed. Feizi readily promiſed all that the Bramin required: how far he kept his word is not known; but the ſacred books of the Indians have never been tranſlated by him or any one elſe, to this day.

As the Bramins are the only perſons who underſtand the language of the ſacred book, their comments on the text are the ſame as thoſe that have ever been made on religious books; all the maxims which fancy, intereſt, paſſion, or falſe zeal can ſuggeſt, are to be found in theſe volumes. They own a ſupreme God, who created Brama, and gave him a power to create the world. They have alſo their ſubaltern deities, their pagods or temples, and idols, whom they fan to defend from flies, dancing before them. They alſo hold a feaſt in honour of the ſun, conſidered as the ſource of light and heat, whereby all nature is fecundified. Their pagods or temples conſiſt of three parts. The firſt is a vaulted roof, ſupported on ſtone columns: it lies open, and all perſons, without diſtinction, are allowed to enter into it. It is adorned with ſymbolical figures, made of wood, as elephants, oxen, and horſes. The ſecond part is open in the day-time, and ſhut at night. It is filled with groteſque and monſtrous figures, as men with many heads and arms. The third, which is a kind of chancel, is kept always ſhut, with a very ſtrong gate. In this is placed the ſtatue of the deity to whom the pagod is dedicated. A great number of lamps burn day and night before the idol. The Bramins, before they go into the pagod, pull off their ſhoes, and leave them at the door.

The Bramins of Siam and Coromandel maintain that the earth will be deſtroyed by fire; and the former aſſert that another will ariſe out of its aſhes, in which there ſhall be no ſea, nor any change of ſeaſons, but an eternal ſpring; and the latter maintain a plurality of worlds, which are alternately deſtroyed and renewed.

Robert de Nobili, an Italian Jeſuit, and one of the Indian miſſionaries, in the beginning of the 17th century, in order to ſecure ſucceſs in his miſſion, aſſumed the title and appearance of a Bramin, and at length perſuaded the credulous people that he was in reality a member of that venerable order. He forged a deed in the ancient Indian characters, ſhowing that the Bramins of Rome were older than thoſe of India, and that the Jeſuits of Rome deſcended in a direct line from the god Brahma. He farther declared on oath, that he derived his origin from this Indian deity. By this impoſture he proſelyted twelve eminent Bramins, whoſe influence proved very favourable to his miſſion. After his death, the Portugueſe Jeſuits carried on the impoſture, with very conſiderable ſucceſs. The miſſions, however, were ſuſpended and abandoned in conſequence of a papal mandate, iſſued out in the year 1744, by Benedict XIV. who declared his diſapprobation of the artifices that had been uſed in the converſion of the Indians.

BRANCHIÆ, βραγχια, a name given by the ancient naturaliſts, to the gills of fiſhes; which are parts compoſed of cartilages, and membranes, in form of leaves; and ſerving inſtead of lungs to perſpire by.—The *branchiæ*, Galen obſerves, are full of little *foramina*, big enough to admit air and vapours, but too fine to give paſſage to water. Pliny held, that fiſhes reſpired by their gills; but he obſerves, that Ariſtotle was of another opinion: to whom we may add, among the moderns, Dr. Needham. The cetaceous fiſhes, as they have lungs, have none of theſe apertures of the *branchiæ*; and in all thoſe fiſhes that have them, the larger they are, the ſooner the fiſh dies, on being taken out of the water. See the Syſtem of Comparative Anatomy, Chap. III. Sect. 7.

BRANDY, properly denotes a proof-ſpirit, obtained by ſimple diſtillation from real wines, or fermented juices of grapes. The veſſels uſed herein, are uſually of copper; and diſtillers, to cool the liquor more readily, make the neck of the matraſs, which is very long and winding like a ſerpent, paſs through a veſſel of cold water. Brandy differs from wine ſpirit, in that the former is drawn from the poorer and thinner ſorts of wines, the latter from the richer and fuller bodied wines. Brandy alſo differs from ſpirit of wine, as the former is only what they call proof-high, or half pure ſpirit, half phlegm; whereas ſpirit of wine is raiſed higher, or carried by rectification to a farther degree of purity.

Brandy

Brandy alſo differs from ſtrong waters, as the latter is a compound whereof the former, or pure ſpirit of wine is only the ingredient. The Portugueſe are lately coming into the way of making brandy. The Greek brandies are the worſt, though made of the beſt wines.

The too free and frequent uſe of brandy is attended with ill effects, as it attenuates the body, and impairs the ſtrength, and ſtupifies the brain. In perſons who have died hereof, the blood has been found thick and coagulated; the pancreas dried; the liver ſcirrhous, and almoſt petrified: the glands tumefied beyond their natural bulk, &c. Conringius even attributes the degeneracy of the modern from the ancient Germans, to the prevalency of drinking this liquor. Phil. Tranſ. No. 97.

Brandy is alſo applied, in a leſs proper ſenſe, to all ſpirituous inflammable liquors, drawn from vegetables by diſtillation. In which ſenſe brandy includes all ardent, or inflammable ſpirits, uſed in the way of beverage. Dr. Shaw adds, a further limitation to brandy ſpirits, viz, that they be proof-high, or conſiſt of equal quantities of water and alcohol. On which principle, ſpirits, either above or below proof, do not come under the appellation of brandies. Arac, rum, malt, and molaſſes ſpirit, in this ſenſe, are brandies, though under another denomination. In the iſland of Andros, they make brandies from the fruits of the arbutus and mulberry-trees.

A patent was ſome time ago obtained for making brandy from carrots and parſnips: the latter of which is ſaid to have nearly reſembled French brandy. Of late we meet with frequent advertiſements of raiſin-brandy, which, if really made of that fruit, is neareſt akin to wine-brandy. Apple, or cyder-brandy, is alſo praiſed by ſome. Cyder is found to yield an eighth part of good ſpirits, and if cloſe kept a year or two in a cool place, much more. Dr. James Anderſon has diſcovered a method of making brandy from potatoes. For an account of the proceſs, ſee the Syſtem of AGRICULTURE, Sect. XIII.

Brandy is alſo uſed to denote certain compound liquors, whereof brandies are the baſis. Such are raſpberry-brandy, cherry-brandy, gooſeberry-brandy, &c.

The French method of diſtilling brandies is the ſame with that practiſed by our diſtillers in working from waſh or wines; only that the former throws a little of the natural lee into the ſtill along with the wine, which gives the ſpirit a flavour, on which a great part of its merit depends.

When brandies prove foul, feedy, or retain the taſte of certain weeds, apt to grow among the vines, they draw them over again, in order to cleanſe them of that adventitious flavour: in which operation they leave out the faints, or rather change the receiver, as ſoon as the ſtream begins to run proof. Then mixing together all that run off before, they call it *trois cinque*, that is, brandy conſiſting of five parts alcohol, and three of phlegm; beyond which the French *bruleurs*, or common diſtillers, rarely go.

The yearly export of brandies from France, prior to the revolution, is ſaid to amount to 25000 tons; an article of itſelf ſufficient to enrich a moderate country. While the duty on French brandy continued at 9l. the ton, the Engliſh alone took ten or eleven thouſand tons off their hands; but now that the duty is raiſed to 52l. the ton, the importation is greatly reduced, to the advantage of the Engliſh diſtillery, except that ſmuggling ſtill intervenes.

The colour of their brandies is acquired from the caſk, and the length of time they uſually lie in them, which is ſometimes twelve or eighteen months, and often two or three years; during which, it is no wonder they acquire a yellow or browniſh caſt. Their lying thus long, as it were in a ſtate of ſlow digeſtion, wonderfully takes off from that hot, acid, and foul taſte, peculiar to all ſpirits, or brandies, newly diſtilled; and gives them a coolneſs and a ſoftneſs, not eaſily introduced by art. And on theſe properties are founded ſeveral methods of trying their goodneſs, or diſcovering whether they are debaſed or adulterated by the admixture of coarſer ſpirits.

Brandies are rarely adulterated in France, where they have no cheaper ſpirits with which to debaſe them; and the like holds, in great meaſure, in favour of the Dutch, though otherwiſe ſuſpected to be great adulterators. The chief temptations for adulterating are in England, where the duties are high, and where there are various kinds of ſpirits in plenty to mix with them, as malt, molaſſes, cyder, and ſugar ſpirits, with all which they are often ſophiſticated, and ſo dextrouſly, as frequently to eſcape all the ways of detection. Brandy may be imitated, by adding to very pure malt ſpirits, ſome dulcified ſpirit of nitre.

The chief uſe of brandy, is a drink; eſpecially in the cold northern countries, among the negroes in Guinea, who ſell one another for a few bottles of brandy; and among the ſavages of Canada, and other parts of North America, who are extremely fond of it. For a particular account of the manner of making brandy in France, ſee the Treatiſe on DISTILLATION.

To try the goodneſs of rectified ſpirit of wine, it muſt be lighted into a blaze; if then it conſumes wholly, without leaving any impurity behind; or, which is ſurer ſtill, if after putting a little gunpowder in the bottom of the ſpirit, the gunpowder take fire when the ſpirit is conſumed; the liquor is good. Thoſe who deal in brandy (we ſpeak only of that made with wine) chooſe it white, clear, of a good taſte, and ſuch as will bear the teſt, or proof; i. e. ſuch as in pouring into a glaſs, forms on the top of it a little white lather, which, as it diminiſhes makes a circle, called by the French brandy-merchants the *chapelet*, by the Engliſh the bead or bubble: there being no brandy but that which is well dephlegmated, and which retains no ſuperfluous humidity, wherein the bead will be entirely formed.

Before we finiſh this article, we ſhall give an acoount of the manner of extracting brandy from the huſks or ſkins of grapes, after the preſſing; becauſe the benefits that ariſe from this diſtillation deſerve ſome attention.

After the grapes have been preſſed, what remains in the preſs is coarſely ſeparated into ſmall particles with the hand, and afterwards thrown into large tubs, where they preſs it very hard, mix a little water with it, and cover it very cloſely with clay: in that condition they leave it to ferment during four or five weeks, obſerving, however, to ſhut the crevices which might happen to open in the clay, to prevent the evaporation.

After that time they fill a very large copper half full with that mixture, cover it with its head, lute it, and diſtil the whole after the ſame manner as they do brandy. By this work they make a great advantage of a matter which they were uſed to caſt on a dunghill. If this brandy be not ſo palatable as that which is made of wine, it is excellent for making ſpirit of wine. Both theſe liquors are a conſiderable branch of trade,

The greateſt part of the brandies in uſe, and thoſe too the beſt, are prepared in France: of the French brandies, thoſe of Nantes and Poictou are the moſt eſteemed; as being of a better taſte, finer and ſtronger, and enduring the bubble-proof longer than any of the reſt: thoſe of Anjou, Touraine, Orleans, Bourdeaux, Rochelle, Cogniac, &c. claim the ſecond place. They are chiefly ſent to Paris and Flanders by the river Loire.

Of brandy, both plain and rectified, are prepared various kinds of ſtrong liquors, with the addition of other ingredients; ſugars, ſpices, flowers, fruits, &c. which are afterwards clarified, by paſſing them through a ſtraining bag, or filtering them through brown paper.—Such are cinnamon-waters, aniſeed-waters, fennel-waters, celery-waters, citron-waters, &c. A great part of theſe are brought from Montpelier: where they are ſuppoſed to be better prepared than any where elſe. Savar. Dict. Commerce.

BRASS, a factitious metal, compoſed of copper fuſed with *lapis calaminaris*, which gives it a hardneſs and yellowneſs. See the Syſtem of Chymiſtry, Part. III. Chap. 2. Sect. 4. The manner of making braſs is ſaid to have been kept a ſecret in Germany for many ages.—The method of preparation among us is as follows: The *lapis calaminaris* being calcined, and ground as fine as flour, is mixed with a third or fourth part of ground charcoal, and incorporated, by means of water, into a maſs. To this compoſition of calamine and coal, ſome manufacturers add common ſalt, by which the proceſs of making braſs is ſaid to be haſtened: thus prepared, about ſeven pounds of the calamine is put into a melting pot of about a gallon, and over it about five pounds of copper, either in plates or grains, which is let down into a wind furnace eight feet deep, remaining there about eleven hours; in which time it is converted into braſs.—After melting, it is caſt into plates, or lumps: forty-five pounds of crude calamine produce thirty pounds burnt, or calcined; and ſixty pounds of copper make, with calamine, an hundred pounds of braſs. The proportion of calamine, and the increaſe which the copper receives from it, are different in different works; and hence ariſes the deeper or paler colour of braſs. The quantity of braſs obtained by the proceſs for making it, had been conſiderably augmented ſince the introduction of the method now commonly practiſed, of uſing granulated copper. The finer and more malleable kinds of braſs are made of the pureſt, calamine and copper, by cementing the braſs a ſecond time with calamine and charcoal, and ſometimes adding to it old braſs, by which the new is ſaid to be meliorated.

Braſs is ſomewhat lighter, harder, and more ſonorous than pure copper. It melts more eaſily, and does not ſcorify ſo ſoon in a moderate red heat. It is ductile only whilſt cold; heated a little, it cracks: and ignited, it falls in pieces under the hammer. This imperfection it derives from the zinc of the calamine; pure copper being malleable when hot, as well as when cold. The beautiful colour of braſs, its hardneſs, its malleability, its fuſibility, and its quality of being leſs ſubject to ruſt or verdigris, than copper, render it fit for the fabrication of many utenſils.

BRASS-*Leaf*, is made of copper, beaten out into very thin plates and afterwards rendered yellow. The German artiſts particularly thoſe of Nuremburg, and Augſburg, are ſaid to poſſeſs the beſt method of giving to theſe thin plates of copper a fine yellow colour like gold, by ſimply expoſing them to the fumes of the zinc, without any real mixture of it with the metal. Theſe plates are cut into little pieces, and then beaten out fine like leaves of gold; after which they are put into books of coarſe paper, and ſold at a low price for the common kinds of gilding. The parings or ſhreds of theſe very thin yellow leaves being well ground on a marble plate, or reduced to a powder ſimilar to gold; which ſerves to cover, by means of gum-water or ſome other glutinuous fluid, the ſurface of various mouldings or pieces of curious workmanſhip, giving

giving them the appearance of real bronze, and even of fine gold at a very trifling expence, becauſe the gold colour of this metallic powder may be eaſily raiſed and improved by ſtirring it on a wide earthen baſon over a ſlow fire.

BRASSICA, CABBAGE: A genus of the ſiliquoſa order, belonging to the tetradynamia claſs of plants.

The calyx is erect and converging; the ſeeds are globular; the gland between the ſhorter ſtamina and the piſtillum, and between the longer ones and the calyx. There are 12 ſpecies. 1. The orientalis with heart-ſhaped ſmooth leaves embracing the ſtem, and four-cornered capſules. 2. The campeſtris, with a ſlender root and ſtem, the leaves being uniform, heart-ſhaped, and ſeſſile. 3. The arvenſis, with ſcolloped leaves embracing the ſtem: the higheſt heart-ſhaped and moſt entire. 4. The alpina, with the radical leaves egg-ſhaped, and erect petals. 5. The napus, with the root-ſtem ſpindle ſhaped. 6. The raſſa, with the radical ſtem growing orbicular, depreſſed, and fleſhy. 7. The oleracea, with the radical ſtem growing columnar and fleſhy. 8. The chinenſis, with very entire oval leaves lanceolated and embracing the ſtem: the calyxes longer than the claw of the petals. 9. The violacea, with lanceolated, egg-ſhaped, ſmooth, undivided, and dentated. In theſe ſpecies the ſtyle is obtuſe; in the following enſiform. 10. The erucaſtrum, with runcinate leaves, a hiſpid ſtem, and poliſhed capſules, 11. The eruca, with lyrated leaves, ſhaggy ſtem, and ſmooth capſules. 12. The veſicaria, with runcinate leaves, and hiſpid capſules covered with a tumid calyx. The moſt uſeful ſpecies of this genus are, the cabbage, the turnip-rooted cabbage, the cauliflower, and the brocoli. As moſt of the ſpecies of this genus are noticed in the Treatiſe on Gardening, we ſhall only mention a few, which have not been ſo fully explained.

The Campeſtris, or Wild Cabbage grows naturally on the ſea-ſhore near Dover. It hath a perennial branching ſtalk, in which it differs from all the other ſpecies. In very ſevere winters when the other ſorts are deſtroyed, this is a neceſſary plant, for the moſt ſevere froſts do not injure it. The flower-ſtalks grow from the end of the branches, and ſpread out horizontally; but thoſe which ariſe from the centre of the plants grow erect, and ſeldom put out branches.

The eighth ſort, which is generally known by the title of rape or cole ſeed, is much cultivated in the iſle of Ely, and ſome other parts of England, for its ſeed, from which rape-oil is drawn; and it hath alſo been cultivated of late years, in other places, for feeding of cattle to great advantage. The cole-ſeed, when cultivated for feeding of cattle, ſhould be ſown about the middle of June. The ground for this ſhould be prepared for it in the ſame manner as for turnips. The quantity of ſeeds for an acre of land, is from ſix to eight pounds; and as the price of the ſeed is not great, ſo it is better to allow eight pounds: for if the plants are too cloſe in any part, they may be eaſily thinned when the ground is hoed, which muſt be performed in the ſame manner as is practiſed for turnips, with this difference only, of leaving theſe much nearer together; for as they have fibrous roots and ſlender ſtalks, ſo they do not require near ſo much room. Theſe plants ſhould have a ſecond hoeing about five or ſix weeks after the firſt, which if well performed in dry weather, will entirely deſtroy the weeds, ſo they will require no further culture. Where there is not an immediate want of food, theſe plants had better be kept as a reſerve for hard weather, or ſpring ſeed, when there may be a ſcarcity of other green food. If the heads are cut off, and the ſtalks left in the ground, they will ſhoot again early in the ſpring, and produce a good ſecond crop in April; which may be either fed off, or permitted to run to ſeed, as is the practice where this is cultivated for the ſeeds: but if the firſt is fed down, there ſhould be care taken that the cattle do not deſtroy their ſtems, or pull them out of the ground. As this plant is ſo hardy as not to be deſtroyed by froſt, ſo it is of great ſervice in hard winters for feeding of ewes; for when the ground is ſo hard frozen as that turnips cannot be taken up, theſe plants may be cut off for a conſtant ſupply. This will afford late food after the turnips are run to ſeed; and if it is afterwards permitted to ſtand for ſeed, one acre will produce as much as, at a moderate computation, will ſell for five pounds, clear of charges. Partridges, pheaſants, turkeys, and moſt other fowls, are very fond of this plant: ſo that wherever it is cultivated, if there are any birds in the neighbourhood, they will conſtantly lie among theſe plants. The ſeeds of this plant are ſown in gardens for winter and ſpring ſallads, this being one of the ſmall ſallad herbs. See the Syſtem of AGRICULTURE, Sect. XI.

The Savoy cabbages are propagated for winter uſe, as being generally eſteemed the better when pinched by the froſt: theſe muſt be ſown about the end of April, and treated after the manner as was directed for the common white cabbage; with this difference, that theſe may be planted at a cloſer diſtance than thoſe; two feet and a half ſquare will be ſufficient. Theſe are always much better when planted in an open ſituation, which is clear from trees and hedges; for in cloſe places they are very ſubject to be eaten almoſt up by caterpillars and other vermin, eſpecially if the autumn prove dry.

The broccoli may alſo be treated in the ſame manner, but need not be planted above one foot aſunder in the rows, and the rows two feet diſtance; theſe are never eaten till the froſt hath rendered them tender; for otherwiſe they are tough and bitter.

The ſeeds of the broccoli (of which there are ſeveral kinds, viz. the Roman or purple, the Neopolitan or white, and the black broccoli, with ſome others, but the Roman is preferred to them all), ſhould be ſown about the latter end of May, or beginning of June, and when the plants are grown to have eight leaves, tranſplant them into beds (as was directed for the common cabbage): and towards the latter end of July they will be fit to plant out, which ſhould be done into ſome well-ſheltered ſpot of ground, but not under the drip of trees; the diſtance theſe require is about a foot and a half in the rows, and two feet from row to row. The ſoil in which they ſhould be planted ought to be rather light than heavy: if your plants ſucceed well (as there will be little reaſon to doubt, unleſs the winter proves extremely hard), they will begin to ſhow their ſmall heads, which is ſomewhat like a cauliflower, but of a purple colour, about the end of December, and will continue eatable till the middle of April. The brown or black broccoli is by many perſons greatly eſteemed, though it doth not deſerve a place in the kitchen garden where the Roman broccoli can be obtained, which is much ſweeter, and will continue longer in ſeaſon: indeed, the brown ſort is much hardier, ſo that it will thrive in the coldeſt ſituations, where the Roman broccoli is ſometimes deſtroyed in very hard winters. The brown ſort ſhould be ſown in the middle of May, and managed as hath been directed for the common cabbage, and ſhould be planted at the ſame diſtance, which is about two feet and a half aſunder. This will grow very tall, ſo ſhould have the earth drawn up to their ſtems, as they advance in height. This doth not form heads ſo perfect as the Roman broccoli; the ſtems and hearts of the plants are the parts which are eaten. The Roman broccoli (if well managed) will have large heads, which appear in the centre of the plants like cluſters of buds. Theſe heads ſhould be cut before they run up to ſeed, with about four or five inches of the ſtem; the ſkin of theſe ſtems ſhould be ſtripped off before they are boiled. After the firſt heads are cut off, there will be a great number of ſide-ſhoots produced from the ſtems, which will have ſmall heads to them, but are full as well flavoured as the large. The Naples broccoli have white heads very like thoſe of the cauliflower, and eats ſo like it as not to be diſtinguiſhed from it.—Beſides this firſt crop of broccoli (which is uſually ſown in the end of May), it will be proper to ſow another crop the beginning of July, which will come in to ſupply the table the latter end of March and the beginning of April; and being very young, will be extremely tender and ſweet.

In order to ſave good ſeeds of this kind of broccoli, you ſhould reſerve a few of the largeſt heads of the firſt crop, which ſhould be let remain to run up to ſeed, and all the under ſhoots ſhould be conſtantly ſtripped off, leaving only the main ſtem to flower and ſeed. If this be duly obſerved, and no other ſort of cabbage permitted to ſeed near them, the ſeed will be as good as thoſe procured from abroad, and the ſort may be preſerved in perfection many years.

The turnip-rooted cabbage was formerly more cultivated in Britain than at preſent; for ſince other ſorts have been introduced which are much better flavoured, this ſort has been neglected. There are ſome perſons who eſteem this kind for ſoups, but it is too ſtrong for moſt palates; and is ſeldom good but in hard winters, which will render it tender and leſs ſtrong. At the end of June the plants ſhould be tranſplanted out where they are to remain, allowing them two feet diſtance every way, obſerving to water them until they have taken root; and as their ſtems advance, the earth ſhould be drawn up to them with a hoe, which will preſerve a moiſture about their roots, and prevent their ſtems from drying and growing woody, ſo that the plants will grow more freely; but it ſhould not be drawn very high, for as it is the globular part of the ſtalk which is eaten, ſo that ſhould not be covered. In winter they will be fit for uſe, when they ſhould be cut off, and the ſtalks pulled out of the ground and thrown away, being good for nothing after the ſtems are cut off. As food for cattle, however, the cultivation of this ſpecies deſerves particular attention. See the Syſtem of AGRICULTURE, Sect. XV.

The curled colewort or Siberian broccoli is now more generally eſteemed than the former, being extremely hardy, ſo is never injured by cold, but is always ſweeter in ſevere winters than in mild ſeaſons. This may be propagated by ſowing of the ſeeds the beginning of July; and when the plants are ſtrong enough for tranſplanting, they ſhould be planted in rows about a foot and a half aſunder, and ten inches diſtance in the rows. Theſe will be fit for uſe after Chriſtmas. and continue good until April, ſo that they are very uſeful in a family.

The beſt method to ſave the ſeeds of all the ſorts of cabbages is, about the end of November you ſhould make choice of ſome of your beſt cabbages, which you ſhould pull up, and carry to ſome ſhed or other covered place, where you ſhould hang them up for three or four days by their ſtalks, that the water may drain from between their leaves; then plant them in ſome border near a hedge or pale, quite down to the middle of the cabbage, leaving only the upper part of the cabbage above ground, obſerving to raiſe the earth above it, ſo that it may ſtand a little above the level of the

The BINDER *is deſired to obſerve, that this Sheet* (6 D 1) *is to be placed before* (6 D 2) *it being an* additional Sheet *introduced in the* new Edition *of this work, to enlarge the Article* BREAD and BREWING.

ground; eſpecially if the ground is wet, they will require to be raiſed pretty much above the ſurface. If the winter ſhould prove very hard, you muſt lay a little ſtraw or peaſe haulm lightly upon them to ſecure them from the froſt, taking it off as often as the weather proves mild, leſt by keeping them too cloſe they ſhould rot. In the ſpring of the year theſe cabbages will ſhoot out ſtrongly, and divide into a great number of ſmall branches: you muſt therefore ſupport their ſtems, to prevent their being broken off by the wind; and if the weather ſhould be very hot and dry when they are in flower, you ſhould refreſh them with water once a week all over the branches, which will greatly promote their ſeeding, and preſerve them from mildew. When the pods begin to change brown, you will do well to cut off the extreme part of every ſhoot with the pods, which will ſtrengthen your ſeeds; for it is generally obſerved, that thoſe ſeeds which grow near the top of the ſhoots, are very ſubject to run to ſeed before they cabbage; ſo that by this there will be no loſs, but a great advantage. When your ſeeds begin to ripen, you muſt be particularly careful that the birds do not deſtroy it, for they are very fond of theſe ſeeds. The beſt method to prevent this, is to get a quantity of birdlime, and daub over a parcel of ſlender twigs, which ſhould be faſtened at each end to ſtronger ſticks, and placed near the upper part of the ſeed in different places, ſo that the birds may alight upon them, by which means they will be faſtened thereto; where you muſt let them remain, if they cannot get off themſelves; and although there ſhould not above two or three birds be caught, yet it will ſufficiently terrify the reſt, that they will not come to that place again for a conſiderable time after.

When your ſeed is fully ripe, you muſt cut it off; and after drying, threſh it out, and preſerve it in bags for uſe.

But in planting cabbages for ſeed, it will be proper never to plant more than one ſort in a place, or near one another: for example, never plant red and white cabbages near each other, nor Savoy with white or red cabbages; for they will, by the commixture of their effluvia, produce a mixture of kinds: and it is ſaid to be owing to this neglect, that the gardeners rarely ſave any good red cabbage ſeed in Britain, but are obliged to procure freſh ſeeds from abroad; as ſuppoſing the ſoil or climate of Britain alters them from red to white, and of a mixed kind betwixt both; whereas, if they ſhould plant red cabbages by themſelves for ſeeds, and not ſuffer any other to be near them, they might continue the kind as good in Britain, as in any other part of the world.

Cauliflowers have of late years been ſo far improved in Britain, as to exceed in goodneſs and magnitude what are produced in moſt parts of Europe, and by the ſkill of the gardener are continued for ſeveral months together; but the moſt common ſeaſon for the great crop is in May, June, and July. See the Treatiſe on GARDENING, Kitchen Garden; months February to September.

There are many people who are very fond of watering cauliflower plants in ſummer; but the gardeners near London have almoſt wholly laid aſide this practice, as finding a deal of trouble and charge to little purpoſe; if the ground be ſo very dry as not to produce tolerable good cauliflowers without water, it ſeldom happens that watering of them makes them much better; and when once they have been watered, if it is not conſtantly continued, it had been much better for them if they never had any; as alſo, if it be given them in the middle of the day, it rather helps to ſcald them: ſo that, upon the whole, if care be taken to keep the earth drawn up to their ſtems, and clear them from every thing that grows near them, that they may have free open air, you will find that they will ſucceed better without than with water, where any of theſe cautions are not ſtrictly obſerved.

But in order to have a third crop of cauliflowers, you ſhould make a ſlender hot-bed in February, in which you ſhould ſow the ſeeds, covering them a quarter of an inch thick with light mould, and covering the bed with glaſs-frames. When the plants are come up, and have gotten four or five leaves, you ſhould prepare another hot-bed to prick them into, which may be about two inches ſquare: and in the beginning of April harden them by degrees, to fit them for tranſplanting, which ſhould be done the middle of that month, at the diſtance directed for the ſecond crop, and muſt be managed accordingly: theſe (if the ſoil is moiſt where they are planted, or the ſeaſon cool and moiſt) will produce good cauliflowers about a month after the ſecond crop is gone, whereby their ſeaſon will be greatly prolonged.

There is alſo a fourth crop of cauliflowers, which is raiſed by ſowing the ſeed about the 23d of May; and being tranſplanted, as hath been before directed, will produce good cauliflowers in a kindly ſeaſon and good ſoil after Michaelmas, and continue through October and November, and, if the ſeaſon permit, often a great part of December. See the Treatiſe on GARDENING, Kitchen Garden, months, February, April, and May.

All the ſpecies of cabbage are ſuppoſed to be hard of digeſtion, to afford little nouriſhment, and to produce flatulencies, though probably on no very good foundation. They tend ſtrongly to putrefaction, and run into this ſtate ſooner than almoſt any other vegetable; when putrefied, their ſmell is likewiſe the moſt offenſive, greatly reſembling that of putrefied animal ſubſtances. A decoction of them is ſaid to looſen the belly. Of all theſe plants, cauliflower is reckoned the eaſieſt of digeſtion. The white is the moſt fœtid, and the red moſt emollient, or laxative; a decoction of this laſt is recommended for ſoftening acrimonious humours in ſome diſorders of the breaſt, and in hoarſeneſs. The red cabbage is chiefly uſed for pickling. In ſome countries they bury the white cabbage when full grown in autumn, and thus preſerve it all the winter. The Germans cut them to pieces, and, along with ſome aromatic herbs and ſalt, preſs them cloſe down in a tub: here they ſoon ferment, and are eaten under the name of *Sour-crout*.

BRAWN, the fleſh of a boar ſouced or pickled; for which end the boar ſhould be old; becauſe the older he is, the more horny will the brawn be. The method of preparing brawn is as follows: The boar being killed, it is the flitches only, without the legs, that are made brawn; the bones of which are to be taken out, and then the fleſh ſprinkled with ſalt, and laid in a tray, that the blood may drain off: Then it is to be ſalted a little, and rolled up as hard as poſſible. The length of the collar of brawn ſhould be as much as one ſide of the boar will bear, ſo that when rolled up, it will be nine or ten inches diameter. The collar being thus rolled up, is to be boiled in a copper, or large kettle, till it is ſo tender, that you can run a ſtraw through it; then ſet it by till it is thorough cold, and put it into the following pickle. To every gallon of water, put a handful or two of ſalt, and as much wheat bran, boil them together, then drain the bran as clear as you can from the liquor; and when the liquor is quite cold, put the brawn into it.

BRAZIL, or BRASIL, an American wood, commonly ſuppoſed to have been thus denominated, becauſe firſt brought from Brazil; though Huet ſhews, it had been known by that name many years before the diſcovery of that country. It is denominated variouſly, according to the place whence it is brought. Thus we have brazil from Furnambuc, brazil of Japan, of Lamon, of St. Martha; and laſtly, braziletto, or Jamaica wood, brought from the Antilles. The brazil tree ordinarily grows in dry barren places, and in the middle of rocks; it is very thick and large, uſually crooked and knotty: its flowers, which are of a beautiful red, exhale a very agreeable ſmell, which ſtrengthens the brain. Though the tree be very thick, it is covered with ſo groſs a bark, that when the ſavages have taken it off the wood, or trunk, which before was the thickneſs of a man, it is ſcarce left equal to that of his leg.

BRAZIL wood is very heavy and dry; it crackles much in the fire, and ſcarce raiſes any ſmoke, by reaſon of its extreme dryneſs. None of the ſeveral kinds hath any pith, except that of Japan: that of Fernambuc is eſteemed the beſt. It muſt be choſen in thick pieces, cloſe, ſound, without any bark on it; and ſuch as, upon ſplitting, from pale becomes reddiſh; and, when chewed, has a ſaccharine taſte.—It is much uſed in turned works, and takes a good poliſh; but its chief uſe is in dying, where it ſerves for a red colour.

BREAD ordinarily is made of the flour or meal of ſome farinaceous vegetable, ground, and kneaded with water and yeaſt. Bread is uſually made of the ſeeds, ſometimes alſo of the roots, and even of the piths of plants. The Greeks attribute the invention of bread to Ceres, the Egyptians to Iſis, others to Menes. The firſt bread is ſuppoſed to have been made of the plant lotus. The poor Tafiters, near Sheraznel, ſtill live upon acorn-bread, Phil. Tranſ. No. 303, and No. 138, p. 2033. and 943.

The grains of all vegetables are almoſt entirely compoſed of ſubſtances very proper for the nouriſhment of animals; and amongſt grains thoſe which contain a farinaceous matter are the moſt agreeable and moſt nutritive.

Man, who appears to be deſigned by nature to eat of all ſubſtances which are capable of nouriſhing him, and ſtill more of vegetables than animals, has, from time immemorial, and in all parts of the earth, uſed farinaceous grains as the principal baſis of his food: but as theſe grains cannot be without difficulty eaten by men in their natural ſtate, this active and intelligent animal has gradually found means, not only to extract the farinaceous part, that is, the only nutritive part of theſe grains, but alſo to prepare it ſo that it becomes a very agreeable and wholeſome aliment, ſuch as the bread we now generally eat.

Nothing appears ſo eaſy at firſt ſight, as to grind corn, to make a paſte with the flour and water, and to bake this paſte in an oven. They who are accuſtomed to enjoy the advantages of the fineſt human inventions, without reflecting on the labour it has coſt to complete them, think all theſe operations common and trivial. However, it appears very certain, that for a long time men no otherwiſe prepared their corn than by boiling and forming compact viſcous cakes, not very agreeable to the taſte, and of difficult digeſtion, before they were able to make bread of good taſte and quality as we have now. It was neceſſary to invent and complete ingenious machines for grinding corn, and ſeparating the pure flour with little trouble and labour; and that inquiries, or rather ſome happy chance, which ſome obſerving perſon availed himſelf of, ſhould diſcover that flour, mixed with a certain quantity of water, is ſuſceptible of a fermentation which almoſt entirely deſtroys its viſcidity, heightens its taſte, and renders it proper to make a light bread, very agreeable to the taſte, and of eaſy digeſtion.

This eſſential operation, on which the good quality of bread depends, is entirely the province of chymiſtry. It would add to the honour of the ancient cultivators of chymiſtry, to attribute to them ſo uſeful and important a diſcovery; but, unhappily, it is

too

too probable that they had no ſhare in it. The ancient chymiſts were engaged in other purſuits than that of bread and other common objects. They hoped to make gold; and what is bread in compariſon with gold?

However that be, to the fortunate invention of raiſing the paſte before baking we owe the perfection of the art of making bread. This operation conſiſts in keeping ſome paſte or dough, till by a peculiar ſpirituous fermentation it ſwells, rarefies, and acquires a ſmell and taſte, quick, pungent, ſpirituous, ſomewhat ſour, and rather diſagreeable. This fermented dough is well worked with ſome freſh dough, which is by that mixture and moderate heat diſpoſed to a ſimilar but leſs advanced fermentation than that above mentioned. By this fermentation the dough is attenuated, and divided; air is introduced into it, which, being incapable of diſengaging itſelf from the tenacious and ſolid paſte, forms in it ſmall cavities, raiſes and ſwells it: hence the ſmall quantity of fermented paſte which diſpoſes the reſt to ferment, is called *leaven* from the French word *lever*, ſignifying to raiſe.

When the dough is thus raiſed, it is in a proper ſtate to be put into the oven; where, while it is baked, it dilates itſelf ſtill more by the rarefaction of the air, and of the ſpirituous ſubſtance it contains, and it forms a bread full of eyes or cavities, conſequently light, and entirely different from the heavy, compact, viſcous, and indigeſted maſſes made by baking unfermented dough.

The invention of beer, or wine of grains, furniſhes a new matter uſeful in making of bread. This matter is the froth which forms upon the ſurface of theſe liquors during fermentation. When it is mixed with dough, it raiſes it better and more quickly than ordinary leaven. It is called yeaſt or barm. By means of this, the fineſt lighteſt bread is made. It often happens, that bread made with leaven dough has a ſouriſh and not agreeable taſte; which may proceed from too great a quantity of leaven, or from leaven in which the fermentation has advanced too far. This inconvenience does not happen to bread made with yeaſt; becauſe the fermentation of this ſubſtance is not too far advanced, or becauſe more attention is given to that of finer bread.

It may be aſked, Why, ſince dough is capable of fermenting ſpontaneouſly and ſingly, as we ſee from the leaven, a ſubſtance is added to diſpoſe it to ferment? The true reaſon is, That all the parts of a fermenting ſubſtance does not ferment at the ſame time, nor to the ſame degree; ſo that ſome parts of this ſubſtance have finiſhed their fermentation, while others have not yet begun. The fermentable liquors which contain much ſugar, as hydromel, and muſt of wines, give proofs of this truth; for, after theſe liquors have become very vinous, they have ſtill very diſtinctly a ſaccharine taſte: but all ſaccharine matter is ſtill ſuſceptible of fermentation: and, in fact, if vinous hydromel, or muſt, or even new beer, be diſtilled, ſo that all their ardent ſpirit ſhall be ſeparated, and the reſiduums diluted with water, we ſhall ſee a ſecond fermentation take place, and a new quantity of ardent ſpirit formed. The ſame thing preciſely happens to dough, and ſtill more ſenſibly, from its viſcoſity and want of fluidity: ſo that if it be left to ferment alone, and without the help of leaven, as the fermentation proceeds very ſlowly and ſucceſſively, the parts which ferment firſt will have become ſour and vapid before all the reſt be ſufficiently attenuated and changed, by which the bread will acquire a diſagreeable taſte.

A mixture of a ſmall quantity of leaven with dough effectually prevents this inconvenience; becauſe the effect of this leaven, and of all fermenting ſubſtances, is to diſpoſe to a ſimilar fermentation all matters capable of it, with which it is mixed; or rather, by means of leaven, the fermentation of all the parts of ſuch ſubſtances is effected more nearly at the ſame time.

Bread well raiſed and baked differs from unfermented bread, not only in being leſs compact, lighter, and of a more agreeable taſte, but alſo in being more eaſily miſcible with water, with which it does not form a viſcous maſs, which circumſtance is of great importance in digeſtion. See the Syſtem of CHYMISTRY, Part IV. Chap. I. Sect. VI.

It is obſervable, that without bread, or ſomewhat of this form, no nation ſeems to live. Thus the Laplanders, having no corn of their own, make a ſort of bread of their dried fiſhes, and of the inner rind of the pine, which ſeem to be uſed not ſo much for their nouriſhment, as for ſupplying a dry food. For this mankind ſeem to have an univerſal appetite, rejecting bland, ſlippery, and mucilaginous foods. This is not commonly accounted for, but ſeems to depend on very ſimple principles. The preparation of our food depends on the mixture of the animal fluids in every ſtage. Among others the ſaliva is neceſſary, which requires dry food as a neceſſary ſtimulus to draw it forth, as bland, ſlippery, fluid aliments are too inert, and make too ſhort ſtay in the mouth, to produce this effect, or to cauſe a ſufficient degree of manducation to emulge that liquor. For this reaſon we commonly uſe dry bread along with animal food, which otherwiſe would be too quickly ſwallowed. For blending the oil and water of our food nothing is ſo fit as bread, aſſiſted by a previous manducation. For which purpoſe, bread is of like neceſſity in the ſtomach, as it is proper that a ſubſtance of ſolid conſiſtence ſhould be long retained there. Now the animal fluids muſt be mixed with our aliments, in order to change the aceſdency it undergoes. But liquid foods would not attain this end, whereas the ſolid ſtimulates and emulges the glands of the ſtomach. The bread then appears to be exceedingly proper, being bulky without too much ſolidity, and firm without difficulty of ſolution.

COMMON METHOD OF MAKING BREAD.

To half a buſhel of meal add ſalt, a pint of yeaſt, and ſix quarts of water that has boiled; in warm ſummer weather put the water nearly cold; in winter, when the weather is very cold, as warm as the hand can be endured in it without cauſing pain; and in temperate weather obſerve a mean between thoſe extremes. This is deemed a common proportionate mixture, and the mode of proceeding is as follows: Put the flour into a trough, or other veſſel uſed for the purpoſe, and making a hole in the middle of the flour put the water into it, to which add the barm and ſalt, ſtirring it together; alſo gently mix the flour with it till it becomes of a very thick conſiſtence. Cover the whole up warm to ferment and riſe, particularly in cold weather; this is called laying ſponge, and on a due management of this part of the proceſs greatly depends the goodneſs of bread, provided the various materials are good. After letting it lie a proper time in this ſtate, an hour and a half, more or leſs, according to the ſtate of the weather, knead it well together; be not ſparing of labour, and afterwards lay the whole thick at one end of the dough trough, and let it lie ſometime longer covered up. During this part of the buſineſs the oven muſt be heated; when that is effected, and properly cleared from aſhes, cinders, &c. make the bread into loaves, and place them in the oven as expeditious as poſſible; obſerving to make a ſmall fire on one ſide the mouth of the oven to give light while ſetting, and alſo to prevent the external air from cooling it; ſtop the oven cloſe, and pull the bread out when baked.

As a valuable and uſeful Improvement, we lay before our Readers, a Practice communicated to us by Mr. JAMES STONE, *of* AMPORT, HAMPSHIRE.

METHOD OF RAISING A BUSHEL OF FLOUR, WITH A TEA SPOONFUL OF BARM.

Suppoſe you want to bake a buſhel of flour, and have but one tea-ſpoonful of barm. Put your flour into your kneading-trough or trendle; then take about three quarters of a pint of warm water, and take the tea-ſpoonful of thick ſteady barm and put it into the water, ſtir it until it is thoroughly mixed with the water: then make a hole in the middle of the flour large enough to contain two gallons of water, pour in your ſmall quantity; then take a ſtick about two feet long, (which you may keep for that purpoſe), and ſtir in ſome of the flour, until it is as thick as you would make batter for a pudding; then ſtrew ſome of the dry flour over it, and go about your uſual buſineſs for about an hour: then take about a quart of warm water more, and pour in; for in one hour you will find that ſmall quantity raiſed ſo, that it will break through the dry flour which you ſhook over it; and when you have poured in the quart of warm water, take your ſtick as before, and ſtir in ſome more flour, until it is as thick as before; then ſhake ſome more dry flour over it, and leave it for two hours more, and then you will find it riſe and break through the dry flour again; then you may add three quarts or a gallon of water more, and ſtir in the flour and make it as thick as at firſt, and cover it with dry flour again; in about three or four hours more you may mix up your dough, and then cover it up warm; and in four or five hours more you may put it into the oven, and you will have as light bread as though you had put a pint of barm. It does not take above a quarter of an hour more time than the uſual way of baking, for there is no time loſt but that of adding water three or four times.

The author of this method aſſures us that he conſtantly bakes this way in the morning about ſix or ſeven o'clock, puts the flour out, and puts this ſmall quantity of barm into the before mentioned quantity of water, in an hour's time ſome more, in two hours more a greater quantity, about noon makes up the dough, and about ſix in the evening it is put into the oven, and he has always good bread, never heavy nor bitter.

When you find, he ſays, your body of flour ſponged large enough, before you put in the reſt of your water, you ſhould, with both your hands, mix that which is ſponged and the dry flour all together, and then add the remainder of warm water, and your dough will riſe the better and eaſier.

The reaſon he aſſigns why people make heavy bread is, not becauſe they have not barm enough, but becauſe they do not know that barm is the ſame to flour as fire is to fuel; that, as a ſpark of fire will kindle a large body by only blowing it up, ſo will a thimbleſull of barm, by adding warm water, raiſe or ſponge any body of flour; for warm water gives freſh life to that which is before at work; and the reaſon of making bread heavy is, becauſe the body ſponged is not large enough, but was made up and put into the oven before it was ripe, or well fermented.

In regard to the difference of ſeaſons, he preſcribes, that in the ſummer you ſhould put your water blood-warm; and in winter, in cold froſty weather, as warm as you can bear your hand in it without making it ſmart; being ſure you cover up your dough very warm in the winter, and your covering of it with dry flour every time you add warm water will keep in the heat; when you have added ſix or eight quarts of warm water, as before mentioned,

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in ſuch a gradual way, you will find all that body of flour which is mixed with the warm water, by virtue of that one tea-ſpoonful of barm, brought into great agitation, waxing, or fermenting; for it is to the flour what the ſpirit is to the body, it ſoon fills it with motion.

The French have alſo a great variety of breads; as queen's bread, alamode bread, bread de Segovie, de Gentillay, quality-bread, &c. all prepared in peculiar manners by the bakers of Paris. The bread de Goneſſe excels all others, on account of the waters at Goneſſe, a town three leagues from Paris. It is light, and full of eyes, which are the marks of its goodneſs. *Pain de menage*, is that which each family bakes for itſelf. Spice-bread, *pain d'epice*, denotes bread baked and iced over with the ſcum taken off ſugar in refining houſes; it is ſometimes alſo made with honey and other ſorts of ſeaſoning, and anſwers to what the ancients call *panis mellitus*.

Among us, bread is chiefly divided into white, wheaten, and houſehold; differing only in degrees of purity. In the firſt, all the bran is ſeparated; in the ſecond, only the coarſer; in the third, none at all: ſo that fine bread is made only of flour; wheaten bread, of flour and a mixture of the finer bran; and houſehold, of the whole ſubſtance of the grain, without taking out either the coarſe bran or fine flour. We alſo meet with ſymnel bread, manchet, or roll bread, and French bread: which are only ſo many denominations of the fineſt and whiteſt bread, made of the pureſt flour; except that in ill-roll bread there is an addition of milk; and in French bread, of eggs and butter. The proceſs is thus managed, they take half a buſhel of fine flour, ten eggs, and a pound and a half of freſh butter, into which they put as much yeaſt, with a manchet; and tempering the whole maſs with new milk, pretty hot, let it lie half an hour to riſe, which done, they make it into loaves or rolls, and waſh it over with an egg beaten with milk; care is taken, the oven be not too hot, this they call French bread.

In Lancaſhire, and ſeveral of the northern counties of England, they have ſeveral ſorts of oaten bread; as, 1. The bannock, which is an oat-cake, kneaded only with water, and baked on the embers. 2. Clap-bread, which is made into thin hard cakes. 3. Bitchineſs-bread, which is made of thin batter, and made into thin ſoft oat-cakes. 4. Riddle-cakes, which are thick and four, have but little leaven, and are kneaded ſtiff. And, 5. Jannock, which is oaten bread made up into loaves. Add to theſe *peaſe-bread*, much uſed in many parts of Scotland; being bread conſiſting either wholly of the flour of peaſe, or of this and oat-meal mixed: the dough, ſometimes leavened, ſometimes made only with water, is formed either into bannocks or cakes, and baked over the embers; or into what they call *baps*, i. e. a kind of flattiſh rolls, and baked in the oven. In the ſtatute of aſſize of bread and ale, 51 Hen. III. mention is made of waſtel-bread, cocket-bread, and bread of treet; which anſwer to the three kinds of bread now in uſe, called *white*, *wheaten*, and *houſehold* bread.

It is for the intereſt of the community that the food of the poor ſhould be as various as poſſible, that, in time of dearth and ſcarcity of the ordinary kinds, they may not be without ready and cheap reſources. To the diſcovery of ſuch reſources ſeveral benevolent philoſophers have ſucceſsfully turned their enquiries, we ſhall lay before the reader the reſult of their experiments.

1. BREAD of Potatoes. Potatoes, previouſly deprived of their ſkin, cut into thin ſlices, and put between paper, will dry in a heat ſomewhat leſs than 35° of Reaumur's thermometer; and, when thus dried, they will preſerve their white colour. By this proceſs they loſe about two thirds of their weight, and they may then be reduced to a fine powder. A little of this powder thrown upon the fire ſends out a ſmoke, accompanied with a ſmell reſembling burnt bread. As this ſmell is perceived from all farinaceous vegetables when treated in the ſame manner, Mr. Parmentier thinks it may be conſidered as the characteriſtic of the preſence of an *amylaceous* matter. This ſmell does not, however, he obſerves, ariſe from the amylaceous or fibrous part ſeparately, but from both taken together. The powder of potatoes, obtained in the manner deſcribed above, has the ſmell and taſte of wheat; and, like it, is devoured by rats and mice: but, even when moſt finely powdered, it has not the feel or brightneſs of the flour of wheat; although, on a chemical analyſis, it yields the ſame products. It is alſo nutritious, and keeps well for a long time.

Finding ſo great a ſimilarity between the meal of wheat and what may be called the meal of potatoes, Mr. Parmentier next endeavoured to make bread of them when mixed in different proportions. His trials were made with one fourth, one third, one half, and two thirds, of the potatoe-meal, the remainder being flour from wheat. Theſe proportions, with the addition of a little ſalt and yeaſt, yielded bread which was well taſted, but which had fermented little, was brown, and covered with hard brown cruſts. Bread made from the meal of potatoes alone, with the addition of ſalt and yeaſt, was eatable, but very heavy, unfermented, and exceedingly brown. This bread, from the meal of potatoes alone, was apt to crumble into powder. To give it more adheſion, he mixed with the meal a decoction of bran, or a mixture of honey and water; either of which made it lighter and more fermented: it obtained alſo a cruſt of a golden colour, became well taſted, and ſufficiently adheſive. Mr. Parmentier obtained bread alſo, well fermented, and of a good colour and taſte, from a mixture of raw potatoe-pulp with meal of wheat, or potatoe-meal, with the addition of yeaſt and ſalt.

Potatoes, when uſed for making bread, are not readily diſpoſed to ferment; without which bread is very inſipid, and not eaſily digeſted. But Mr. Parmentier found, from a variety of experiments, that good bread might be made from equal quantities of flour and potatoe-meal. He concludes, therefore, with recommending the mixture of potatoes, in times of ſcarcity with the flour of wheat, inſtead of employing rye, barley, or oats, as has frequently been done.

When grain is altogether wanting, he recommends the uſe of bread made from a mixture of the amylaceous powder of potatoes and of their pulp, this mixture being fermented with leaven or with honey. The meal of this root, when diluted with hot water, acquires a tenaceous and gluey conſiſtence. However fair the meal of potatoes may be, it always gives a grey colour to the bread made by mixing it with the flour of wheat: but a mixture of the pulp of potatoes with the flour of wheat does not produce brown coloured bread.

Mr. Parmentier made bread, very much like that of wheat, by a mixture of the following four ſubſtances, viz. four ounces of amylaceous powder of potatoes, one drachm of mucilare extracted from barley, one drachm of rye, and a drachm and a half of glutinous matter dried and powdered.

2. BREAD from different vegetables not commonly in uſe. Although horſe-cheſnut has not hitherto been employed, yet is is certain that wholeſome bread, without any bitterneſs, may be obtained from it. Mr. Parmentier adviſes, that the fruit, after the ſkin is taken off, and the juice preſſed from it, be made into a paſte. This maſs muſt be diluted in water, and then ſtrained through a ſieve. A milky-coloured liquor is thus ſeparated, which, on ſtanding, depoſits a fine powder. This, being dried, is without either ſmell or taſte, and very fit for aliment; the maſs from which it is procured retaining the bitterneſs of the fruit.

The roots of the bryona, when treated in the ſame manner, yielded a ſimilar white powder. By the ſame treatment alſo, fine white, inſipid, inodorous powders may be procured from the roots of the iris, gladiolus, ranunculus, fumaria, arum, dracunculus, mandragora, colchicum, filipendula, and helleborus; plants which grow ſpontaneouſly and in great abundance.

Of acorns bread has frequently been made; and to this day, in ſome countries, they are in common uſe. The method of preparation which Mr. Parmentier recommends is, that they be deprived of their cover by boiling, then dried and powdered, and afterwards baked in the ſame manner as the flour of wheat. When fully ripe, and made into a paſte, they were deprived of their aſtringency by merely preſſing their juice from them. The maſs remaining after the preſſure, when dried, was eaſily reduced to a fine powder by no means diſagreeable.

The gramen caninum arvenſe, in its appearance, approaches to corn; and ſome naturaliſts have conſidered it as the original ſpecies from which all our grain is produced. Its roots are ſweet taſted, and have been employed in making ptiſans. In the preparations of them for bread, it is only neceſſary that the roots ſhould be cleanſed, cut ſmall, dried and pounded. This powder, Mr. Parmentier obſerves, does not diſſolve in cold water or ſpirits; but it does in boiling water, which it renders thick and cloudy, and, upon cooling, the whole maſs obtains a gelatinous conſiſtence. Upon a chemical analyſis, it yields an acid empyreumatic oil, which poſſeſſes a ſingular odour, reſembling that which is perceived on burning the plant. The ſpongy reſiduum, calcined in the air, gives a fixed alkali. Theſe properties inconteſtably prove, that it contains an *amylaceous* matter ſimilar to that of grain, which appears to be the nutritive part of vegetables*.

* M. Beccari of the Bolognian academy has diſcovered in the flour of wheat two diſtinct ſubſtances. The one he terms an *animal* or *glutinous* matter; the other, an *amylaceous* matter or *vegetable paſte*.

The *gluten* has been ſuppoſed to be the nutritive part of corn, from its not diſſolving unleſs in vegetable acids; from its aſſuming a ſpongy form in boiling water; from its ſuppoſed analogy to the animal lymph; and, laſtly, from the ſimilitude which the products it affords, on a chemical analyſis, bear to thoſe obtained from animal ſubſtances. M. Parmentier, however, from various experiments, was led to conclude, with the celebrated Model of Peterſburg, that the gluten or animal matter of Beccari exiſts in the bran, and is not the nutritive part of the wheat. Having made experiments with four different kinds of flour, it appeared that the quantity of animal matter was always proportioned to the coarſeneſs of the flour. Hence, were this gluten the nutritive part, the coarſeſt bread, or that which contained moſt bran, would afford the greateſt quantity of nouriſhment. The contrary of this, however, is known to be fact.

The *amylaceous* part, or, as ſome have termed it, the *feeula*, of wheat and other vegetables, is a peculiar gum, not ſoluble in ſpirit of wine, vinegar, or cold water. It contains more acid, and leſs water, than the ordinary gums. It is found in many of thoſe plants that make the nouriſhment of men and other animals. Hence Mr. Parmentier concludes it to be the nutritive matter.

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This amylaceous matter, formed into a jelly, diffuſed in water, keeps for a long time without ſuffering any change: it then turns, and at length putrifies.

The amylaceous matter of acrid and poiſonous plants, although innocent and nutritive, cannot be converted into bread without the addition of ſome mucilaginous ſubſtance. In times of great ſcarcity, common bran will anſwer the purpoſe: but, when potatoes are to be had, the addition of a proportion of theſe is to be preferred.

Mr. Parmentier gives an account of the bread which he obtained from the amylaceous powders of the different vegetables mentioned above, with the addition of potatoes, and a ſmall quantity of common leaven of grain. This bread appeared in general to be well fermented; it was of a good white colour, and free from any diſagreeable odour; but to the taſte it was ſomewhat inſipid: which, however, he imagines, might have been corrected by the addition of a proper quantity of ſalt.

As the reſources againſt ſcarcity here pointed out can be procured only at particular ſeaſons, the author propoſes a method for preſerving the matter thus obtained. For this purpoſe, he adviſes that bread prepared in the manner mentioned above ſhould be carefully dried, reduced to powder, and then kept in a cloſe caſk. By this means he is of opinion that it may be preſerved for a very long time, and will always be ready to make an agreeable and wholeſome panada by the addition of a little butter and ſalt.

Mr. Parmentier, in order to diſcover the degree of power wherewith this alimentary powder nouriſhed, made himſelf the ſubject of experiment; and found, that three ounces of it for dinner, and as much for ſupper, made into panada with water, was a ſufficient quantity of aliment for a day. From his diſcharge by ſtool while he uſed it, he had reaſon to believe that it is alſo totally alimentary. He concludes with recommending it not only as uſeful in times of ſcarcity, but as a proper ſubſtitute for ſea-biſcuit, and as a ſpecies of food well adapted for armies and hoſpitals.

Cheap method of making wholeſome BREAD, when wheat flour is dear, by mixing turnip with it, communicated by a correſpondent.

"At the time I tried this method, bread was very dear, inſomuch that the poor people in the country where I live, could hardly afford themſelves half a meal a-day. This put me upon conſidering whether ſome cheaper method might not be found than making it of wheat-meal. Turnips were at that time very plentiful. I had a number of them pulled, waſhed clean, pared, and boiled; when they were become ſoft enough to maſh, I had the greateſt part of the water preſſed out of them, and afterwards had them mixed with an equal quantity in weight of coarſe wheat-meal; the dough was then made in the uſual manner, with yeaſt or barm, ſalt, water, &c. It roſe very well in the trough; and after being well kneaded, was formed into loaves, and put into the oven to be baked. I had at the ſame time ſome other bread made with common meal in the ordinary way. I baked my turnip-bread rather longer than the other. When they were drawn from the oven, I cauſed a loaf of each ſort to be cut; and found, on examination, the turnip bread was ſweeter than the other, to the full as light and as white, but had a little taſte (though no-wiſe diſagreeable) of the turnip. Twelve hours afterwards I taſted my turnip bread again, when I found the taſte of the turnip in it ſcarce perceivable, and the ſmell quite gone off. On examining it when it had been baked twenty-four hours, had I not known that there were turnips in its compoſition, I ſhould not have imagined it: it had, it is true, a peculiar ſweetiſh taſte, but by no means diſagreeable; on the contrary, I rather preferred it to the bread made of wheat-meal alone. After it had been baked forty-eight hours, it underwent another examination, when it appeared to me to be rather ſuperior to the other; it eat freſher and moiſter, and had not at all abated in its good qualities: in ſhort, it was ſtill very good after a week; and, as far as I could ſee, kept as well as the bread made of common wheat-meal.

"In my trials of this bread by the taſte, I was not ſatisfied with eating it by itſelf; I had ſome of it ſpread with butter; I taſted it with cheeſe; I eat of it toaſted and buttered, and finally in boiled milk and in ſoup: in all theſe forms it was very palatable and good."

In the iſlands of Banda and Amboyna, they make a kind of bread called *ſaegam*, or *ſagoe*, of the pith of a faranaceous tree, whoſe trunk is the thickneſs of a man's thigh, ten feet high, and having a round head-top like a cabbage; in the middle whereof is a white mealy ſubſtance, which, being kneaded with water, fermented, and baked upon coals, ſerves the poorer ſort for bread. Phil. Tranſ. No. 26. p. 485.

In the Caribee iſlands, they make bread of the root of a poiſonous plant called *manioc*: probably the ſame with the CASSADA bread, which is made of the root of the *yucca Mexicana*. Phil. Tranſ. No. 33, p. 635, and No. 311, p. 2434. In Benzoni's time, all the ſhips bound from Spain to Mexico, when they returned were victualled with CASSADA bread inſtead of biſcuit.

Aſſize of BREAD.—The price and weight of bread is regulated by the magiſtrates according to the price of wheat; and, in order, to direct them in their allowance to the baker, they are to take notice, that the peck loaf of each ſort of bread is to weigh, when well baked, 17lb. 6 oz. avoirdupoiſe weight, and the reſt in proportion; and that every ſack of meal or flour, is to weigh two hundred weight and two quarters neat; and that from every ſack there ought to be made, at an average, twenty ſuch peck loaves of bread.

We have divers tables of the weights of the loaves both of wheaten and houſehold bread, at every price of wheat. If bread wants one ounce in thirty-ſix, the baker formerly was to ſuffer the pillory; now, to forfeit not more than five ſhillings, nor leſs than one for every ounce wanting; and for every defect leſs than an ounce, not more than two ſhillings and ſixpence, nor leſs than ſixpence; ſuch bread being complained of and weighed before a magiſtrate within twenty-four hours after it is baked or expoſed to ſale, within the bills of mortality, or within three days in any other place. Bakers are obliged, under a penalty, to mark their wheaten-bread with a large Roman W. and their houſehold-bread with an H. It is to be obſerved, bread loſes weight by keeping: in ſome experiments recited by Bartholin, the diminution was near one-fourth in ſix months. By 13 Geo. III. cap. 62, a ſtandard wheaten-bread was ordered to be made of ſuch flour as is the whole produce of the grain, the hull only excepted, and to be marked SW, but it is little uſed.

The weight of loaves of any ſize may be eſtimated from thoſe of the penny loaf, by ſimple addition; e. g. the ſixpenny loaf weighs ſix times as much, &c. and the wheaten loaves are three-fourths of the weight of houſehold loaves. See Burn's Juſtice, vol. i. p. 220.

BREAD, in *Medicine*. Beſides alimentary, bread has alſo medical qualities; decoctions, creams, and jellies of bread, are directed in ſome diſpenſaries. Some direct acorn-bread, dipped in red wine, to be thruſt up the anus, in prolapſuſes of that part. Bread carefully toaſted, and infuſed or lightly boiled in water, imparts a deep colour, and a ſufficiently agreeable reſtringent taſte. This liquor taken as a common drink, has done good ſervice in a weak lax ſtate of the ſtomach and inteſtines; and in bilious vomitting and purging, or the cholera morbus, examples are related in the Edinburgh eſſays of ſeveral caſes of this kind cured by it, without the uſe of any other medicine.

Bread made of good wheat well leavened, and thoroughly baked, with a little ſalt, is the beſt; that which is not thoroughly baked, ill kneaded, and without ſalt, is hurtful and unwholeſome, eſpecially in ſmoaky cities; ſo are unleavened bread, and cakes baked under the aſhes. In general, the lighter the bread, the better and more agreeable it is: coarſe and barley bread is deterſive, and gently purgative, at leaſt to thoſe not uſed to it. Some recommend it, for perſons in the gout. See farther concerning bread in the writers on food and cookery; eſpecially in Hen. Nicolaus, who has a treatiſe expreſs on bread. Hen. Nicolai Tract. de Pane, Dantiſc. 1651. See alſo Fabr. Bibl. Antiq. cap. 19, Sect. 6.

BREAD, in *Chymiſtry*.—The chymiſt's art can extract from ſo mild a ſubject as bread, an acid, which is a powerful *menſtruum*. It is done in this manner: put two pounds of coarſe bread, cut into ſmall pieces, into a glaſs retort: place this in a ſand-heat and luting on a receiver, diſtil with a gentle fire, and there will be produced a liquor appearing like water, with a ſmall quantity of oil: ſeparate the oil, and filtre and rectify the liquor by a ſecond diſtillation in *balneo Mariæ*, and afterwards diſtil it again in a ſand-heat, and there will be produced a moderately ſtrong, clear, acid liquor. This is a *menſtruum* capable of extracting the red colour from coral, and even from garnets. Common bread affords it, but coarſe rye bread yields the greateſt quantity. Shaw's Lect. p. 104. Oil of vitriol, poured upon crumbs of bread, will excite a ſurpriſing degree of heat. Boyle's Works abridged, vol. i. p. 569.

Bonpournichole, or *bonpournickel* BREAD, the name of a very coarſe bread eaten in Weſtphalia, and many other places. This bread of the Weſtphalians ſtill retains the opprobious name once given it by a French traveller, *bonpournichole, good for his horſe Nichole*, but it is by no means a contemptible kind. It is far from being peculiar to this age or country: it has been known in diſ-

No. 40.

Though we are not to conſider the glutinous matter as the nutritious part of vegetables, yet it is a very neceſſary ingredient. It is that which preſerves the coheſion of the paſte in fermenting bread; it is that which forms the viſcid pellicle, and ſtops the air in fermentation; gives the ſavoury taſte to bread; occaſions it to be light, to ferment, and which forms the ſmall cells ſeen in it. It is found eſpecially near the cortical part of grain; and this accounts for its being found in the greateſt quantity in coarſe brown meal. It is this gluten which renders wheat a ſuperior aliment to the other grains and roots.

This being an additional Sheet (6 D 2) to the new Edition of this Work, the Binder is deſired to be careful in placing it after (6 D 1); ſhould it be miſplaced, or thrown out in the Binding under the Idea of its being a ſuperfluous Sheet, this Work will be rendered imperfect.

tant places, and in different ages, and was called by the ancient *panis furfuraceus*, or *panis impurus*, from its not being ſo thoroughly cleanſed from the huſk or bran, as the fine ſorts of bread are.

The wreſtlers of old eat only this ſort of bread, to preſerve them in their ſtrength of limbs; and we may learn from Pliny, that the Romans for three hundred years knew no other bread: unqueſtionably, this coarſe bread nouriſhes more, aſſuages hunger better, and generates humours leſs ſubject to corruption, than the white.

The inhabitants of Weſtphalia, who are a hardy and robuſt people, and capable of enduring the greateſt fatigues, are a living teſtimony of the ſalutary effects of this ſort of bread; and it is remarkable, that they are very ſeldom attacked by acute fevers, and thoſe other diſeaſes which ariſe from an ebullition of the humours, and a malignant colliquation of the blood, and of the humours of which it is compoſed. It is certain that a leſs ſtrong diet is more proper to weakly conſtitutions, and people of ſedentary lives, than this; but for thoſe who will uſe the neceſſary exerciſe with it, it is eaſy to ſee that it is preferable to all other kinds of bread, ſince it remarkably reſtores ſtrength, and has another ſalutary effect, which is, that it renders the belly ſoluble; this was a quality remarkable in coarſe bread, and highly commended in it, ſo early as in the days of Hippocrates.

The Germans make two ſorts of waters by diſtillation from this bread; the one with, the other without, the addition of a ſpirituous liquor: to both which great virtues are aſcribed. That without any thing ſpirituous, is made of the juice of cray-fiſh, May-dew, roſe-water, nutmegs, and ſaffron, diſtilled from a large quantity of this bread. This is eſteemed a great reſtorative, and given in hectic habits. The other is diſtilled from this bread, and Rheniſh wine, with nutmegs and cinnamon. This is given in all the diſorders of the ſtomach, vomiting, and loſs of appetite, and other complaints of the ſame kind: and beſides theſe, there is a ſpirit diſtilled from it by the retort, in the dry way, which, when ſeparated from its fœtid oil, is eſteemed a powerful ſudorific, aud very valuable medicine, in removing impurities of the blood,

BREAD-*fruit*, at Otaheite, in the South Sea, grows on a tree about the ſize of a middling oak: it is about the ſize and ſhape of a child's head; the ſurface is reticulated, and covered with a thin ſkin; the eatable part lies between the ſkin and the core; it is white as ſnow, and of the conſiſtence of new bread. It has an inſipid, ſweetiſh taſte, reſembling that of the crum of wheaten bread, mixed with a Jeruſalem artichoke. It is roaſted and baked before it is eaten. Three different diſhes are prepared from this fruit, by beating it into a paſte with water, or the milk of the cocoa-nut, and mixing it with ripe plantains, bananas, or the ſour paſte which they call *mahie*. For a particular account of the tree, its fruit, &c. ſee the Article ARTOCARPUS.

BREAST, in anatomy, a prominent fleſhy part of the human body, on the outſide of the thorax, ſerving to ſeparate the milk. Anatomiſts ſometimes divide breaſts into perfect, which are compoſed of a multitude of glands, interwoven with veins, arteries, and nerves; ſuch as are thoſe of women; and imperfect breaſts, compoſed chiefly of fat, with a few glands, ſuch as thoſe of men.

The internal ſubſtance of the breaſt is compoſed of a great number of glands, of various ſizes and an oval figure, intermixed with globules and veſſels of fat. Theſe excretory ducts, as they approach the nipple, join and unite together till at laſt they form ſeven, eight, or more ſmall pipes, called *tubuli lactiferi*, which have ſeveral croſs canals, by which they communicate with one another, to obviate the inconveniences that might accrue from the caſual obſtruction of one or more of them. Theſe tubes are not every where of equal capacity, but in ſome places more, in others leſs, dilated: ſo as to form cells, which ſeem contrived to hinder the ſpontaneous efflux, and to create a neceſſity of ſucking, to fetch out the contents. Of the concurrence of theſe *tubuli*, or pipes, is the ſubſtance of the *papillæ*, in great meaſure, formed; among which is interſperſed a glandulous ſubſtance, ſerving to keep them from preſſing too cloſe on each other: and with it are intermixed abundance of fibres derived from the external teguments of the *papillæ*; by means whereof, the lacteal tubes are conſtringed, and the motion of the milk is modified.

Beſides theſe veſſels, are abundance of fatty globules, called *ductus adipoſi*, which ſome would have only to fill up the interſtices of the glands; but Dr. Drake, after Malpighi, thinks they contribute to the compoſition of the milk, which ſeems nothing elſe but water and oil artfully united.

The office of the breaſts is to ſecrete the milk from the arteries, in their glandulous ſubſtance, to collect it in their lacteal tubes, and, at proper ſeaſons, to yield it to the infant through the nipple. Some, however, aſſert, that the milk is not formed from the blood, but from the chyle, which is immediately conveyed thither by the thoracic, or pecquet ducts. And what confirms the ſuggeſtion, is the quick ſupply of the milk in nurſes, after a draught of cow's milk. The difficulty is to prove, that the thoracic duct reaches to the breaſts, which ſome abſolutely deny. Phil. Tranſ. No. 65, and No. 40. p. 1357, and 805.

Swelling breaſts, eſpecially if there be milk found in them, is generally judged a mark of the loſs of VIRGINITY, and a proof that a woman has been with child; though, it is ſaid, it does not hold univerſally.

The ſwelling of the breaſts during the time of geſtation, is owing to the conſent between the breaſts and the UTERUS: there being ſo near a communication between the mammary veſſels, and the hypogaſtric veſſels of the womb, that dilation in the latter is attended with a ſimilar one in the former. See PREGNANCY, &c.

In virgins, the tubes which compoſe the glands of the breaſt, like ſpincter muſcles, contract ſo cloſely, that no part of the blood can enter them: but when the womb grows big with a FŒTUS, and compreſſes the deſcending trunk of the great artery, the blood flows in greater quantity, and with a greater force, through the arteries of the breaſts, and forces a paſſage into their glands, which being at firſt narrow, admits only of a thin water, but growing wider by degrees, as the womb grows bigger, the glands receive a thicker *ſerum*, and after birth they run with a thick milk; becauſe that blood which before flowed to the *fœtus*, and for three or four days afterwards by the *uterus*, beginning then to ſtop, does more dilate the mammillary glands.

The breaſts, eſpecially after delivery, are liable to divers diſeaſes; as inflammations, excoriations, indurations, tumefactions, nodes, abſceſſes, ſcirrhuſes, and cancers; to which may be added, certain peculiar diſorders, as the *ſparganoſis*, *ſtrangalides*, and *gynæcomaſton*. See CANCER.

In men, the breaſts are very ſmall, and chiefly for ornament; though phyſical hiſtories give inſtances of thoſe who have had milk in them.

The ancients repreſented Diana of Epheſus with many breaſts, as appears from ſeveral medals of that city; whence ſhe had the epithet *Mammoſa*; q. d. having many breaſts; an appellation which is alſo given to Iſis and to Ceres.

BREAST alſo denotes that cavity or region of the body by anatomiſts more frequently called THORAX. See the Syſtem of ANATOMY, Part IV. Sect. I. throughout. Though in propriety, the breaſt is rather reſtrained to the anterior part of the thorax where the ribs meet; called alſo *ſternum* and *pectus*; in Engliſh, popularly, the boſom. We ſay, a flat, a narrow, a ſtrait breaſt; a broad breaſt, not high, is ranked among the ſigns of longevity. Defluxions on the breaſt and lungs are dangerous.

Smiting on the breaſt is one of the expreſſions of penitence. In the Romiſh church, the prieſt beats his breaſt in rehearſing the general confeſſion at the beginning of maſs. Coughs, catarrhs, aſthmas, phthiſes, peripneumonies, &c. are diſeaſes of the breaſt. See ASTHMA. Phyſicians alſo ſpeak of a dropſy of the breaſt, *hydrops pectoris*. See DROPSY. Medicines for diſorders of the breaſt are called *pectorals*.

BREATH, the WIND or AIR which is received and expelled by the mouth and noſtrils, in the act of RESPIRATION. See that Article. A ſtinking breath is one of the ſymptoms uſually preceding the acceſs of an intermitting fever. In ſome perſons, a ſtinking breath is an indication of the menſes being at hand. It generally ariſes from an indigeſtion of the ſtomach. It is diſputed whether a ſtinking breath called *ſcabro*, owing to rotten teeth or gums, ſhould be reputed a diſeaſe. Calvin. Lex. Jur.

BREATH is more particularly uſed to denote a ſtrength of lungs, whereby a man is enabled to hold out without taking wind, ſo often. In this ſenſe, we ſay a long, a ſhort breath. The ordinary term of holding the breath does not exceed one third of a minute. Bacon's Hiſt. of Life and Death. Ap. Works, tom. ii. p. 176.

For the pearl fiſhery they chooſe ſlaves who have the beſt breath, or can continue the longeſt under water without fetching their breath. Pechlin has a diſſertation expreſs on living long without breathing.

BREECHES, a garment wore by males reaching from the girdle to the knees, and ſerving to cover the hips, thighs, &c. The ancient Romans had nothing in their dreſs anſwering to our breeches and ſtockings; inſtead of which, under their lower tunics and waiſtcoats, they ſometimes bound their thighs and legs round with ſilken ſcarves, or *faſciæ*, called *tibialia* and *femoralia*. Salmuth. ad Panoiroll. p. i. p. 161. Kennet. Rom. Ant. Not. p. ii. lib. v. cap. 8.

Breeches appear to be a habit peculiar to the barbarous nations, eſpecially thoſe inhabiting the colder countries of the north; whence Tacitus calls them *barbarum tegmen*. We find mention made of them among the ancient Getæ, Sarmatæ, Gauls, Germans and Britons; they alſo obtained among the Medes and Perſians, as being a people of Scythian origin: they alſo afterwards got footing in Italy, ſome pretend as early as the time of Auguſtus; but without much foundation, that emperor's breeches, mentioned by Suetonius, being apparently only ſwaths tied over his thighs. Tacit. Hiſt. lib. ii. cap. 20. Pers. ſat. iii. v. 51. Ovid. Triſt. lib. v. Eleg. 11. Suet in Auguſt. cap. 82.

However this be, breeches were at length received into Italy, and grew ſo highly into faſhion, that it was thought neceſſary under Honorious and Arcadius, to reſtrain them by law, and expel the *braccarii*, or breeches makers, out of the city; it appearing a thing unworthy, that a nation, which commanded the world, ſhould wear the habit of barbarians. We find frequent mention of

of *bracæ*, *braccæ*, or *bracchæ*, in claſſic writers, but the form of this habit is not agreed on: ſome will have it to have been a rough party coloured coat.

BREEDING, in a moral ſenſe, denotes a perſon's deportment or behaviour in the external offices and decorums of ſocial life. In this ſenſe, we ſay well-bred, ill-bred, a man of breeding, &c.

Good-breeding amounts to much the ſame with what is otherwiſe called politeneſs, among the ancient Romans urbanity. Good-breeding is near to virtue, and will of itſelf lead a man a great part of the way towards the ſame; it teaches him to rejoice in acts of civility, to ſeek out objects of compaſſion, and be pleaſed with every occaſion of doing good offices.

Lord Shafteſbury compares the well-bred man with the real philoſopher: both characters aim at what is excellent, aſpire to a juſt taſte, and carry in view the model of what is beautiful and becoming. The conduct and manners of the one are formed according to the moſt perfect eaſe, and good entertainment of company; of the other according to the ſtricteſt intereſt of mankind; the one according to his rank and quality in his private ſtation, the other according to his rank and dignity in nature. Horace ſeems to have united both characters.

Quid verum atque decens curo et rogo, et omnis in hoc ſum.

Shafteſ. Charact. vol. i. p. 64. vol. ii. p. 242. vol. iii. p. 161. Hor. lib. i. ed. i. ver. 11.

BREEDING *of Fiſh*. The neceſſary qualities of a pond, to make it ſerve well for breeding fiſh, are very different from thoſe which are to make it ſerve for the feeding of them, inſomuch that ſome particular ponds ſerve only for one of theſe purpoſes, and others for the other; and ſcarce ever the ſame pond is found to anſwer for them both. In general, it is much more rare to find a good breeding pond than a good feeding one. The beſt indications for a good breeding pond are theſe; that there be a good quantity of ruſhes and graſs about its ſides, with gravelly ſhoals, ſuch as horſe-ponds uſually have: when a pond has this property, and takes to the breeding of fiſh, it is amazing what a progreſs will be made in a little time. The ſpawn of fiſh is prodigious in quantity; and where it ſucceeds, one is able to produce many millions: thus, in one of theſe breeding ponds, two or three melters, and as many ſpawners, will, in a very little time, ſtock the whole country.

When theſe ponds are not meant entirely for breeding, but the owner would have the fiſh to grow to ſome ſize in them, the method is to thin the numbers, becauſe they would otherwiſe ſtarve one another, and to put in other fiſh they will prey upon the young, and thin them in the quickeſt manner. Eels and perch are the moſt uſeful on this account; becauſe they prey not only upon the ſpawn itſelf, but upon the young fry from the firſt hatching to the time they are of a conſiderable ſize. Some fiſh are obſerved to breed indifferently in all kinds of waters, and that in conſiderable plenty; of this nature are the roach, pike, and perch. See the Article FISH PONDS.

BREEZE, a ſhifting wind, blowing from the ſea and lands alternately, during certain hours of the day or night; only ſenſible near the coaſts.

The ſea breeze, Dampier obſerves, commonly riſes with the morning about nine, proceeding ſlowly in a fine ſmall black curl on the water towards the ſhore: it increaſes gradually till twelve, and dies about five.—Upon its ceaſing, the land-breeze commences, which increaſes till twelve; and is ſucceeded in the morning by the ſea breeze again.

The ſea-breezes rule by day, and the land-breezes by night: ſo that, dividing their empire, they remain as conſtant as the ſeaſons of the year, or courſe of the ſun, on which they ſeem alone to depend; not but that they appear ſooner or later, ſtronger or weaker, in ſome places than others, and vary the alternative according to the ſeveral latitudes, ſituations, ſoils, mountains, valleys, woods, and other circumſtances of the countries where they are found.

In ſome countries, the ſea-breezes appear only to be efforts of the general or trade-wind, as at Barbadoes, and in many places between the tropics, where the general wind, if not impeded by mountains or iſlands, blows freſh in the day-time, but, after ſun ſet, the terreſtrial exhalations becoming precipitated, beget a new wind, which is not only able to make head againſt the trade-wind, but to repel it from their coaſts.

The ſea-breezes do not all come from the ſame point of the compaſs, but from different points as the land lies.

In Brazil, and many of the Caribbee iſlands, they have no land-breeze, eſpecially if the ſhores lie low, as at Barbadoes, where the general or eaſtern wind blows from one end of the iſle to the other, and ſerves inſtead of the land-breeze. In other places they want the ſea-breeze, eſpecially between the tropics, in coaſts which lie weſterly, as in the weſtern kingdoms of Africa.

If either the eaſterly or weſterly winds blow freſh, they hinder both the land and ſea-breezes in the Mediterranean; of which thoſe are always found the weakeſt which riſe lateſt. In England, in very hot days, and when no other winds are ſtirring, the like alteration of land and ſea-breezes may be obſerved on our coaſts, though with little certitude, any where to the northward of Portugal.

Breezes are more conſtant in ſummer than in winter, and more between the tropics than in the temperate zone.

The general cauſe of thoſe alternate breezes which ſet on and off the coaſts in hot countries, is the greater rarefaction of the air by reflected heat, and by fermenting exhalations over the land than over the water: the denſer air from the water becomes a ſea-breeze in the day; but this air condenſed again by the cold of the night, may then occaſion a land-breeze.

Breezes differ from *etaſiæ*, or TRADE-WINDS, as the former are diurnal, or have their periods each day; and, beſides they are only perceived near the ſhore or coaſt; whereas the latter are anniverſary, and blow at a diſtance from land. Phil. Tranſ. No. 183. p. 158.

BREVITY, in a general ſenſe, that which denominates a thing brief or ſhort. Brevity is more particularly uſed in ſpeaking of the ſtyle or compoſition of diſcourſe. Brevity of diſcourſe is by ſome called *brachylogia*, and *breviloquentia*; ſometimes *laconiſmus*. Tacitus and Perſius are remarkable for the brevity of their ſtyle. There are two kinds of brevity, one ariſing from dryneſs, poverty, and narrowneſs of genius; the other from judgment and reflection: which latter alone is laudable. Brevity is ſo eſſential to a tale, a ſong, and an epigram, that without it, they neceſſarily languiſh and become dull.

Rhetoricians make brevity one of the principal marks or conditions of eloquence; but the rules they preſcribe for attaining it, are difficult to apply, ſo as ſtill to keep the due medium between too much and too little. A juſt brevity is attained by uſing all the words which are neceſſary, and none but thoſe which are neceſſary. Sometimes it may alſo be had, by chooſing a word which has the force of ſeveral. It is this laſt kind which Quintilian admires ſo much in Salluſt; and the imitation of which, by other writers, has cauſed ſo much obſcurity.

BREWER, a perſon who profeſſes the art of brewing; in the Eaſt parts of this kingdom, common brewers are very general, but in the Weſt and North-weſt it is cuſtomary for all deſcriptions of houſeholders to brew their own beer; the Company of Brewers of the city of London, were incorporated in the year 1427, in the reign of Henry IV.

TREATISE ON THE ART OF BREWING.

Brewing is the operation of preparing ale or beer from water, malt, and hops.

INTRODUCTION.

In the following we intend giving theoretic obſervations on the different proceſſes employed in the Art of Brewing, arranged under their reſpective heads; particularly intended to familiarize the practice in private families, avoiding as much as poſſible all philoſophic abſtruſe ideas.

Common brewers, and thoſe who purſue the buſineſs profeſſionally, may uſe inſtruments and learned phraſes in order to make their trade appear myſterious; but ſuch is not the object of the editor of this treatiſe, he is only ambitious to give ſuch inſtructions as will enable an attentive maſter, miſtreſs, or ſervant, to prepare a wholeſome pleaſant liquor, either to enliven the hours of convivality, or a beverage eſſentially neceſſary for the uſe of the table. From general opinion, home-brewed beer is much more wholeſome than that ſold by brewers and publicans; this gives ſuſpicion that unfair practices or noxious materials are uſed in common brew-houſes; whether ſuch practice is cuſtomary or not we will not pretend to determine; being convinced no perſon of reputation could, conſiſtent with a fair character, ſell poiſon to his fellow creatures: therefore, as we are unacquainted with any baſe adulteration, we certainly have no right to beſtow cenſure. After the theory, we mean to give conciſe practical rules for the proceſs of brewing, and ſubſequent management of different denominations of malt liquor; to conclude with ſome miſcellaneous obſervations on the ſubject.

1ſt. CONSIDERATIONS ON THE PROPERTIES OF WATER, MALT, AND HOPS.
2d. BOILING, WORTS, and FERMENTATION.
3d. BREWING STRONG BEER.
4th. MILD ALE.
5th. TABLE BEER.
6th. OAT ALE, and other fermented liquors, for the uſe of the table.
7th. CONCLUSIVE REMARKS.

Though the art of brewing is undoubtedly a part of chymiſtry, and certainly depends upon fixed and invariable principles as well as every other branch of that ſcience, theſe principles have never yet been thoroughly inveſtigated. For want of a ſettled theory, therefore, the practice of this art is found to be precarious; and to ſucceed ſometimes, and at others to fail under the ſame management. Some ingenious theoretic hints, however, have been thrown out, in order to eſtabliſh a regular theory of brewing; the principal of which we ſhall lay before our readers.

I. CONSIDERATIONS ON THE PROPERTIES OF WATER, MALT, AND HOPS.

Water. The firſt conſideration is the quality of the water to be employed in brewing; and here ſoft water is univerſally allowed

to

to be preferable to hard, both for the purpoſes of maſhing and fermentation. Tranſparency is, however, more eaſily obtained by the uſe of hard than ſoft water; firſt, from its inaptitude to extract ſuch an abundance of that light mucilaginous matter, which, floating in beer for a long time, prevents its fining; ſecondly, from its great tendency to a ſtate of quietude after the vinous fermentation is finiſhed, by which thoſe floating particles are more at liberty to ſubſide; and, laſtly, from the mutual uniting of the earthy particles of the water with thoſe of the materials, which by their greater ſpecific gravity thus united, not only precipitate themſelves, but carry down alſo that lighter mucilage juſt mentioned. For theſe reaſons, hard water is not well adapted to the brewing of porter, and ſuch beers as require a fulneſs of palate, when drawn to the great lengths of the London brewery, and of ſome country ſituations.

The purity of water is determined by its lightneſs; and in this, diſtilled water only can claim any material degree of perfection. Rain water is the pureſt of all naturally produced; but by the perpetual exhalations of vegetables, and other fine ſubſtances floating in the atmoſphere, it does not come down to us entirely free from thoſe qualities which pond and river waters poſſeſs in a greater degree. Theſe, eſpecially of rivers running through fens and moraſſes, from the quantity of graſs and weeds growing therein, imbibe an abundance of vegetable ſolutions, which occaſions them to contain more fermentable matter, and conſequently to yield a greater portion of ſpirit; but at the ſame time induces ſuch a tendency to acidity as will not eaſily be conquered. This is more to be apprehended towards the latter end of the ſummer than at any other time; becauſe theſe vegetable ſubſtances are then in a ſtate of decay, and thence more readily impart their pernicious qualities to the water which paſſes over them.

At ſuch an unfavourable time, ſhould the brewer be neceſſitated to purſue his practice, it will behove him to pay the utmoſt attention to the cauſe of this diſpoſition in his liquor, and thence endeavour to prevent the ill conſequences, by conducting his proceſs to the extraction and combination of ſuch parts of the materials as his judgment informs him will beſt counteract its effects.

Where there is the liberty of choice, we would recommend the uſe of that water, which from natural purity, equally free of the auſterity of imbibed earths, and the rankneſs of vegetable ſaturation, has a ſoft fulneſs upon the palate, is totally flavourleſs, inodorous, and colourleſs; whence it is the better prepared for the reception and retention of ſuch qualities as the proceſs of brewing is to communicate and preſerve.

The next thing to be conſidered is the proper degree of heat to be employed in making the infuſion; and here it is evident, that though this muſt be an object of the utmoſt importance to the ſucceſs of the operation, it is extremely difficult, perhaps impoſſible, to fix upon a preciſe ſtandard that ſhall at all times fully anſwer the purpoſe. On this ſubject Mr. Richardſon preſents us with the following obſervations:

Maſhing.—"The quality of the ſaccharine part of malt reſembles that of common ſugar, to which it is practicable to reduce it; its properties are entirely owing to its intimate connection with the other parts of the malt, from which ſuch diſtinguiſhing flavours of beers are derived as are not the immediate reſult of the hop. Were it not for theſe properties, the brewer might adopt the uſe of ſugar, molaſſes, honey, or the ſweet of any vegetable, to equal advantage; which cannot now be done, unleſs an eligible ſuccedaneum be found to anſwer that purpoſe. As we are at preſent circumſtanced, a ſearch on the other ſide would turn more to the brewer's account. We have in malt a ſuperabundance of the groſſer principles; and would government permit the introduction of a foreign addition to the ſaccharine, which is too deficient, many valuable improvements might be made from it; as we could, by a judicious application of ſuch adventitious principles, produce a ſecond and third wort, of quality very little inferior to the firſt.

"But in theſe experiments a very particular attention would be neceſſary to the ſolvent powers of the water at different degrees of heat, and to the inquiry how far a menſtruum ſaturated with one principle may be capable of diſſolving another. Such a conſideration is the more neceſſary on this occaſion to direct us clear of two extremes equally diſagreeable: the firſt is, that of applying the menſtruum pure, and at ſuch a heat as to bring off an over proportion of the oleaginous and earthy principles, which would occaſion in the beer, thus wanting its natural ſhare of ſaccharum, a harſhneſs and auſterity which ſcarce any time the brewer could allow would be able to diſſipate; the other is, that of previouſly loading the menſtruum with the adopted ſweet in ſuch abundance as to deſtroy its ſolvent force upon the characteriſtical qualities we wiſh to unite with it, and thereby leave it a mere ſolution of ſugar. The requiſite mean is that of conſidering what portion of the ſaccharine quality has been extracted in the firſt wort, according to the quantity of water and degree of heat applied; and then to make ſuch a previous addition of artificial ſweet as will juſt ſerve to counterbalance the deficiency, and aſſimilate with that portion of the remaining principles, we are taught to expect will be extracted with ſucceeding wort.

From the nature of the conſtituent principles of malt, it is eaſy to conceive, that the former, or ſaccharine or mucilaginous parts, yield moſt readily to the impreſſion of water, and that at ſo low a degree of heat as would have no viſible effect upon the latter. If, therefore, we are to have a certain proportion of every part, it is a rational inference, that the means of obtaining it reſts in a judicious variation of the extracting heat according to the ſeveral proportions required.

"A low degree of heat, acting principally upon the ſaccharum, produces a wort replete with a rich ſoft ſweet, fully impregnated with its attendant mucilage, and in quantity much exceeding that obtainable from increaſed heat; which, by its more powerful inſinuation into the body of the malt acting upon all the parts together, extracts a conſiderable portion of the oleaginous and earthy principles, but falls ſhort in ſoftneſs, fulneſs, ſweetneſs, and quantity. This is occaſioned by the coagulating property of the mucilage, which, partaking of the nature of flour, has a tendency to run into paſte in proportion to the increaſe of heat applied; by which means it not only locks up a conſiderable part of the ſaccharum contained therein, but retains with it a proportionate quantity of the extracting liquor, which would otherwiſe have drawn out the impriſoned ſweet, thence leſſening both the quantity and quality of the worts. And this has ſometimes been known to have had ſo powerful an effect, as to have occaſioned the ſetting of the goods, or the uniting the whole into a paſty maſs; for though heat increaſes the ſolvent powers of water in the moſt inſtances, there are ſome in which it totally deſtroys them. Such is the preſence of flour, which it converts into paſte; beſides thoſe of blood, eggs, and ſome other animal ſubſtances, which invariably tends to harden.

"From a knowledge of theſe effects, we form our ideas of the variations neceſſary in the heat of the extracting liquor; which are of more extenſive utility than has been yet intimated, though exceedingly limited in their extent from one extreme to he other.

"The moſt common effects of too low a heat, beſides ſometimes producing immediate acidity, are an inſipidity of the flavour of the beer, and a want of early tranſparency, from the ſuperabundancy of mucilaginous matter extracted by ſuch heats, which, after the utmoſt efforts of fermentation, will leave the beer turbid with ſuch a cloud of its lighter feculencies as will require the ſeparation and precipitation of many months to diſperſe.

"The contrary application, of too much heat, at the ſame time that it leſſens the mucilage, has, as we have ſeen before, the effect of diminiſhing the ſaccharum alſo; whence that lean thin quality obſervable in ſome beers; and by extracting an over proportion of oleaginous and earthy particles, renders the buſineſs of fermentation difficult and precarious, and impreſſes an auſterity on the flavour of the liquor which will not eaſily be effaced.

"Yet the true medium heat for each extract cannot be univerſally aſcertained. An attention not only to the quality of the malt, but to the quantity wetted, is abſolutely neceſſary to the obtaining every due advantage; nor muſt the period at which the beer is intended for uſe to be omitted in the account. The quality of the water alſo claims a ſhare in the conſideration, in order to ſupply that deficient thinneſs and want of ſolvent force in hard, and to allow for the natural fulneſs and fermentative quality of ſoft; a particular to which London in a great meaſure owes the peculiar mucilaginous and nutritious quality of its malt liquors.

"Although the variations above alluded to are indiſpenſable, it is eaſy to conceive, from the ſmall extent of the utmoſt variety, that they cannot be far diſtant. If, therefore, we know that a certain degree extracts the firſt principles in a certain proportion, we need not much conſideration to fix upon another degree that ſhall produce the required proportion of the remaining qualities, and effect that equal diſtribution of parts in the extract which it is the buſineſs of fermentation to form into a conſiſtent whole."

Having given the ideas of the ſcientific Mr. Richardſon on Water, and the proper degrees of heat neceſſary to extract the eſſential qualities of the malt, denominated maſhing, we ſhall only notice the properties of malt, referring the proceſs of making it, to the place where it will appear with more conſiſtence and propriety. See the Article MALT.

Malt is dried brown and pale, or a mean between thoſe extremes; in London called amber. To procure either of theſe the brewer muſt depend on his own judgment, or on the fidelity of his maltſter; either kind, if made properly with good barley, will brew fine beer.

The goodneſs of malt may be known by the following marks: Bite a grain of it aſunder, and if it taſtes mellow and ſweet, breaks ſoft, and is full of flour from one end to the other, it is good. If it has a round body, and upon putting ſome grains of it into water, they ſwim on the ſurface, it is good. Barley ſinks in water, and malt that is not well made will do the ſame: but it is to be obſerved that this is not an invariable proof, becauſe, if the malt be broken, or in the leaſt cracked, it will take in water, and ſink. Malt that is rightly made will not be hard, but of ſo mellow a nature, that if drawn over an oak board, acroſs the grain, it will leave a white line upon the board, like a mark of chalk. Its ſmell alſo may be conſulted; for malt, though otherwiſe good, may

may have contracted an ill ſcent from the fuel it is dried with, or from the water uſed in the ſteeping.

Before malt is ground, it ſhould be ſcreened or ſifted from the tails and duſt, which would otherwiſe heighten the colour of the wort, render the liquor muddy, and give it a bad taſte, which could not afterwards be got rid of.

The malt muſt be broken, in order to its communicating its virtue to the water. If it be ground too ſmall, its flour will mix too freely with the water, and cauſe the wort to run thick. Many are of opinion that the beſt way is only to crack it, ſo that none of the grains may come out whole: for the intent is, that the water ſhould draw out an extract, but not be mixed with the mealy part, in the manner of a paſte, or gruel. Some think that malt is better ground by a ſtone mill, than by a ſteel one, becauſe the former bruiſes it, and the latter only cuts the grains.

After the malt is ground, it ſhould lie ſome time to mellow, in a cool room, where no ſun comes. The time for this is different, according to its kind. Brown malt may be ground at from three to fourteen days before it is uſed, in order that the corn, which is rendered uncommonly hard, by that degree of dryneſs, may be gradually ſoftened by the moiſture in the air; by which means it will become the more ſoluble in water. The pale malts require only one or two days. After lying thus in the air, leſs maſhing ſuffices: the ſtrength of the malt is more perfectly extracted, and the beer will be conſiderably ſtronger than it would be with the ſame quantity of malt taken directly from the kiln. Care muſt be taken that it gets no damage in lying.

Hops. On the properties of hops we take the liberty to extract the following from Mr. Richardſon's Theoretic Hints:—

In hops, the quantity of oil is abundant; the finer part, of an agreeable fragrance and great volatility; the coarſer, from its intimate union with an auſtere ſaline earth, of the alkaline kind, is groſſer in its odour, harſher in its flavour, and leſs ſubject to avolation.

The time of picking, the mode of curing, the care in bagging, the place of keeping, all have their ſhare in the preſervation or deſtruction of the finer qualities of this vegetable. If the hop be plucked too early, the conſequence of immaturity is obvious; if it hangs too late, the conſtant avolation of its fine unctuous parts waſtes its fragrance, deſtroys its colour, and renders it of leſs value and efficacy. An application of too much heat in the curing has ſimilar effects; for by evaporating the aqueous parts of the vegetable too haſtily, the finer parts of the eſſential oil riſe with them and are loſt, while the remainder receives an injury ſomewhat ſimilar to that of malt by the like injudicious treatment. The care in bagging and keeping is equally important, on the ſame principle of excluding, as much as poſſible, the action of the external air upon the hop, which carries off its more valuable qualities in the ſame manner as by too long continuance on the plant. The cloſer they are preſſed down in the bag, the more effectual is their ſecurity againſt this injury; and the beſt practical method of keeping them, is in a cloſe but dry room, the bags laid upon each other, and the interſtices well filled with a dry inodorous matter, ſuch as the firſt ſcreenings of malt, &c.

Time, however, will impair their virtues, in ſpite of the utmoſt precaution, and that ſo rapidly, as to render them incompetent to the nicer purpoſes of the pale-ale brewer, after the expiration of the firſt year, in all the ordinary modes of preſerving them.

In theſe virtues of the hop are we to look for the primary principles of flavour and preſervation of malt liquors, which are to be extracted in ſuch manner and proportion, as the judgment of the brewer ſhall ſeem moſt likely to anſwer thoſe intentions. To accompliſh this, with certainty and advantage, particular attention muſt be had to the ſeveral ends of extracting, and the different effects of thoſe extracts upon the reſt of the proceſs, viz. whether the purpoſe of flavour will not defeat that of preſervation, and whether the too anxious purſuit of preſervation will not weaken the powers and leſſen the effect of fermentation, to the very great loſs of the ſubject; for it is very certain, that every unctuous principle is an enemy to fermentation, and has a direct tendency to impair its action and deſtroy its efficacy.

Hence are we taught by reaſon, what is confirmed by experience, that the ſoluble parts of the hop, extracted ſeverally, anſwer ſeveral different purpoſes in beers, but taken collectively, tend to confound their virtues and pervert their uſes; and that in their extraction, if the means be not nicely proportioned to the end, the order of the proceſs is deſtroyed, and the intention of the brewer defeated.

The flavour and the virtue of the hop is given in the common way, by a great deal of boiling. We have obſerved already, that a very little, with proper management, will anſwer the purpoſe, and the drink will be proportionably better. Therefore, in order to this, the hops ſhould be rubbed to pieces thoroughly between the hands, and then put in a bag into the receiver, for the wort to run gradually upon them. After this gentle wetting and ſoaking, they will give their virtue with a few minutes boiling; and the drink will be not only flavoured with this ingredient, but will be the better alſo in itſelf by ſparing the reſt of the boiling.

Sixty or ſeventy miles round London, Kent hops are preferred, but more particularly thoſe called Farnham hops, from their growing in the vicinity of that place; their reputation is ſo great, that they generally bear an extra price of 6d. per pound. In Worceſterſhire, Herefordſhire, and the adjacent counties, hops of the plantation called the Worceſter, are uſed; and if we may judge of the goodneſs of the hop from the quality of the beer, there certainly is not more excellent malt liquor brewed in this kingdom, than in the circuit where the hop of the latter plantation is uſed; particularly in private families. For the cultivation, ſee AGRICULTURE, Sect. XVI.

II. BOILING WORTS AND FERMENTATION.

Boiling Worts. The principal uſe of boiling, as it reſpects the worts particularly, is to ſeparate the groſſer or more palpable parts of the extract, preparatory to that more minute ſeparation which is to be effected in the gyle tun. The eye is a very competent judge of this effect; for the concretions, into which the continued action of boiling forms thoſe parts, are obvious to the ſlighteſt inſpection; whilſt the perfect tranſparency of the interſtices of the worts points out its utility in promoting that deſirable quality in the beer. Theſe coagulable parts are formed from the ſuperabundant mucilage already mentioned; and hence they are found in greater proportion in the firſt worts than in thoſe that come after; at the ſame time, they are in theſe laſt ſo mingled with a quantity of oleaginous matter, that they become with much more difficulty coagulable in the weak worts than in ſuch as are ſtronger, and hence theſe require to be much longer boiled than the others.

During this operation the hops are generally added, which are found to be abſolutely neceſſary for preventing the too great tendency of beer to acidity. The fine eſſential oil of hops being moſt volatile and ſooneſt extracted, we are thence taught the advantage of boiling the firſt wort no longer than is ſufficient to form the extract, without expoſing it to the action of the fire ſo long as to diſſipate the finer parts of this moſt valuable principle, and defeat the purpoſe of obtaining it. To the ſubſequent worts we can afford a larger allowance, and purſue the means of preſervation ſo long as we can keep in view thoſe of flavour; to which no rules can poſitively direct, the proceſs varying with every variety of beer, and differing as eſſential in the production of porter and pale ale as the modes of producing wine and vinegar.

The conſequence of not allowing a ſufficient time for the due ſeparation of the parts of the wort and extraction of the requiſite qualities of the hop muſt be obvious. If we proceed to the other extreme, we have every thing to apprehend from the introduction of too large a quantity of the groſſer principles of the hop, which are very inimical to fermentation; and from impairing the fermentative quality of the worts themſelves, by ſuffering their too long expoſure to the action of the fire paſſing through them, whereby they are reduced to a more denſe conſiſtence, and their parts too intimately blended to yield to the ſeparating force of fermentation with that eaſe the perfection of the product requires.

Fermentation. The laſt ſtep in the proceſs of brewing is to ferment the liquor properly; for if this is not done, whatever care and pains have been taken in the other parts, they will be found altogether inſufficient to produce the liquor deſired. The firſt thing to be done here is to procure a proper ferment; for though all fermentable liquors would in time begin to ferment of themſelves, yet, being alſo ſuſceptible of putrefaction, the vinous and putrefactive ferments would both take place at the ſame time, in ſuch a manner that the product would be entirely ſpoiled. There are only two kinds of artificial ferments procurable in large quantity, and at a low price, viz. beer-yeaſt and wine-lees. A prudent management of theſe might render the buſineſs of the brewery for diſtillation, as in the buſineſs of the malt-diſtiller, &c. much more eaſy and advantageous. Brewers have always found it a conſiderable difficulty to procure theſe ferments in ſufficient quantities, and preſerve them conſtantly ready for uſe; and this has been ſo great a diſcouragement to the buſineſs, that ſome have endeavoured to produce other ferments, or to form mixtures or compounds of particular fermentable ingredients: but this has been attempted without any great ſucceſs, all theſe mixtures falling ſhort even of common baker's leaven in their uſe. Whoever has a turn for making experiments and attempting improvements of this kind, will find it much eaſier and more advantageous to preſerve and raiſe nurſeries of the common ones, than to deviſe mixtures of others. Yeaſt may be preſerved by freeing it from its moiſter parts. This may be done by the ſun's heat, but ſlowly and imperfectly. The beſt method is by gently preſſing it in canvas bags: thus the liquor part, in which there is ſcarce any virtue, will be thrown off, and the ſolid will remain behind in form of a cake, which may be packed in a barrel or box, and will keep for a long time ſweet and fragrant, and fit for the fineſt uſes; and the ſame method may be taken either with wine-lees, or the flowers of wine. The former may be brought from abroad with great eaſe in this manner; the latter may be made with us from the lees, by only diſſolving them in water, and ſtirring them about with a ſtick; by this means, the lighter, more moveable, and more active part of the lees will be thrown up to the top, and may be taken off and preſerved, in the manner above mentioned, in any quantity deſired. By this means, an eaſy method is found of raiſing an inexhauſtible fund; or a perpetual ſupply of the moſt pro-

per ferments may be readily formed in the way of ſucceſſive generation, ſo as to cut off all future occaſion of complaint for want of them in the buſineſs of diſtillation. It muſt be obſerved, that all ferments abound in eſſential oil much more than the liquors which produce them; whence they very ſtrongly retain the particular flavour and ſcent of the ſubject from whence they were made. It is requiſite, therefore, before the ferment is applied, to conſider what flavour ought to be introduced, and accordingly what ſpecies of ferment is moſt ſuited to the liquor. The alteration thus cauſed by ferments is ſo conſiderable, as to determine or bring over any naturally fermentable liquor of a neutral kind, to be of the ſame kind with that which yielded the ferment. The benefit of this, however, does not extend to malt, or to any other matter that does not naturally yield a tolerably pure and taſteleſs ſpirit, as it otherwiſe makes not a ſimple, pure, and uniform flavour, but a compound mixed one.

The greateſt circumſpection and care are neceſſary in regard to the quality of the ferment. It muſt be choſen perfectly ſweet and freſh: for all ferments are liable to grow muſty and corrupt; and if in this caſe they are mixed with the fermentable liquor, they will communicate their nauſeous and filthy flavour to it, in ſuch a manner, as never to be got off. If the ferment is ſour, it muſt by no means be uſed for any liquor; for it will communicate its flavour to the whole, and even prevent its riſing to a head, and give it an acitous, inſtead of a vinous, tendency. When the proper quantity is got ready, it muſt be put to the liquor in a ſtate barely tepid, or ſcarce luke-warm. The beſt method of putting them together, ſo as to make the fermentation ſtrong and quick, is as follows:—When the ferment is ſolid, it muſt be broken to pieces, and gently thinned with ſome of the warm liquor; but a complete or uniform ſolution of it is not to be expected or deſired, as this would weaken its efficacy for the future buſineſs. The whole intended quantity being thus looſely mixed in ſome of the luke-warm liquor, and kept near the fire or elſewhere in a tepid ſtate, free from too rude commerce with the external air, more of the inſenſibly warm liquor ought, at proper intervals, to be brought in, till thus, by degrees, the whole quantity is ſet at work together. When the whole is thus ſet at work, ſecured in a proper degree of warmth, and kept from a too free intercourſe with the external air, it becomes as it were the buſineſs of nature to finiſh the operation.

In the operation of fermentation, however, the degree of heat employed, is of the utmoſt conſequence. In forming the extracts of the malt, the variation of a few degrees of heat produces an important difference in the effect. In the heat of fermentation, ſimilar conſequences reſult from ſimilar variety. Under a certain regulation of the proceſs, we can retain in the beer, as far as art is capable, the finer mucilage, and thereby preſerve that fulneſs upon the palate which is by many ſo much admired: on the other hand, by a ſlight alteration we can throw it off, and produce that evenneſs and uniformity of flavour which has ſcarce any characteriſtical property, and is preferred by ſome only for want of that heavineſs which they complain of in full beers. If a more vinous racy ale be required, we can, by collecting and confining the operation within the body of the wort, cauſe the ſeparation and abſorption of ſuch an abundant portion of the oleaginous and earthy principles, as to produce a liquor in a perfect ſtate at the earlieſt period, and ſo highly flavourous as to create a ſuſpicion of an adventitious quality.

Further Obſervations. When the wort is in a proper degree of coolneſs, the yeaſt is generally put into a large bowl, and a little of the wort, juſt warm, is added to it. The yeaſt ſwims at firſt on the ſurface, but ſoon blends itſelf with the wort, and begins the fermentation. As ſoon as this happens, the whole is mixed with the wort in the working tun.

If the fermentation ſhould not riſe properly, a little of the fineſt wheat flour, ſifted over the wort, ſo as to cover the whole ſurface of the liquor, will, by forming a kind of artificial head, confine the air, and ſoon produce the effect deſired. If a greater degree of warmth ſhould be wanted, a ſtone jug filled with boiling water, and put into the wort, will communicate a gentle heat to the whole, and as the liquor warms, the fermentation will come on in a gradual and proper manner.

In the courſe of the fermentation, it may ſometimes be neceſſary, in order to quicken it, to beat in the yeaſt, or rather to ſtir it with a whiſk, which ſhould be perfectly clean, ſcalded in boiling water, and then wiped dry. It will alſo by this means retain ſome degree of warmth, which will likewiſe help to promote the fermentation. Theſe meaſures, with an additional warmth given to the air, and warm coverings laid over the working tun, ſeldom fail to anſwer the end deſired.

If the fermentation proceeds too violently, owing to the warmth of the weather, or too great quantity of yeaſt, the beſt way of checking it is, to cool the air, by giving it a more free admiſſion, and to mix a little cold wort with the fermenting liquor. The practice of adding ſome unctuous ſubſtance is bad, and therefore ſhould be rejected.

Care ſhould be taken to have the caſks in good order againſt the time that the fermentation is completed in the tub; that is, they ſhould be tight and clean, and perfectly free from filth or ſmell; for if they have either of theſe defects, the whole labour will be loſt, becauſe the excellency and fine flavour of the liquor will be deſtroyed.

The perfection of malt liquors depends not only on the proportion of the oils to the ſalts, and on the proportion of hops uſed in brewing, but alſo on the fermentations being carried on ſlowly and coolly. For this reaſon cool weather is beſt for brewing of beer intended for long keeping. If, therefore, the liquor be not drawn off before the fermentation has proceeded too far, ſome of the coarſer oils will return into the liquor, and give it a diſagreeable and greaſy taſte. On the contrary, if the fermentation has not been continued its due time, the impurities which would either have ſunk down in the lees, or have been thrown up with the head, will remain in the liquor, and prevent its becoming clear and well taſted.

When the fermentation is at its height, all the dirt or foul yeaſt, which riſes on the ſurface, muſt be carefully ſkimmed off.

When the fermentation begins to ſubſide, after the liquor has been drawn off into the caſk, the caſk ſhould be filled up with a reſerve of the ſame liquor taken from another veſſel, but by no means with that which runs over.

When the fermentation has ceaſed, the caſk being filled up, ſhould be bunged down, leaving the vent-hole open, or but ſlightly covered, till all motion in the liquor be ſubſided; and after this is over, the vent-hole ſhould be ſtopped quite cloſe. The cuſtom of uſing bungs made of cork is wrong. A wooden bung ſhould be fitted to the bung-hole as exactly as poſſible, and covered with a cloth, ſand or clay.

Practical Brewing.

Brewhouſe and utenſils. To treat of the brewhouſe and utenſils, we preſume will be needleſs, as the conſtruction of the one is the entire province of the builder, and the other of the brazier, cooper, and other artificers, who are badly qualified for the buſineſs, if they do not know the beſt mode of proceeding: we ſhall now proceed to give an approved eaſy practice, and we hope, intelligible, to every reader who will beſtow an attentive peruſal.

Malt liquors, when we ſpeak of them in general, are of three kinds: 1. Strong beer, which is intended for keeping, and is called October, becauſe the beſt is brewed in that month: 2. Ale, which is a ſtrong malt liquor, but not deſigned for long keeping: and 3. Small beer, which, when made but of a moderate ſtrength in the way we ſhall direct, will keep a very conſiderable time, and be improving all the while.

III. BREWING STRONG BEER.

If the conveniencies of the brewhouſe will ſerve for brewing three or four hogſheads of October or ſtrong beer at a time, that will be the beſt practice. We will ſuppoſe three hogſheads. Theſe directions will equally ſerve for any larger or ſmaller quantity, only allowing the due proportion of the ingredients. For brewing the three hogſheads, have five quarters of fine ſweet malt, 36 buſhels may be ſufficient, and is in general preferred. Let it be ſuch as has been malted about a quarter of a year, and has lain in a large heap all that time to mellow. See that it be perfectly ſound, fine, tender, and entirely clean from duſt or any other mixture. Let this be ground with care, juſt ſo much, that every grain is fairly broken, and no more; then lay it up in a heap in a cool ſhady place, and let it lie eighteen hours. Thus will you have a perfect fine malt, in the exact right condition for brewing.

Procure a ſweet, clean, and well-taſted ſoft water, perfectly pure. When the water is got into the copper, put in a quarter of a pound of hops with it, and an ounce of common ſalt; and, when it begins to heat, ſift over it, through a coarſe ſieve, as much malt as will juſt coat it over to keep in the ſpirit. When this is on, briſk up the fire, and bring the water to ſimmer; but do not let it boil up: then draw it off at once into the maſh tub, which muſt be placed in a larger tub, as before obſerved, with the coat of malt upon it; and let it ſtand till the thick vapour ceaſes, and you can conveniently look down into it, and ſee your face. When it is in this condition, pour in the malt, a little at a time, and let ſome other perſon ſtir it about all the while it is running in, that there may be no clodding of it together in any part. When all is in, let the ſtirring be continued a little, that you may be ſure every part of the malt is free and well mixed with the liquor: then fill up the cavity between the outſide of the maſh-tub and the outer veſſel with water of the ſame heat that in the maſh-tub was when the malt was put in: keep water boiling to ſupply the place of this as it cools: obſerve the temper of it at firſt, and once in ten minutes draw off as much of that which is cool as will be needful to make room for ſo much freſh boiling water as will bring the whole to the ſame heat it had at firſt; and every time the freſh hot water is put into the ſpace between the two veſſels, give a very ſlow and gentle ſtirring to the malt in the maſh-tub.

In theſe double veſſels there is to be always one cock that communicates with the ſpace between the two where the water is, to let that out as it cools, and another through the real bottom and falſe bottom of the maſh-tub, which goes alſo through the outer veſſel, for diſcharging the clear wort, when the maſhing is

done

and ſuch as prefer this, which is indeed vaſtly preferable, may underſtand the reaſons of the difference. The ſeveral points in which the variation conſiſts, may ſeem little; but it is on theſe little things the excellence of brewing depends.

It is a common direction that the worts are to lie thin for cooling; and the uſual practice, which in theſe caſes is to let the worts, one parcel after another, into the coolers, and thence into the tun, favours it; but experience in this perfect method of brewing ſhews otherwiſe. In this way the whole three hogſheads of wort are to be in the upper cooler together; and this way the whole will cool more ſlowly indeed, but much better, than in the three parcels; for while it cools in this large body, it mellows all the time, and loſes leſs of the ſpirit; for when the wort is laid thin, as brewers expreſs it, that is, a ſmall quantity in a broad cooler, the air has great power in evaporation; and the wort not only becomes thicker by what it loſes in the cooling, but what is much more eſſential even than that, this loſs is of the moſt ſpirituous and excellent part.

Theſe are the diſadvantages attending the common practice, and the common rules of ſpreading the wort thin: but beſides the benefit ariſing from preventing theſe, by our method of cooling in a large body, there are ſeveral particular advantages attending this practice. The mellowing of the wort from a perfect mixture of its parts is one: another is the certainty that all the three runnings are perfectly mixed one with the other; and conſequently, every part of the liquor is alike before the working begins; and thirdly, the dropping ſome coarſe matter twice over, namely, once in each cooler, which, being the heavieſt part of the ingredients, and, perhaps, ſome accidental foulneſs with it, would have prevented the regular and perfect fermentation. Every one knows how delicate and nice a point the working of beer is, and how ſmall a quantity of any improper ſubſtance is able to check it; therefore this is a very uſeful practice, which gives any ſuch matter, that may by accident have got in, time to ſeparate from the wort. The perfect mixing of the ſeveral parcels of the wort, is a point as eſſential to the regular fermentation, though it be not ſo well underſtood, for the working never begins regularly, unleſs it begins in the whole liquor at a time; and it never can do that, unleſs the ſeveral portions of it are perfectly mixed. This mixture cannot be ſo well made in the common way of brewing; but in this method it is done completely, partly by the time the three parcels ſtand together in the upper cooler, partly by the running of the whole from the upper to the under; and, finally, by the running of the whole in that cool and eaſy manner into the working tun.

Having now got the wort into the tun, and explained the reaſons of our particular practice in every article, we are to proceed to the fermenting or working of it. We have a fine ſubject to work upon: for this will be a clear, ſtrong, and excellent wort; and nothing is wanted but care to make this fermentation as complete in its kind, as any of the other operations.

When the wort is in the tun, immediately get to work upon the yeaſt. Care muſt be taken to get that which is perfectly good, and it muſt be mixed with a little of the wort firſt, in a large bowl. Some of the wort muſt be ſaved for this purpoſe, as it is running into the tun, and a little more than is directly wanted for this ſervice; becauſe, if the fermentation runs too high, which is what nobody can foreſee whether it will or not, then a little of the cold, unfermented wort is, of all things, the mildeſt and quickeſt method to check it.

The yeaſt muſt be thick, and in perfect good condition; and about three quarts will be ſufficient for the working this quantity of beer. It muſt be mixed very gradually with a ſmall quantity of wort, let into the bowl for that purpoſe, and then the wort and yeaſt together gently into the tun. Cover it up cloſe, and watch it from time to time carefully, to ſee that the fermentation goes on as it ſhould. It ought to begin very gently, and encreaſe gradually: and if it proceed in this right manner, there will be firſt a ſmiling flowery head upon the whole liquor, and by degrees this will thicken into a yelloviſh white cruſt; and, upon holding the head a little over it, when uncovered, there will a ſharp penetrating ſcent ariſe. The head will from this time thicken more and more, and the ſcent will become more penetrating, for the ſpace of three days and nights: at the end of this time it will naturally abate, and by degrees ceaſe; and the drink is then to be got into the caſks.

Casking.

Therefore when the falling of the head ſhews the fermentation to be declining, let the wort be let out of the tun. This muſt be done by a cock, and that ſhould be let into the tun at five inches above the bottom, for ſo much will be thick, making a kind of ſediment: and this muſt be carefully left behind: only the pure and clear wort being taken off. This ſediment is not altogether uſeleſs, though it muſt not be let into the caſk of the fine beer; it is, conſiderably ſtrong, and will be a good addition to ſmall beer, which may be brewed after this, and while it is working. This is a point that has been diſputed; but there is no guide like experience, and that declares in favour of this way of uſing the large ſediment that is thus made from the drawing of the fine wort from the tun.

The caſks ſhould be got in perfect good order by the time the wort will be fit for putting into them; and this is eaſily done, becauſe we know perfectly when they will be wanted. Every thing ſhould be of the beſt kind for this excellent ſort of drink, and conſequently the caſks for keeping it ſhould be of good ſtuff, and well made. No wood is proper but heart of oak: and they ſhould be ſo well made, that the inſide being true and ſmooth, no foulneſs can lodge. If they have been painted ſome time they will keep the drink the better, for the paint ſtops up the pores moſt perfectly, and by that means confines the ſpirit of the drink much better than plain wood: but this ought to be done in time, and they muſt be very well freed of ſcent, by ſtanding in the air, before they are uſed; for the abominable ſcent of freſh paint would certainly affect the beer while it was in ſo delicate a ſtate as working. Never put this fine beer into a new caſk; the true way to prepare the veſſels for it, is to ſcald them very well, over and over, and then keep one or two brewings of good ſmall beer in them. Theſe will thoroughly ſeaſon the caſk; and after this nothing will be required, but ſuch thorough good cleaning as may be given by boiling water, and a little hard broom. When caſks are painted, this ſhould be at the time of the firſt ſeaſoning, that, if any flavour of the paint ſhould be troubleſome, it may be in the ſmall beer, and not in ſuch as is of this value.

While the beer is put into the caſks, make a reſerve of ſome of it in a ſmall veſſel by itſelf, to fill up the others as they work over. It is the common practice to fill them up with the very beer that has worked out of the veſſel: but this is a coarſe method, and not fit to be uſed for theſe fine kinds of drink.

Let the beer be drawn ſoftly and carefully out of the working tun, not to diſturb the ſediment it has made, and fill up the caſks quite full. The drawing from the tun to the caſk will put the whole in motion; this will effect the languid fermentation; and the working will begin again. They muſt be ſuffered to work out at the bung hole; and, as the quantity is diminiſhed that way, make it up out of what was reſerved in the ſmall caſk for that purpoſe. This muſt be done with great care, not to diſturb the fermentation that is now going on in the liquor; and the beſt method of putting it in is by means of a tin funnel, with a long ſpout: this ſhould be put in ſo far, that the end of the ſpout is two inches and a half buried in the beer, and then the liquor from the reſerved caſk muſt be gradually let into it, by pouring gently into the funnel. This will fill up the veſſel without giving the leaſt diſturbance to the liquor: and thus it ſhould be kept filling up from time to time during the working.

In this manner wait with patience the natural period of this ſlight fermentation: according to the nature of the malt, the water, the degree of boiling, or the ſeaſon of the year, but moſt of all according to the management of it in the working tun, this will be longer or ſhorter; ſo that no time can be fixed when it ſhall be over: but when it is, and all is quiet, ſtop up the caſks cloſe, and let them ſtand till the beginning of the next year, that is, ſuppoſing the beer was brewed in October, which is in general the beſt time of all, it ſhould ſtand perfectly quiet, and without any mixture, till the following ſpring. In this time it will perfectly fine itſelf. The cold of the winter ſtopping all inteſtine motion in the beer will aſſiſt in this; but in the beginning of ſpring the weather will take effect, and there will begin a new fermentation which will laſt all ſummer. To prepare for this, the vent-hole muſt be opened, and it will be eaſy to ſee whether the fermentation is or is not begun. If it be, the vent-hole muſt be left open; and in that manner it is to continue all the ſummer; if the fermentation is not yet begun, the hole muſt be ſtopped again: and once in a week it muſt be opened to watch the beginning of this new fermentation.

This is a good time for putting thoſe ingredients into the beer which are ſometimes wanted: but we need not name them farther here, for the beer thus brewed, and managed throughout with this due care, there will be no occaſion for any aſſiſtance more than the beer will get itſelf from time. If the examination of the beer ſhould be omitted, till the fermentation has got any power, and the veſſel all this time pegged faſt down, there will be danger of its burſting: for though a very little communication with the air be ſufficient, as we ſee by opening the vent-hole; yet if the veſſel were every way cloſe, the power of the fermenting liquor would certainly deſtroy it.

The veſſel ſhould ſtand with this opening till autumn. Uſually a week before Michaelmas, or thereabouts, is the time when this laſt fermentation naturally ceaſes; it was brought on by the increaſing air of the ſpring, and it goes off as it cools in autumn.

The beer may now be conſidered as completely fermented: the hop will be mellowed in it, and one uniform taſte will prevail in the whole, which will be a mixture of the malt and hop mellowing one another; and neither will be predominant, therefore all this beer can poſſibly want is perfect clearneſs. This is ſo great a recommendation to all malt liquors, that ſuch as has been brewed with this expence and care, certainly ſhould not be deficient in it. If it were now ſtopped up, and to ſtand the winter in quiet, it would of itſelf fine down, by ſettling a ſmall ſediment, and be very clear: but it is eaſy to help nature in this operation, and to cauſe the ſediment to fall more fully and more regularly. The only

ingredient

done, into the receiver. No mashing veſſel of any other kind can keep a due heat, or anſwer the purpoſe of opening the ſubſtance of the malt; for if the water be too hot when the malt is put in, it hardens inſtead of diſſolving it; and if it be too cool at firſt, it ſoon grows into full condition of ſervice. The malt is to be kept in the mash tub in this manner one hour and three quarters: and in that time another copper of water, equal to the firſt, muſt be made ready, covering it with the head of malt, and bringing it juſt to ſimmer.

A little before the ſecond copper of water is ready, the firſt wort is to be begun to be run off; and the hops are to be prepared for ſoaking in it as it runs. This is the improved method of brewing. The whole quantity of hops for the three hogſheads of this beer, which is intended for keeping a conſiderable time before it is uſed, muſt be eighteen pounds, that is, ſix to each hogſhead. Therefore as the quantity of one hogſhead is now in the maſh, take ſix pounds of hops, ſprinkle them over with a very little ſalt, and rub them well to pieces between the hands. Tie them up in a looſe bag of coarſe canvas, and put them into the receiver, that is under the maſh tub: then let the wort run clear out at the tap in the maſh-tub in a ſmall ſtream, not thicker than a large ſtraw; and let it run upon theſe bruiſed hops. This will ſoak them, ſo that they will readily, and that at once, as it were, give their full virtue, when the wort comes to be boiled. The ſalt that is put to the water, and to the hops, is not enough to give the leaſt taſte to the wort; but it will give it a kind of ſpirit that water alone never has; and will make it extract, much better than it otherwiſe would, the virtues both of the malt and of the hops.

As the wort drains from the malt in the maſh-tub, there muſt be a gradual ſupply from the copper of boiling water. The intent is, that a hogſhead of wort be run off; but though ſomething more than a hogſhead of water was uſed, to allow for the quantity that the malt ſoaks up without return; yet this whole quantity muſt not be had from what was firſt in the maſh-tub. There are to be three ſuch maſhings from this quantity of the malt; and one is to follow another, without letting the malt ever grow dry. Therefore, when the liquor is ſo far drained out of the maſh-tub, that the malt begins to look dry, let ſome of the hot water be let out of the copper into the maſh-tub; and ſtir the malt well about in it. This muſt be let in very gradually, cooling it firſt to a due degree; and by this means there is to be a ſupply of water kept to the malt, while the firſt wort runs off; ſo that when there is a copper full run into the receiver, the ſecond copper of water will be all got into the maſh-tub.

The hops having been all this time ſoaking, and the copper being now empty, the wort in the receiver muſt be pumped or ladled into it, and the hops put in with it; then the fire muſt be made up, and the wort muſt be brought to boil briſkly. Let it boil a quarter of an hour and no longer, then let it be drawn off into the cooling backs; and the copper be filled the third and laſt time with water.

In this proceed exactly as before. The ſecond copper is now maſhing; it muſt be ſtirred gently about, and there muſt be boiling water from time to time added as before to the quantity, between the maſh-tub and the outer veſſel, to keep up an equal degree of heat. This maſhing muſt laſt an hour and three quarters; and in that time the third copper of water muſt be got to a due degree of heat.

When the time is near expired, ſix pound more of the hops muſt be juſt ſprinkled over with a tea ſpoonful of ſalt, and thoroughly rubbed to pieces in the hands again: then they muſt be tied up in a bag as the former, and put into the receiver. The ſecond maſh having now been kept at a due degree of heat the appointed time, the wort is to be let out in a ſmall ſtream into the receiver, running upon the hops. Manage this exactly as before; and, when ſo much of the wort has run off that the malt begins to be dry, let in ſome of the water again out of the copper. This may be of a degree of heat, ſomewhat greater than the firſt or ſecond; becauſe the grains, having already parted with a great deal of their ſtrength, require it, and becauſe being to be maſhed a laſt time, ſomething more in point of heat is neceſſary.

When there is the full quantity of a hogſhead run out of this ſecond wort, ſtop the cock of the maſh-tub, let in the remainder of the water from the copper, and immediately put in the wort out of the receiver into the copper, with the bag of hops along with it.

A quantity of malt having been ſaved out for the purpoſes of covering the water and capping the maſh, both theſe articles muſt be duly attended to in the three ſeveral operations; we have thought it therefore beſt, for the ſake of avoiding three repetitions, to name theſe articles here together. The quantity of water in each copper is to be ſo much as will allow a full hogſhead of wort, beſide what the malt ſoaks up. Upon each copper full of water there is to be ſpread a thin coat of malt to keep in the ſpirit; and over each maſh there is alſo to be ſpread the quantity of half a buſhel, by way of cap to the whole.

The third copper of water being now in the tub, and therefore the laſt maſh made, put on the cap of freſh malt, which is all that was left, and let it ſtand: keeping the water between the outer tub and the maſh-tub always of a due heat, to keep up the full degree of warmth in the maſh.

A ſmall copper will be neceſſary for the heating the water for this ſervice; becauſe the other will be conſtantly employed in the heating the water, or boiling off the wort, the whole time of the brewing.

The ſecond running of wort being now in the copper, briſk up the fire, and bring it to boil: let it boil twenty-five minutes, and no longer; and then run this off into the coolers.

The buſineſs now becomes eaſy; there is only one maſhing remains, which is to be in the maſh-tub an hour and half, and no longer. Then rub the laſt quantity of hops, which is to be alſo ſix pounds, between the hands, without any ſalt; for the wort is now thinner, and will take effect upon them alone; tie them up in a bag, and put them into the receiver. When the maſh has ſtood its time, turn the cock to run a ſomewhat larger ſtream; and, when the liquor is all come off, pump it, or ladle it into the copper, and put in not only the hops new ſoaked, but alſo the two former parcels. Boil all together the ſame time that the laſt copper was boiled, and then let the wort run off into the coolers.

Cooling.

Theſe three worts being mixed, make one regular and excellent quantity, in which there is all the ſtrength and virtue of the malt very perfectly; and the entire flavour, and due bitter of the hops; without any of the earthy and heavy part of the grain, or of that auſtere and unpleaſant taſte which hops yield when they have undergone a vaſt deal of boiling.

The proof of this is eaſily found; for this beer will keep ever ſo long: and hence it is plain that the hop has given all that was expected or required of it, a fine flavour, and a power of keeping: and, as to the other, the fact is ſo evident, that the wort has all the virtue of the malt, and the grains are mere chaff.

If this brewing has been managed exactly according to the orders here laid down, there could not be ſmall-beer made of the grains that any one could drink, that full virtue having been taken out by theſe repeated maſhings, with a continued heat.

If any one diſlikes the addition of this ſmall quantity of ſalt, it may be left out; but the beer will neither be ſo ſtrong, ſo briſk, nor ſo clear without it. As to the uſe of the double veſſel for maſhing, with the hot water between, that is eſſential. It is on this depends the entire virtue of the malt being taken into the wort.

One great advantage of the putting the hops into the receiver is, that the beer which is made thus never foxes, as the brewers call it; but the great article is, that being thus ſoaked by degrees, and ſteeped in the water, they will give out their virtue with ſo little boiling, as will not damage the drink; for when the wort is boiled too long, as is the moſt common of all errors in brewing, it becomes too thick to ferment perfectly, and its ſediment can never get clear down; ſo that all the pains that can be beſtowed, and all the judgment that can be employed afterwards, will never make it good and perfectly fine drink.

One thing there is in this method which differs from the common practice, and the uſual opinions: this is the degree of boiling given to the three coppers of worts. It is cuſtomary to boil the ſecond longer than the firſt, and the third longer than the ſecond; and, with the common way of making, that is certainly right: but when the malt is kept up in its proper heat all the time, by the water between the two tubs, leſs and leſs boiling always anſwers for the ſucceeding worts. The time here directed for each is nearly what does, and perhaps comes as cloſe to as good general rule, as any meaſure of time can; nay, we may add, if the malt be juſt ſuch as is directed, and the whole managed regularly from the beginning, this very time almoſt to a minute will do the buſineſs; but the eye and taſte are the true and certain judges, and they muſt determine whether the worts ſhall be kept in the copper a few minutes longer, or run off a little ſooner than has been here directed.

Working.

The worts in common brewing are uſually cooled ſeparate and let down into the tun one after the other: but this is an injudicious practice; for the buſineſs is to mix them perfectly, without which they will not enter upon the great article of fermentation regularly; and they can never be mixed ſo well as while the ſeveral parcels are all warm. It is therefore we have directed the running off the worts from the copper into the coolers, one to the other. And when there are two backs or coolers, as we have directed, that are large enough, the beſt way of all is this: let all the three worts run into the upper of the two backs or coolers; and when the third is in, let the whole ſtand two hours; then draw it off ſlowly and leiſurely into the under cooler or back, and by this means leave behind any coarſe ſediment that may have come in with it.

In this ſecond cooler let the whole ſtand till it is perfectly cold, if the weather be mild; but if the ſeaſon be very cold, let there be a very ſmall degree of heat remain in the wort; then draw it off leiſurely and ſlowly into the working tun, ſo as not to diſturb the liquor in falling in, and to leave a ſecond ſediment in the cooler.

As in ſeveral points this method differs from the common practice, and from what are called the beſt receipts for this kind of beer, it may be neceſſary, as we go on, to ſay in what the difference conſiſts; that thoſe who chooſe the old way may follow it,

and

gredient that need be uſed in iſinglaſs; and this is ſo perfectly innocent, that there is no need to decline its aſſiſtance. The beſt way of uſing it is thus:

Buy two ounces of beaten iſinglaſs; and take care that it is ſo well beaten that there is no part of it thicker than a piece of thin paper; cut this very ſmall, draw out a gallon of the beer, and put this iſinglaſs to it; ſtir it well about from time to time, and let it ſtand till it is perfectly diſſolved, then ſtrain the ſolution through a coarſe and perfectly clean cloth; take out the bung of the veſſel, and carefully put it in: ſtir this about to mix it with the whole, and then lightly lay over the bung: there will be ſome ſmall motion in the liquor from this, and the bung muſt not be put faſt down till it is over. Then faſten the bung, and only leave a little opening at the vent-hole: then let it ſtand three weeks, and it will then be perfect. It may either be drank from the caſk or bottled, and will be very fine, ſtrong, mellow, well-taſted, and wholeſome. Where the intent is to drink it from the caſk, till there ſhould be a reſerve for bottling, the beſt way is to drink off two thirds by draught, and then bottle the reſt, which in a good cellar will ſoon be in excellent condition.

If the whole be intended to be bottled off, the time is at one year's end; in the ſame manner as for drinking from the caſk. If the beer be brewed in October, it will be ready for bottling the October following: and, to give it full perfection, it ſhould ſtand a year in the bottles; ſo that the beginning of drinking it ſhould be two years old from the brewing.

This is the complete method of brewing the October, or fine beer; and whoever will obſerve the ſeveral rules cannot fail of ſucceſs. As to the degree of ſtrength what is here directed for the quantity of malt, will make ſuch as ſhall be ſufficiently potent; but it may be varied in this matter at the pleaſure of the perſon, by increaſing or diminiſhing the quantity of malt. The allowance in this receipt is about thirteen buſhels to the hogſhead. There are ſome who brew with only ten or eleven buſhels for this kind of drink; and others who go as far as twenty buſhels: but this ſeems to be a kind of medium between the ſtronger and the weaker kinds, what we call the ſtrong October being generally brewed with ſixteen buſhels to the hogſhead, for thoſe with twenty are too heady. There is no drink pleaſanter than this kind, with the degree of ſtrength here directed: and none can be more wholeſome.

IV. BREWING MILD-ALE.

The liquor called ale, in diſtinction from beer, is uſually of leſs ſtrength; and is leſs tinctured with the hop: being intended for drinking ſoon after it is brewed; not for keeping years as the other. This ſhould be brewed alone, that is, without any ſmall beer to be made from the ſame malt. The method of brewing is in general the ſame in all kinds; but as there are particulars needful to be regarded, in order to ſuit the operation to each particular kind of drink, we ſhall here give the method of brewing this kind, with proper management. With regard to the ſtrength, that is to be according to every one's particular pleaſure; but ſome ſtandard muſt be fixed for the directions to be given here; and therefore we ſhall make the allowance eight buſhels to the hogſhead; which will make a very excellent drink of this kind.

Grind or bruiſe the malt two or three days previous to brewing, in fact malt always brews better for this precaution. Get water, ſuch as is ſoft, no matter how it is in other reſpects. As much muſt be boiled as will allow for the ſoaking up the malt, and afford a clear hogſhead of the wort, with allowance alſo for waſte. Set this on in the copper, put in a table ſpoonful of ſalt, and make the fire briſk, a ſlight ſcum will riſe to the ſurface; take that off, and then ſprinkle on about three quarts of bran: let it remain till the water ſimmers and is going to boil, then ſkim this alſo off, and the water will be perfectly clear and ready; damp the fire and draw off half of the water into the maſh-tub; then let it ſtand till the great ſteam is over, and you can look into it. Then pour in all the malt except half a buſhel: let it ſlowly and gradually into the water, and let ſome perſon ſtir it all the while, that there may not be the leaſt lump of it together: then ſtrew over the half buſhel that was ſaved out; and thus leave it two hours, covering it up carefully to keep in the ſteam, and filling up between the maſh-tub and outer-veſſel, with hot water from time to time as it cools.

When the two hours are expired, rub to pieces in the hands three pounds of hops; tie them up in a coarſe canvas bag; put this into the receiver, and then begin to let it in the wort from the maſh-tub in a fine ſmall ſtream, running directly upon the hops; and with a whiſk beat the bag in which the hops are lightly, to promote their moiſtening in the liquor. As this ſtream is running, obſerve the other water. We ordered the fire to be damped when the firſt half was drawn off; and by this time, the fire being kept low, this water will be about as hot as the water in the maſh-tub was when the malt was put in. Briſk up the fire by one ſtirring, to make it a little hotter, and then run it off by degrees upon the grains; as the firſt wort is run off into the receiver. Thus, when the quantity of one maſhing is got into the receiver, the ſecond quantity or water will be in the tub. Let this ſtand two hours as the firſt did, keeping up a regular heat, and covering it; only take care to ſtir it very well together, but without beating when it is firſt put together; and in the ſame manner to take off the covering, and ſtir them once more at the end of the firſt half hour. All this while the firſt wort will ſtand upon the hops: and, when the two hours are expired, this ſecond wort is to be let off from the maſh-tub to the firſt in the receiver in a large ſtream. The grains will be very well exhauſted by this management; and the worts will be ſtrong, with all the virtue of malt.

Let the worts ſtand in the receiver one hour, in which time they will let fall a ſmall but coarſe ſediment. Then the whole, except this ſediment, muſt be got into the copper, together with the bag of hops; for though there have been two maſhings, there need be but one boiling. As this drink will not have time for ſettling in the caſk like the October or ſtrong beer, all poſſible care is to be taken to clear it in the wort. For this reaſon the wort is not to be pumped out of this receiver into the copper, as was directed in the brewing of October: but care ſhould be taken in time to raiſe the receiver upon a foot, ſo that the wort can be drawn out of it by a cock placed an inch from the bottom.

The clear wort muſt be put in the copper with the hops, and boiled about eighteen minutes; the exact time muſt be known from the eye and taſte, becauſe it varies conſiderably in different brewings, from the weather, the nature of the malt, and other cauſes.

It muſt be then let into the upper cooler; and after ſtanding an hour, it muſt be drawn from that into the lower; leaving the ſettlement carefully behind. In this ſecond cooler it muſt ſtand till it is perfectly cold, if the brewing be in ſummer; otherwiſe it need only ſtand till it is milk-warm.

Then it muſt be let off into the working tun, ſtill leaving the ſettlement behind; and the clear wort will be then in perfect good order for working.

Theſe ſeveral ſettlements of the wort will be a vaſt advantage to the ale, making it nearly as clear as old ſtrong beer: and the quantity that is loſt will be very trifling. However, it will be proper to make allowance for it at the firſt proportioning of the water; becauſe the brewing is intended to yield a full hogſhead, and there can be no making up the deficiencies, without greatly hurting the drink. Therefore, in the firſt allowance, there muſt be three gallons of water for each buſhel of malt, allowed for what will be ſoaked up in the grains; and if half a gallon to the buſhel, that is, four gallons for this quantity be allowed farther for this article, it will make up the loſs of all the three ſediments.

The wort being thus got into the ton, the manner of working it is to be in all reſpects the ſame with what we have directed for the other kinds. A quart of yeaſt will be ſufficient, if it is good in its kind; and this is to be firſt put into a little of the drink in a bowl, and then mixed with the whole. The tun is then to be covered up, and kept to the right degree of working, by the methods before directed. After this the drink is to be got into the caſk, by drawing it clear out of the working tun, and leaving the full ſediment behind; a ſmall quantity is to be ſaved to ſupply what is loſt in the working in the barrel: after this, when the working is thoroughly over, it is to be ſtopped down, and will in a little time be fit to tap. If the materials were good, this will be excellent wholeſome liquor.

V. BREWING TABLE BEER.

Moſt families have got into ſo regular a way of brewing their table beer after their ale, that it will not be eaſy to perſuade them out of it; but they may be aſſured, that if they have any value for that kind of drink, it is their intereſt to brew it alone: for the trouble and expence is very little more than the other way, and the drink is incomparably better. The method is very little different from the brewing of any other kind. As to the quantity of malt, or ſtrength of the beer, that is at the pleaſure of the perſon; but, however it is intended in point of ſtrength, the brewing ſhould be performed at once; and all that is made ſhould be of one kind, not a ſtronger firſt and a weaker afterwards. We ſhall give directions at the rate of two buſhels and a half to the hogſhead, which will make a very excellent kind. Grind the malt as uſual a day or two before brewing, to cool the mellow. Boil half a hogſhead and two or three pails of water: this is the proper quantity for the firſt copper, as it will yield a clear half hogſhead of wort. Put into the copper a handful of hops, as much ſalt as will lie on a ſhilling, and a race of whole ginger; ſift over a little malt to keep in the ſpirit, and juſt make it boil: let it out into the maſh-tub, and let it ſtand to be ſomewhat cooler than for the ſtronger kinds of beer: then pour in the malt, except about a peck; and ſtir it a good while very carefully together, not beating it about haſtily to break it, but mixing it very well with the liquor: then ſift on the malt that was ſaved out, through a coarſe ſieve, and cover it up; let it ſtand two hours, then rub to pieces a pound and a half of hops, and tie them up in a coarſe bag: put them into the receiver, and let the wort run out upon them, in a ſmall ſtream. While this maſh is ſtanding, the ſame quantity of water muſt be brought to a due degree of heat. It ſhould be ſomewhat hotter than the firſt; and when the maſh-tub is drained pretty near dry, this muſt be let in. It is to ſtand two

hours as the other did, and then to be run off to the reſt in the receiver.

When the grains are well drained, the liquor is to be put into the copper with the hops; and it ſhould boil about half an hour: for more boiling is neceſſary for theſe ſmall worts, than for the ſtrong, nor does it do them ſuch miſchief. After this the working is to be managed as in other caſes; and the beer will be capable of keeping to a perfect fineneſs; and will far exceed that ordinary and poor kind, which it is poſſible to make after other drinks. When ſuch ſmall beer has ſtood to a due fineneſs, there is no wholeſomer liquor. If the cellar is good, and the ſeaſon for brewing neither two warm nor too cold, this beer will keep ſound two or three months.

VI. OAT ALE, &c.

We meet with very poor liquor often under the name of oat ale; and, indeed, very little is really brewed from the grain from whence it has its name. Bottled ſmall beer is what we commonly get when we call for this liquor; and even that is ſeldom brewed on purpoſe: but real oat ale is a very different liquor. It differs from all others in two moſt eſſential articles, for it is made from a different grain, and is brewed cold. When thus made it is briſker than any thing that is ſold under its name, and has a great many other good qualities. No malt liquor is ſo agreeable at meals, and nothing is more wholeſome. We ſhall give the reader an exact knowledge of what it is, that he may know how far from the deſcription every thing is that he meets with at public houſes under that name: and ſhall then give the true method of brewing it; which is ſo eaſy, that I ſhould think none who had a brewhouſe would omit to make this particular liquor.

Oat ale, when genuine and well brewed, is a fine, ſpirited and balſamic liquor; it is very pale in colour, briſk, and yet extremely ſoft to the taſte; it ſparkles in the glaſs, and riſes to a fine creamy head; it is perfectly clear, and free from all ill-flavour. By this deſcription we ſhall eaſily ſee, that what is commonly ſold is not genuine. The true way to make it is this:

The malt muſt be made of the fineſt white oats, without any mixture; and the water muſt be clean, and yet not hard; that of a fine running brook is beſt: but if ſuch cannot be had, the ſofteſt water that can be got, muſt be uſed, and it muſt have time to ſettle. With ſuch malt and ſuch water, the fineſt oat ale may be brewed; but the quantity ſhould be no more than can be uſed in about two months, for when it is the fineſt that can be, it will keep no longer.

Take eight buſhels of this oat malt, perfectly clean and ſweet: let it be ground very lightly, juſt to crack the corns, and no more; then lay it in a heap, in a cool, but dry, airy room, for two days and nights; then put it into a large maſh-tub, and pour upon it fifty gallons of cold water, ſuch as has been juſt directed, ſtir it about juſt enough to prevent the malt from ſticking together in lumps, and then cover it up. Open the maſh-tub after one hour, and ſtir it altogether again; then cover it up as before; repeat this afterwards once in two hours, till the whole has been maſhing, without any heat, thirteen hours. Then tie a piece of flannel looſely over the cock of the maſh-tub, and prepare the hops. Chuſe the fineſt and freſheſt hops; two pounds and a quarter are the proper quantity for this brewing. Rub them to pieces in the hands and tie them up in a piece of coarſe canvas; lay them in the receiver under the maſh-tub, and let the wort out of the tub run upon them in a ſmall ſtream through the flannel. Give it time to drain thoroughly; and, after it is all in, let it ſtand four hours; then pour the wort through a flannel, faſtened to a hoop, into the working-tun; and put to it a pint and half of fine thickiſh yeaſt. Mix this firſt with a little of the wort, and then with the whole; cover the working-tub very carefully, and a fermentation will preſently come on; let the head riſe fairly, and let it work briſkly for two days. Then ſkim off the head, and draw it off out of the tun into the caſk, by a cock placed five inches above the bottom of the tun, and let it this time alſo run through flannel. Thus will the drink be got quite clear and fine into the caſk; there it will have a new, but very ſlight fermentation; and this alſo muſt be allowed its regular time, the veſſel being kept filled up with ſome of the wort ſaved for that purpoſe. When the ſlight working is thoroughly over, the veſſel is to be ſtopped down faſt, and the drink muſt be allowed a fortnight to mellow and ſettle perfectly. In that time the hop and wort will be thoroughly blended together, ſo as to make but one united taſte, and the drink will be as clear as the pureſt water, and very lightly coloured.

Let the bottles be perfectly clean, and thoroughly dry: draw off the drink ſlowly and gradually into them; and while one fills, let another cork. All this muſt be done with as little motion as is poſſible; and the corks ſhould not now be thruſt down perfectly faſt. The bottles ſhould be held as little as can be in the hand, and moved gently without ſhaking: as they are corked they ſhould be ſet regularly upon the floor; and it will be beſt if this be in a place where cold water can be thrown over them and run off freely. As ſoon as the whole is bottled off, throw ſeveral pails of cold water upon the bottles: this will check any tendency to heat or fermentation which the operation of bottling might have occaſioned. The next day drive in the corks faſt, and once more throw cold water over them, and as ſoon as it is run off ſet them in a cold dry cellar or other regularly temperate ſituation.

Beer without Malt. A cheap and wholeſome beer without malt, much uſed in Staffordſhire, and the adjacent counties; it has alſo this further advantage, that it will be fit for uſe in three or four days.

The method is this: Take of water ſixteen gallons, and boil one half of it. Put the water thus boiled, while in full heat, to the reſerved cold part, which ſhould be previouſly put into a barrel or other veſſel; then add twelve or ſixteen pounds, more or leſs, of treacle, ſtirring the whole well together; add half a pint of yeaſt, and keep it in a temperate ſituation, with the bung hole open, for two days, till the fermentation is abated, then cloſe it up and it will be fit to drink in a day or two afterwards, or you may bottle it off. With the addition of a few table ſpoonfuls of the eſſence of ſpruce to the above, at the time you put in the treacle, the celebrated Spruce Beer is made. Thoſe beers muſt be drank before the fixed air with which they abound is exhauſted, otherwiſe its good medical qualities and the pleaſantneſs of the taſte will be loſt.

VII. CONCLUSIVE REMARKS.

The common brewers uſe many ingredients, beſides thoſe we have named, in making of their beers: and when they grow foul, or become ſtale, or otherwiſe faulty, they have a long liſt of remedies to recover them. Thoſe who will follow the directions we have given, will need no other expedients than malt, hops, and water, to make the moſt excellent of malt-drinks; nor will they be apt to fail or become faulty: we utterly diſcommend the uſe of jalap, opium, and all pernicious drugs in brewing; yet, as by ſome accident or over-ſight, the beſt brewer may ſometimes have his beer turn bad, we ſhall not omit the methods of prevention, when the danger is foreſeen; or the remedies that may be innocently and ſafely uſed, when it has happened.

As it is better to prevent the miſchief than to ſuffer it, and then try an uncertain remedy, we ſhall firſt give the way of preparing what is called the feeding paſte: this is a compoſition, the ingredients of which are all innocent, and all tend to the purpoſe; therefore it is effectual.

We know the brewers mean by food, ſomething that is to remain at the bottom of the caſk, and upon which the drink lies and mellows. Often the fineſt part of its natural ſediment anſwers this purpoſe; but when that is deficient, or more is required than will naturally reſult from its effect, the feeding-paſte is very proper. It is thus made:

Diſſolve two ounces of the fineſt iſinglaſs in as much good ſtrong beer as will thoroughly melt it; then add to this a pound and half of good lump ſugar. Let them ſtand till the ſugar alſo is melted. Powder very fine three pounds of clean ſoft chalk, and one pound of white oyſter-ſhells, ſuch as are ſold at the druggiſts; add to this, of the flour of malt, ſifted fine, one pound and a quarter, and powder of hops two ounces: grind theſe well together; then put in the ſyrup of iſinglaſs, and beat up the whole in a marble mortar, to a good paſte; ſpread this upon a piece of paper, on the back of a large ſieve, and lay it in the air to dry. When it is hard and dry, put it up for uſe. Two pounds of this is the proper quantity to put into a hogſhead of drink; and it muſt be uſed in a like proportion for any leſſer or greater quantity. If any ſmall over-ſight has happened in the brewing: or if the ſeaſon of the year has been unfavourable, or there be any other cauſe to fear the drink may grow ſour, or come to other harm; this, being put in at the faſtening down the bung will prevent the miſchief. The beer will be fine, clear, ſoft, and well-taſted; and will keep without danger.

If from any omiſſion of this aſſiſtance, when it was neceſſary, or from any other cauſe, a caſk of beer grows unexpectedly foul and thick, and taſtes, as it always will in that caſe, dead and muddy; the proper remedy is by a ſyrup of the hop, made with iſinglaſs. The way to prepare it is this: and for a hogſhead, the following quantity. Rub to pieces a pound of fine freſh hops; put them into a ſtone jar, and pour upon them as much boiling water as will cover them, without preſſing them down: ſtop up the jar, and ſet it in a large pan of boiling water: pour away this as often as it cools, and put freſh boiling water in its place: in this manner keep the hops ſteeping, in the cloſe jar, 12 hours, then let them ſtand 12 hours longer in the cold. After this ſtrain the liquor without preſſing the hops; diſſolve in this two ounces and a half of beaten iſinglaſs; and then to every pint of the liquor put a pound of lump ſugar, and ſtrain it through a flannel bag. When this is ready, clean and ſweeten a freſh caſk. Burn two or three brimſtone matches in it, then put in this ſyrup, draw off the beer, out of the hogſhead it was in, carefully into this, and leave all the ſettlement behind. Bung it up, but leave the vent-open a little for three or four days, then ſtop it up entirely, and let it ſtand three weeks, after which it will be perfectly fine.

It is found by experience, that the paler malt is dried, the ſhorter time beer will take in fining, and be fit for uſe; in faſt, very

very brown or high-dried malt will not fine, although the ſtrongeſt acid menſtruums are uſed for the purpoſe.

Foreigners conjecture variouſly to account for the excellency of the Britiſh beer, and its ſuperiority to that of other countries, even of Bremen, Mons, and Roſtoch. It has been pretended, our brewers throw dead dogs flea'd into their wort and boil them till the fleſh is all conſumed. Others, more equitable, attribute the excellency of our beer to the ſuperior quality of our malt and water, and the ſkill of our brewers in preparing it.

Sour Beer. Various receipts are given to reſtore ſour beer, which we lay before the reader for choice and experiment. Salt, made of the aſhes of barley-ſtraw, put into the veſſel, and ſtirred; or by three or four handfuls of beech-aſhes thrown into the veſſel, and ſtirred; or, where the liquor is not very ſour, by a little put in a bag, without ſtirring, chalk calcined, oyſter-ſhells, egg-ſhells burnt, ſea-ſhells, crabs' eyes, alcalized coral, &c. do the ſame, as they imbibe the acidity, and unite with it into a ſweetneſs. Beer, it is ſaid, may be kept from turning ſour in ſummer, by hanging into the veſſel a bag containing a new laid egg, pricked full of pin-holes, ſome laurel-berries, and a few barley grains; or by a new laid egg and walnut-tree leaves. Glauber commends his ſal mirabile and fixed nitre, put in a linen bag, and hung on the top of the caſk ſo as to reach the liquor, not only for recovering ſour beer, but preſerving and ſtrengthening it.

Laurel-berries, their ſkin being peeled off, will keep beer from deadneſs: and beer already dead, may be reſtored by impregnating it with fixed air.

Beer taſting of the caſk, may be freed from it, by putting a handful of wheat in a bag, and hanging it in the veſſel.

Cellarage. A cellar ſhould be deep beneath the ſurface of the earth, the bottom laid on a proper deſcent to permit all water to run off clear; as much ſecluded from the air as poſſible. The roof of all cellars ſhould be arched or vaulted, and ſhould be ſituate underneath the northern aſpect of buildings. A ready communication between the brewhouſe and cellar greatly facilitates the concluſive operations of brewing; the pipes or ſpouts for the purpoſe of pouring the liquor, are very convenient; but in cold weather may, perhaps, chill it too much.

Brewing is an art depending upon chymiſtry, and capable of being improved various ways, both with regard to the preparation of the malt, the uſe of hops, and the management of the working or fermentation. Some have introduced the uſe of vegetable ſap, as birch and ſycamore waters, to good purpoſe, into the art of brewing. Honey, treacle, and ſugar, are alſo capable of being applied to advantage in brewing. Phil. Tranſ. No. 68. p. 2071. No. 84. p. 917.

The ſap or juices of trees is a very valuable article in *brewing*, and not only improves malt liquor, but renders it much cheaper. The ſycamore is the beſt tree for tapping for this purpoſe; it yields a great quantity, and that without any other trouble than boreing a hole properly, and placing a veſſel under it. One buſhel of malt brewed with this juice, will make as good beer as four buſhels in the ordinary way. The beſt way of procuring this ſap is this: take a large auger, and with it bore two holes on the oppoſite ſides of the tree, each ſo deep as to the pith. Each hole is to be bored ſloping upwards, and the beſt place for it is immediately under a large arm of the tree near the ground; and if the arm be pierced through with the auger in the way to the tree, it will be ſo much the better: in this manner, there needs no ſpigot or ſtone to keep open the hole, or to direct the courſe of the liquor, for it will of itſelf run down into a veſſel placed to receive it; and one tree will thus, in a few days, yield a ſufficient quantity of liquor to brew with.

In order to preſerve the ſap in a proper condition for brewing, what is firſt gathered muſt be inſolated by a conſtant expoſition of it to the ſun, in proper glaſſes, till the reſt be obtained; otherwiſe the firſt will contract an acidity that will ſpoil it. When a ſufficient quantity of the ſap is thus collected, as much rye bread muſt be put into it, cut thin and well toaſted, but not burnt, as will ſerve to ferment it; when it works well, the bread is to be taken out, and at a convenient time, it is to be bottled up, and will thus afford a pleaſant liquor, of conſiderable ſtrength, without malt or any other addition. Some people add ſage to this liquor, baking it in their cruſts of rye-bread, till thoroughly dry, and then adding it with the bread to the working liquor. If a few cloves be tied up in a rag, and put into the veſſels into which the ſap is received from the tree, they will preſerve it the year round, without any fermentation: they are very apt to give a taſte to the liquor; but if it be ſo contrived that they are taken out before they give this taſte, the liquor will keep as well without any flavour of them. The adding a few drops of oil of ſulphur, will have the ſame effect; and ſo will the fuming with ſulphur itſelf. A little ſpirit of wine, poured on the top of the juice in every bottle, will alſo be very inſtrumental in preſerving it.

Many people, inſtead of adding malt, and brewing the ſap of the ſycamore or birch into ale, uſe raiſins, and make a ſort of wine of it; and ſome add ſugar. Some have uſed the rye-toaſts with very good ſucceſs, though they were not put into the liquor, but only hung over it, at ſuch a diſtance as to give a warmth and motion to the ſurface. Common ale yeaſt has been tried by ſome to ferment the juice of the birch; but it uſually ſpoils it, turning the liquor into a very bad ſmall beer. The Flemiſh wheat-ferment would probably in time excellently mature the bottled juice of the birch or ſycamore, but it would require a conſiderable time for it. Cinnamon is worthy to be tried in the room of cloves, as of a much more agreeable flavour. Honey has no effect on cyder at all; for it will not mix with it, though boiled in it to make mead; but after a time the cyder lets fall the honey, and becomes ſimple cyder again: it is a queſtion whether it would mix with theſe juices; but if it would, it might probably make a great improvement in them. The tops and young leaves of birch boiled in the ſap, are ſaid by ſome to preſerve it. Phil. Tranſ. No. 146.

BREWING, among Diſtillers, denotes the method of extracting the more ſoluble parts of vegetables with hot water, and thus procuring a ſolution or decoction fitted for vinous fermentation. In which ſenſe brewing is a neceſſary ſtep towards diſtillation. See the Treatiſe on DISTILLATION. A fermentable ſolution, fit for yielding a ſpirit, or brandy, is obtainable from any vegetable, under proper management; but the more readily and perfectly the ſubject diſſolves; the better it is diſpoſed for fermentation, and the production of brandies. Thus ſugar, honey, treacle, manna, and other inſpiſſated vegetable juices, which totally unite with water, into a clear and uniform ſolution, are more immediate, more perfect, and better adapted ſubjects of fermentation than roots, fruits, or herbs, in ſubſtance, the grains, or even malt itſelf; all which diſſolve but very imperfectly in hot water. Yet malt, for its cheapneſs, is generally preferred in England, and brewed for this purpoſe, much after the common manner of brewing for beer; only the worſt malt will ſerve for diſtillation; and the tincture, without the addition of hops, and the trouble of boiling, is beer directly cooled and fermented. The grain intended for brewing is previouſly malted, to prepare it for diſſolving more eaſily and copiouſly in the water, ſo as to afford a richer tincture of ſolution, which after due fermentation, will yield about one half more of proof ſpirit than the tincture of an equal weight of unmalted corn.

BRIBERY, in law, is a high offence, where a perſon in a judicial place takes any fee, gift, reward, or brokage, for doing his office, but to the king only. But taken largely, it ſignifies the receiving or offering any undue reward to or by any perſon concerned in the adminiſtration of public juſtice, whether judge, officer, &c. to act contrary to his duty; and ſometimes it ſignifies the taking or giving a reward for a public office. Plato, in his ideal republic, orders thoſe who take preſents for doing their duty to be puniſhed in the ſevereſt manner: and by the laws of Athens, he that offered a bribe was alſo proſecuted, as well as he that received a bribe. In England this offence of taking bribes is puniſhed, in inferior officers, with fine and impriſonment; and in thoſe that offer a bribe, though not taken, the ſame. But in judges, eſpecially the ſuperior ones, it has been always looked upon as ſo heinous an offence, that the chief juſtice Thorp was hanged for it in the reign of Edward III. By a ſtatute 11 Henry IV. all judges and officers of the king convicted of bribery, ſhall forfeit treble the bribe, be puniſhed at the king's will, and be diſcharged from his ſervice for ever. And ſome notable examples have been made in parliament, of perſons in the higheſt ſtations, and otherwiſe very eminent and able, but contaminated with this ſordid vice. Thus in the reign of king James I. the earl of M. lord treaſurer of England, being impeached by the commons, for refuſing to hear petitions referred to him by the king, till he had received bribes, &c. was, by ſentence of the lords, deprived of all his offices, and diſabled to hold any for the future, or to ſit in parliament; he was alſo fined 30,000l. and impriſoned during the king's pleaſure. In the 11th year of king George I. the Lord Chancellor M— had a ſomewhat milder puniſhment: he was impeached by the commons, with great zeal, for bribery, in ſelling the places of maſters in chancery for exorbitant ſums, and other corrupt practices, tending to the great loſs and ruin of the ſuitors of that court; and the charge being made good againſt him, being before diveſted of his office, he was ſentenced to pay a fine of 30,000l. and impriſoned till it was paid.

BRICK, a fat reddiſh earth, formed into long ſquares, four inches broad, and eight or nine long, by means of a wooden mould, and then baked or burnt in a kiln, to ſerve the purpoſes of building.

Bricks are commonly red; though there are ſome alſo of a white colour, for which ſort Walpit in Suffolk is famous. Bricks may be made of any earth that is clear of ſtones, even ſea-ouſe; but all will not burn red, a property peculiar to earths which contain ferruginous particles. In England, bricks are chiefly made of a hazely, yellowiſh-coloured, fatty earth, ſomewhat reddiſh, vulgarly called *loam*. The earth, according to Leibourn, ought to be dug before winter, but not made into bricks before ſpring. For the making of ſuch bricks as will ſtand the fierceſt fires, Sturbridge clay or Windſor loam are eſteemed the beſt. In general, the earth whereof bricks are made

made ought not to be too ſandy, which would render them heavy and brittle; nor too fat, which would make them crack in drying.

BRICK-*duſt*. It is a cuſtom with ſome perſons to reduce this ſubſtance to a very fine powder, and give it, inſtead of chalk, in the heart-burn. Many of the lozenges, ſo much famed for the cure of this diſorder, and ſold under the pompous name of coral lozenges, are only made of a mixture of this uncouth medicine, and ſugar made into the conſiſtence of a paſte, with gum tragacanth reduced to a mucilage with roſe-water. But it is to be obſerved, that this, as well as chalk, is a very dangerous remedy. It has grown into an opinion, that the ſole cauſe of this complaint was an acid humour in the ſtomach, and thence an abſorbent was judged alone ſufficient for a cure: chalk was the firſt ſubſtance pitched upon for this purpoſe; but ſome miſchievous events having happened from the taking of it, recourſe was had by ſome to this odd medicine. But ſuch ſhould have obſerved, that as chalk did all its miſchief by being an aſtringent, this new medicine was qualified to do much more harm, on the ſame principle; it being a much more powerful one.

BRICK *layer*, an artificer whoſe buſineſs is to build with bricks, or make brick-work. Great care is to be taken, that bricks be laid joint on joint in the middle of the walls as ſeldom as may be; and that there be good bond made there, as well as on the outſides. Some bricklayers, in working a brick and half wall, lay the header on one ſide of the wall perpendicular on the header on the other ſide, and ſo all along the whole courſe; whereas, if the header on one ſide of the wall were toothed as much as the ſtretcher on the other ſide, it would be a ſtronger toothing, and the joints of the headers of one ſide would be in the middle of the headers of the courſe they lie upon on the other ſide. If bricks be laid in winter, let them be kept as dry as poſſible; if in ſummer, it will quit coſt to employ boys to wet them, for that they will then unite with the mortar better than if dry, and will make the work ſtronger. In large buildings, or where it is thought too much trouble to dip all the bricks ſeparately, water may be thrown on each courſe after they are laid, as was done at the building the phyſician's college, by order of Dr. Hooke. If bricks are laid in ſummer, they are to be covered from the intenſe heat of the ſun: for if the mortar dries too haſtily, it will not bind ſo firmly to the bricks as when left to dry more gradually. If the bricks be laid in winter, they ſhould alſo be covered well, to protect them from rain, ſnow, and froſt; which laſt is a mortal enemy to mortar, eſpecially to all ſuch as have been wetted juſt before the froſt aſſaults it.

BRIDE, a woman juſt married, or a wife in the firſt days of her matrimonial ſtate. See MARRIAGE. Among the Greeks, it was cuſtomary for the bride to be conducted from her father's houſe to her huſband's in a chariot, the evening being choſen for that purpoſe, to conceal her bluſhes; ſhe was placed in the middle, her huſband ſitting on one ſide, and one of her moſt intimate friends on the other; torches were carried before her, and ſhe was entertained in the paſſage with a ſong ſuitable to the occaſion. When they arrived at their journey's end, the axle-tree of the coach they rode in was burnt, to ſignify that the bride was never to return to her father's houſe.

Among the Romans, the maid eſpouſed remained a *bride*, *eſpouſa*, till ſhe entered the huſband's houſe; from which time ſhe commenced a wife, *uxor*. The bridegroom was attended by a brideman, *paranymphus*; the *bride* by a *pronuba*, or bridemaid, whoſe buſineſs was to inſtruct her young miſtreſs in the duties of the genial bed, and to prepare every thing for a proſperous copulation.

The ancient ceremonies practiſed in reſpect of a *bride* were numerous; moſt of them emblematical, or ſignificant of ſome part of her duty: as dreſſing her hair after a peculiar manner, and parting it with a ſpear: putting on her a crown; girding her with a girdle, which the bridegroom was to looſen; putting a yoke on her neck; dreſſing her in yellow ſocks; and vailing her with the *flammeum*. She was to ſeem to be raviſhed or torn by force from her mother, in memory of the rape of the Sabines under Romulus; fire and water being ſet on the threſhold, ſhe touched both; but ſtarting back from the door, refuſed to enter, till at length ſhe paſſed the threſhold, being careful to ſtep over, without touching it; here the keys were given her; a nuptial ſupper was prepared for her, and minſtrels to divert her; ſhe was ſeated on the figure of a Priapus, and here the *patrimi* and *matrimi* reſigned her to the *pronubæ*, who brought her into the nuptial chamber and put her into the genial bed. This office was to be performed by matrons who had only been once married, to denote that the marriage was to be for perpetuity. When the bridegroom was brought to her, to drown the cries and ſquallings of a coy maid at the firſt conflict, epithalamia were ſung by the women who were divided for that purpoſe into two bands, one whereof ſung in the evening, the other the next morning; and, for the like purpoſe, nuts were alſo thrown about for the boys to ſcramble for. Potter Archæol. lib. iv. cap. 11. tom. ii. Val. Max. 10. Plut. Queſt. Rom. 30. Serv. ad Æn. lib. iv. ver. 450. Kenn. Rom. Ant. p. ii. lib. 1. c. 9. Fabr. Bibl. Ant. cap. 13. § 5.

BRIDEGROOM, a man newly married, the ſpouſe of the bride. By the ancient canons, the bridegroom was to forbear the enjoyment of his bride the firſt night, in honour of the nuptial benediction given by the prieſt on that day. In Scotland, and perhaps alſo ſome parts of England, a cuſtom called *marchet*, obtained; by which the lord of the manor was intitled to the firſt night's habitation with his tenants' bride.

BRIDEWELL, denotes a work-houſe for the correction and labour of whores, rogues, and vagrants. Bridewell near Fleet-ſtreet, is a foundation of a mixt and ſingular nature, partaking of the hoſpital, the priſon, and work-houſe; it was founded in 1553, by Edward VI. who gave the place where King John had formerly kept his court, and which had been repaired by Henry VIII. to the city of London, with 700 marks of land, bedding, and other furniture. Several youths are ſent to this hoſpital as apprentices to manufacturers, who reſide there; they are clothed in blue doublets and breeches, with white hats. Having faithfully ſerved their time of ſeven years, they have their freedom, and a donation of ten pounds each for carrying on their reſpective trades.

BRIDLE, among *Surgeons*, is a kind of bandage contrived for retaining the lower jaw in its place.

Scolding BRIDLE, or BRANK, an inſtrument uſed in ſome parts of Scotland and in Staffordſhire, for correcting ſcolding women. It is a ſort of head-piece, which opens and incloſes the head of the impatient, while an iron, ſharp as a chiſſel, enters the mouth, and ſubdues the more dreadful weapon within. Thus harneſſed, the offender is led in triumph through the ſtreets. Dr. Plott, in his hiſtory of Staffordſhire, has favoured the world with a minute deſcription and figure of the inſtrument, which is there called a ſcolding-bridle; and tells us, he looks upon it "as much to be preferred to the ducking-ſtool, which not only endangers the health of the party, but alſo gives the tongue liberty betwixt every dip; to neither of which this is at all liable."

BRIG, or BRIGANTINE, a merchant-ſhip with two maſts. This term is not univerſally confined to veſſels of a particular conſtruction, or which are maſted and rigged in a manner, different from all others. It is variouſly applied, by the manners of different European nations, to a peculiar ſort of veſſel of their own marine. Amongſt Britiſh ſeamen, this veſſel is diſtinguiſhed by having her mainſails ſet nearly in the place of her keel; whereas the mainſails of larger ſhips are hung athwart, or at right angles with the ſhip's length, and faſtened to a yard which hangs parallel to the deck: but in a brig, the foremoſt edge of the mainſail is faſtened in different places to hoops which encircle the main-maſt, and ſlide up and down it as the ſail is hoiſted or lowered: it is extended by a gaff above, and a boom below. For the repreſentation, ſee the Treatiſe on Naval Affairs, Plate II. Fig. 5.

BRIGADE, in the *Military Art*, a party or diviſion of a body of ſoldiers, whether horſe or foot, under the command of a brigadier. See the Treatiſe, Sect. 3 and 4.

There are two ſorts of brigades, 1. A brigade of an army, which is a body of horſe of ten or twelve ſquadrons: or of foot, of five or ſix battalions.—And in this way, an army is ſometimes divided into eight brigades; four of horſe, and four of foot. 2. A brigade of a troop of guards, which is a third part thereof, when the troop conſiſts of fifty ſoldiers; but only a ſixth, when it conſiſts of a hundred: that is, in the former caſe, the troop is divided into three brigades; in the latter into ſix.

BRIGADIER-*general*, an officer that commands a brigade of horſe or foot in any army. The brigadier is an officer of importance; being the next in order below a major-general. Brigadiers are only general officers in their reſpective corps. They have no particular command out of their brigades, nor any place or vote in councils of war; they have no aids de camp to carry their orders, but only a major of brigades to ſee their orders executed, within the extent only of their own brigade.

BRIMSTONE. For its nature and properties ſee SULPHUR, and Syſtem of CHYMISTRY, Part I. Sect. 2.

BRINE, or PICKLE; water replete with ſaline particles. Brine taken out of brine-pits, or brine-pans, uſed by ſome for curing or pickling of fiſh, without boiling the ſame into ſalt; and rock-ſalt, without refining it into white ſalt; are prohibited by 1 Ann. cap. 21. Brine is either native, as the ſea-water, which by coction turns to ſalt; or factitious, formed by diſſolving ſalt in water. In the ſalt works at Upwick in Worceſterſhire, there are found, at the ſame time, and in the ſame pit, three ſorts of brine, each of a different ſtrength. They are drawn by a pump; and that in the bottom, firſt brought up, is called *firſt man*; the next, *middleman*; and the third, *laſt man*.

LEACH *Brine*, a name given to what drops from the corned ſalt in draining and drying, which they preſerve and boil again: being ſtronger than any brine in the pit. There is ſand found in all the Staffordſhire brines after coction; but naturaliſts obſerve, it did not pre-exiſt in the water, but rather is the product of the boiling. Some ſteep their ſeed-wheat in brine, to prevent the ſmut. Brine is alſo commended as of efficacy againſt gangrenes.

BRINE-PANS, the pits wherein the ſalt-water is retained, and ſuffered

ſuffered to ſtand, to bear the action of the ſun, whereby it is converted into ſalt. There are divers ſorts of ſalt-pans, as the water-pan, ſecond-pan, ſun-pan; the water being transferred orderly from one to another.

BRINE-PIT, in ſalt-making, the ſalt ſpring from whence the water to be boiled into ſalt is taken. There are of theſe ſprings in many places; that at Namptwich in Cheſhire, is alone ſufficient, according to the account of the people of the place, to yield ſalt for the whole kingdom; but it is under the government of certain lords and regulators, who, that the market may not be overſtocked, will not ſuffer more than a certain quantity of the ſalt to be made yearly. See the next article.

BRINE SPRINGS, are fountains which flow with ſalt-water inſtead of freſh. Of theſe there are a good number in South Britain, but though not peculiar to this iſland, are far from being common in the countries on the continent. There are ſome of them in ſeveral different counties; and perhaps, on a due ſearch, others might be diſcovered. The moſt remarkable of theſe already known, are, one at Eaſt-Chennock in Somerſetſhire, about 20 miles from the ſea. Another at Leamington in Warwickſhire, very near the river Learn; which, however, is but weak. Such a ſpring likewiſe runs into the river Cherwell in Oxfordſhire: and ſeveral more in Weſtmoreland and Yorkſhire: but as they are but poor, and the fuel in moſt of thoſe counties ſcarce and dear, no ſalt is prepared from them. At Barrowdale, near Grange, three miles from Keſwick in Cumberland, a pretty ſtrong ſpring riſes in a level near a moſs, 16 gallons of water of which yield one of pure ſalt; which is the more remarkable, when it is conſidered that the ſame quantity of ſalt cannot be obtained from leſs than 22 gallons of the waters of the German ocean. At a place called *Salt-water Haugh*, near Butterpy, in the biſhopric of Durham, there are a multitude of ſalt ſprings which riſe in the middle of the river Weare, for the ſpace of about forty yards in length, and ten in breadth; but particularly one out of a rock, which is ſo ſtrong, that in a hot ſummer's day, the ſurface will be covered with a pure white ſalt. At Weſton, in Staffordſhire, there are brine-pits which afford about a ninth part of very fine ſalt. There are others at Enſon, St. Thomas, and in the pariſh of Ingeſtre, but ſo weak that they are not wrought; though it is believed, that by boring, ſtronger ſprings might be found in the neighbourhood. In Lancaſhire there are ſeveral ſalt ſprings, but, (if we except that at Barton, which is as rich as the ſpring at Northwich) by no means ſo famous as thoſe of Cheſhire, called in general by the name of the *wiches*. Namptwich, on the river Weever, has a conſiderable ſpring not far from the river, which is ſo rich, as to yield one ſixth-part of pure white ſalt. At ſix miles diſtance ſtands Northwich, at the confluence of the Weever and the Dan; where the brine is ſtill richer, ſince they obtain ſix ounces of ſalt from ſixteen of water. There are, even at this day, ſome viſible remains of a Roman cauſeway between theſe two towns. The inhabitants of Wales, who, before that country was incorporated into England, were ſupplied chiefly, if not ſolely, with that neceſſary commodity from theſe two towns, called the former *Halleth Wen*, and the latter *Halleth Du*; i. e. the white and black ſalt-pit. In 1670, a rock of ſalt was diſcovered at a ſmall diſtance from Northwich, which has been wrought to a great depth, and to a vaſt extent, ſo as to be juſtly eſteemed one of the greateſt curioſities in England; and it is highly probable, that there is an immenſe body of foſſil ſalt in the bowels of the earth, under this whole county; ſince, upon boring, brine-pits have been found in many places on both ſides the river Weever. This is the more likely, ſince, at Middlewich, which ſtands at the confluence of the Croke and the Dan, there are ſalt ſprings with a freſh brook running between them. The brines from theſe pits are of unequal ſtrength; but when mixed, they commonly obtain four ounces of ſalt from a pound of brine. Experience ſhows, that in theſe ſprings the water is ſtrongeſt neareſt the bottom, richer in dry weather than in wet, and when long drawn than when firſt wrought. But theſe are no rules in reſpect to other ſalt ſprings, ſince in thoſe of Franche Compte the brine is ſtrongeſt in wet weather. There are ſeveral other bodies diſſolved in theſe brines beſides ſalt; in ſome a ſulphureous ſubſtance, which ſublimes as the brine heats; a ſort of dirty ochre which diſcolours the brine, but, if ſuffered to ſtand, ſpeedily ſubſides; and in moſt brines a calcareous, or rather ſelenetic earth, which ſettles to the bottom of the pans.

BRINING of *Corn*, in huſbandry, an operation performed on the wheat-ſeed, in order to prevent the ſmut. A liquor is to be prepared for this purpoſe, by putting 70 gallons of water into a tub (like a maſh-tub uſed for brewing), and a corn-buſhel of unſlacked limeſtone. This is to be well ſtirred till the whole is diſſolved, and left to ſtand for 30 hours; after which it is to be drained off into another tub, in the manner practiſed for beer. In this way about a hogſhead of ſtrong lime-water will be obtained, to which muſt be added three pecks of ſalt. The wheat muſt be ſteeped in this pickle, by running it gently, and in ſmall quantities, into a broad-bottomed baſket of about 24 inches in diameter, and 20 inches deep, and ſtirring it. The light ſeed that floats muſt be ſtrained off with a ſtrainer, and muſt not be ſown. When the baſket has been drawn up, and drained of the pickle, the wheat will be fit for ſowing in two hours after the brining. See the Syſtem of AGRICULTURE, Sect. 3.

BRISTOL-WATER. Of the four principal warm waters naturally produced in England, this is the leaſt ſo. As the Bath waters are proper where the ſecretions are defective, ſo the Briſtol water is of ſervice where they exceed the requirements of health. The Bath water warms; the Briſtol cools. Bath water helps the ſtomach, inteſtines, and nerves; the Briſtol favours the lungs, kidneys, and bladder. Except a jaundice attend, the Briſtol water may be of uſe in dropſies, by its drying and diuretic qualities. Dr. Wynter aſſerts, that there is no iron in Briſtol water; and that its mineral contents are chalk, lapis calcareus, and calaminaris. Five gallons of this water, after evaporation, afforded only 3 iii. and gr. ii. of a mineral-like ſubſtance. The diſeaſes in which this water is uſeful, are internal hæmorrhagies, immoderate menſes, internal inflammations, ſpitting blood, dyſentery, purulent ulcers of the viſcera, conſumption, dropſy, ſcurvy with heat, ſtone, gravel, ſtrangury, habitual gout, atrophy, ſlow fever, ſcrophula, gleets, and diabetes, in which laſt it is a ſpecific, and may be drank as freely as the thirſt requires it. The hotter months are the beſt for uſing it. The Briſtol and Matlock waters are of exactly the ſame qualities. Doctors Mead and Lane, firſt eſtabliſhed the reputation of Briſtol waters in diſeaſes of the kidneys and bladder. For a more copious account of this Water, ſee the Article WATER.

BRITTLENESS, in *Natural Philoſophy*, that quality of bodies by which they are ſoon and eaſily broken by preſſure or percuſſion. It ſtands oppoſed to TENACITY. Brittle bodies are extremely hard; the leaſt percuſſion exerts a force on them equivalent to the greateſt preſſure, and may conſequently eaſily break them. This effect is particularly remarkable in glaſs ſuddenly cooled, the brittleneſs of which is thereby much increaſed. TIN, though in itſelf tough, gives a brittleneſs to all the other metals, when mixed therewith. The brittleneſs of GLASS ſeems to ariſe from the heterogeneity of the parts whereof it is compoſed, ſalt and ſand, which can never bind intimately together. In TIMBER, brittleneſs ſeems to be connected with durableneſs; the more brittle any ſort of wood is, the more laſting it is found. Thus it is oak is of ſo long duration, while beech and birch, as being tough, preſently rot, and are of little ſervice for building.

BROAD-*caſt*, as oppoſed to the *Drill-Huſbandry*, denotes the method of cultivating corn, turnips, pulſe, clover, the foreign graſſes, and moſt other field plants, that are not tranſplanted, by ſowing them with the hand at large; in which method they are ſown over the ground at large, and thence ſaid to be ſown in *broad-caſt*. This is called the *Old Huſbandry*, to diſtinguiſh it from the *Drill*, *Horſe-hoeing*, or *New Huſbandry*. For the methods of ſowing and other means of diſpoſing ſeeds in the earth, ſee the Syſtem of AGRICULTURE, Sect. 27.

BROCCOLI, among *Gardeners*, the ſhoot of a ſort of cabbage. There are ſeveral ſorts of it, as the Roman, the Neapolitan, and the black; but the Roman is far the beſt, and is therefore the only ſort now in uſe. For a particular deſcription, and the method of cultivation, ſee the Article BRASSICA. See alſo the Treatiſe on GARDENING, Article *Kitchen Garden*, months April and July.

BROKER. BROKERS are of three kinds; *exchange-brokers*, *ſtock-brokers*, and *pawn-brokers*.

Exchange-BROKERS, are a ſort of negotiators, who contrive, make, and conclude bargains between merchants and tradeſmen, in matters of money or merchandiſe, for which they have a fee or premium. See EXCHANGE.

Theſe in our old Engliſh law-books, are called *broggers*, and in Scotland, *broccarii*, i. e. according to Skene, mediators or interceſſors in any contract, &c.

They make it their buſineſs to know the alteration of the courſe of Exchange, to inform merchants how it goes, and to notify to thoſe who have money to receive or pay beyond ſea, who are proper perſons for negotiating the exchange with; and when the matter is accompliſhed, that is, when the money is paid, they have, for brokage, two ſhillings per 100 pounds ſterling.

Theſe, by the ſtatute of 8 and 9 William III. are to be licenſed in London, by the lord-mayor; and any perſon acting without ſuch a licence, is liable to the forfeiture of 500l. and perſons employing them forfeit 50l. They are alſo to regiſter contracts, &c. under the like penalty; and not to deal for themſelves on pain of forfeiting 200l. They are likewiſe to carry about with them a ſilver medal, having the king's arms, and the arms of the city, &c. and to pay 40s. a year to the chamber of the city. 6 Ann. cap. 16.

Stock-BROKERS are thoſe who are employed to buy and ſell ſhares in the joint ſtock of a company or corporation, and alſo in the public funds. As the practice of ſtock-jobbing has been carried to ſuch an exceſs, as became not only ruinous to a great number of private families, but even affected, or at leaſt might

ſoon affect the public credit of the nation, the legiſlature thought fit to put a ſtop to it, or at leaſt to bring it within certain bounds, and under ſome regulation. The negotiations, &c. of theſe brokers, are regulated by ſtat. 6 Geo. I. cap. 18. and 7 and 10 Geo. II. cap. 8. which, among other things, enact, that contracts in the nature of wagers, &c. incur a penalty of 500l. and by the ſale of ſtock, of which the ſeller is not poſſeſſed, a forfeit of 100l. and that brokers keep a book, in which all contracts, with their dates, and the names of the parties concerned, ſhall be entered, on pain of 50l.

The Jews, Armenians, and Banians, are the chief brokers throughout moſt parts of the Levant and the Indies. In Perſia, all affairs are tranſacted by a ſort of brokers whom they call *delal*, i. e. *great talkers*. The manner of making their markets is very ſingular: after the brokers have launched out into long, and uſually impertinent diſcourſes, coming towards a concluſion, they only converſe with their fingers. The buyer and ſeller's broker, each take the other by the right hand, which they cover with their coat, or a handkerchief: the finger ſtretched out, ſtands for ſix; bent, for five; the tip of the finger for one; the whole hand for 100; and the hand clenched for 1000. They will expreſs even pounds, ſhillings, and pence, by their hands. During all this myſtic commerce, the two brokers appear as cold and compoſed, as if there were nothing paſſing between them.

The French, prior to the Revolution, diſtinguiſhed two kinds of brokers; one for the ſervice of merchants, the other for manufacturers, artificers, and workmen. The buſineſs of the former, was to facilitate the ſale of goods in the wholeſale and mercantile way; that of the other, to procure the goods wanted for manufacturers, artificers, &c. or to ſell their goods when made. At Paris, there was ſcarce a company of tradeſmen, or even mechanics, but had their brokers, who were uſually taken out of their body, and made it their ſole buſineſs to negotiate in the particular kinds of goods to which ſuch company were by ſtatutes reſtrained. There were brokers for drapery, brokers for grocery, brokers for mercery, &c. There were even brokers for tanners, curriers, cutlers, and the like. Dict. of Commerce.

PAWN-*brokers*, are perſons who keep ſhops, and let out money to neceſſitous people upon pledges, for the moſt part on uſurious conditions.

Theſe are more properly called *pawn-takers* or *tally-men*, ſometimes *fripers*, or *friperers*.

Of theſe is to be underſtood the ſtatute of 1 Ja. 1. cap. 21. by which it is enacted, that the ſale of goods wrongfully gotten, to any broker in London, Weſtminſter, Southwark, or within two miles of London, ſhall not alter the property thereof.—If a broker, having received ſuch goods, ſhall not, upon the requeſt of the right owner, truly diſcover them, how and when he came by them, and to whom they are conveyed, he ſhall forfeit double the value thereof to the ſaid owner.

In the cities of Italy, there are companies eſtabliſhed by authority for the letting out money in pawns: called, *mounts of piety*; an honourable title, like that of the *charitable corporation*, but little becoming ſuch inſtitutions; inaſmuch as the loan is not gratis. In ſome parts of Italy, they have likewiſe *mounts of piety*, of another kind, wherein they only receive ready money, and return it again, with intereſt, at ſo much *per annum*. At Bologna they have ſeveral ſuch *mounts*; which are diſtinguiſhed into *frank* and *perpetual*: the intereſt of the former is only four *per cent.* in the latter, ſeven.

BROMELIA, the PINE-APPLE: A genus of the Monogynia order, belonging to the Hexandria claſs of plants.

Species. Of this genus Linnæus enumerates ſeven ſpecies; but the following are the moſt remarkable. I. The ananas; of which there are ſix varieties, viz. 1. The Ovatus, or oval-ſhaped pine-apple. 2. The pyramidalis, pyramidal, or ſugar-loaf pine. 3. The glaber, with ſmooth leaves. 4. The lucidus, with ſhining green leaves. 5. The ſerrotinus, with a yelloviſh coloured fleſh. 6. The viridis, or green pine-apple. The other ſpecies are, II. The mudicaulis, with the lower leaves indented and prickly. III. The lingulata, with obtuſe, ſawed, and prickly leaves.—The firſt ſort hath leaves very like ſome ſorts of aloes, but not ſo thick and ſucculent, which are ſtrongly armed with black ſpines. From the centre of the plant ariſes the flower-ſtalk, which is near three feet high, the lower part of which is garniſhed with entire leaves placed alternately at every joint. The upper part of the ſtalk is garniſhed with flowers ſet in a looſe ſpike or thyrſe quite round: theſe are ſucceeded by oval ſeed-veſſels, having a longitudinal partition, in the centre of which are faſtened ſmooth cylindrical ſeeds.—The ſecond has ſhorter leaves than the firſt, which are ſharply ſawed on their edges, and of a green deep colour. The flower-ſtem ariſes from the centre of the plant, which divides upward into ſeveral branches: the upper part of theſe are garniſhed with ſpikes of flowers, which come out alternately from the ſides of the branches, each having a narrow entire leaf juſt below it, which are longer than the ſpike. The flowers are placed very cloſe on the ſpikes; and when they decay, the empalement turns to an oval pointed ſeed-veſſel, incloſing ſeeds of the ſame ſhape with the other.

Culture, &c. The firſt ſort of ananas is the moſt common in Europe, but the ſecond ſort is much preferable to it, the fruit of this being larger and much better flavoured: the juice of this ſort is not ſo aſtringent as that of the firſt; ſo that this fruit may be eaten in greater quantity with leſs danger. This ſort frequently produces ſuckers immediately under the fruit, whereby it may be increaſed much faſter than the common ſort; ſo that in a few years it may be the beſt common ſort in Britain.—The third ſort is preſerved by ſome curious perſons for the ſake of variety; but the fruit is not worth any thing.—This ſort with very ſmooth graſs-green leaves was raiſed from ſeeds taken out of a rotten fruit which came from the Weſt Indies to the late Henry Heathcote, Eſq. from whom Mr. Miller received one plant, which produced large fruit: this is what the people of America call the *king-pine*.

The plants are propagated by planting the crowns which grow on the fruit, or the ſuckers which are produced either from the ſides of the plants or under the fruit: both which are found to be equally good; although by ſome perſons the crown is thought preferable to the ſuckers, as ſuppoſing it will produce fruit ſooner than the ſuckers, which is certainly a miſtake. The ſuckers and crowns muſt be laid to dry in a warm place for four or five days, or more (according to the moiſture of the part which adhered to the old plant or fruit); for if they are immediately planted, they will rot. The certain rule of judging when they are fit to plant, is by obſerving if the bottom is healed over and become hard; for if the ſuckers are drawn off carefully from the old plants, they will have a hard ſkin over the lower part, ſo need not lie ſo long as the crowns of thoſe whoſe bottoms are moiſt. But whenever a crown is taken from the fruit, or the ſuckers from old plants, they ſhould be immediately diveſted of their bottom leaves, ſo high as to allow depth for their planting; ſo that they may be thoroughly dry and healed in every part, leſt when they receive heat and moiſture they ſhould periſh, which often happens when this method is not obſerved. If theſe ſuckers or crowns are taken off late in the autumn, or during the winter, or early in the ſpring, they ſhould be laid in a dry place in the ſtove for a fortnight or three weeks before they are planted; but in the former ſeaſon, they will be fit for planting in a week at fartheſt.

Theſe ſhould be planted in a rich good kitchen-garden mould not too heavy ſo as to detain the moiſture too long, nor over light and ſandy; but where this is wanting, you ſhould procure ſome freſh earth from a good paſture, which ſhould be mixed with about a third part of rotten neats dung, or the dung of an old melon or cucumber bed which is well conſumed. Theſe ſhould be mixed ſix or eight months before they are uſed, but if it be a year it will be the better; and ſhould be often turned, that their parts may be the better united, as alſo the clods well broken. This earth ſhould not be ſcreened very fine; for if you only clear it of the great ſtones, it will be better for the plants than when it is made too fine. You ſhould always avoid mixing any ſand with the earth, unleſs it be extremely ſtiff, and then it will be neceſſary to have it mixed at leaſt ſix months or a year before it is uſed; and it muſt be frequently turned, that the ſand may be incorporated in the earth ſo as to divide its parts: but you ſhould not put more than a ſixth part of ſand; for too much ſand is very injurious to theſe plants. In the ſummer ſeaſon, theſe plants muſt be frequently watered; but you ſhould not give them large quantities at a time: you muſt alſo be very careful that the moiſture is not detained in the pots by the holes being ſtopped, for that will ſoon deſtroy the plants. If the ſeaſon is warm, they ſhould be watered twice a week; but in a cool ſeaſon once a-week will be often enough: and during the ſummer ſeaſon, you ſhould once a-week water them gently all over their leaves, which will waſh the filth from off them, and thereby greatly promote the growth of the plants.

There are ſome perſons who frequently ſhift theſe plants from pot to pot. But this is by no means to be practiſed by thoſe who propoſe to have large well-flavoured fruit: for unleſs the pots be filled with the roots, by the time the plants begin to ſhow their fruit, they commonly produce ſmall fruit, which have generally large crowns on them; therefore the plants will not require to be new potted oftener than twice in a ſeaſon. The firſt time ſhould be about the end of April, when the ſuckers and crowns of the former year's fruit which remained all the winter in thoſe pots in which they were firſt planted, ſhould be ſhifted into larger pots; *i. e.* thoſe which were in half-penny or three-farthing pots ſhould be put into penny, or at moſt three half-penny pots, according to the ſize of the plants; for you muſt be very careful not to over-pot them, nothing being more prejudicial to theſe plants. The ſecond time for ſhifting of them is in the beginning of Auguſt; when you ſhould ſhift thoſe which are of a proper ſize for fruiting the following ſpring into two-penny pots, which are full large enough for any of theſe plants. At each of theſe times of ſhifting the plants, the bark-bed ſhould be ſtirred up, and ſome new bark added, to raiſe the bed up to the height it was at firſt made; and when the pots are plunged again into the bark-bed, the plants ſhould be watered gently all over their leaves, to waſh off the filth, and to

ſettle

ſettle the earth to the roots of the plants. If the bark-bed be well ſtirred, and a quantity of good freſh bark be added to the bed, at this latter ſhifting, it will be of great ſervice to the plants, for they may remain in the ſame tan until the beginning of November, or ſometimes later, according to the mildneſs of the ſeaſon, and will require but little fire before that time. During the winter, they will not require to be watered oftener than once a week, according as you find the earth in the pots to dry: nor ſhould you give them too much at each time; for it is much better to give them a little water often, than to overwater them. You muſt obſerve never to ſhift thoſe plants which ſhow their fruit, into other pots; for if they are removed after the fruit appears, it will ſtop the growth, and thereby cauſe the fruit to be ſmaller, and retard its ripening, ſo that many times it will be October or November before the fruit is ripe: therefore you ſhould be very careful to keep the plants in a vigorous growing ſtate from the firſt appearance of the fruit, becauſe upon this depends the goodneſs and the ſize of the fruit; for if they receive a check after this, the fruit is generally ſmall and ill-taſted.—When you have cut off the fruit from the plant whoſe kind you are deſirous to propagate, you ſhould trim the leaves, and plunge the pots again into a moderate hot-bed, obſerving to refreſh them frequently with water, which will cauſe them to put out ſuckers in plenty; ſo that a perſon may be ſoon ſupplied with plants enough of any of the kinds, who will but obſerve to keep the plants in health. The moſt dangerous thing that can happen to theſe plants is their being attacked by ſmall white inſects, which appear at firſt like a white mildew, but ſoon after have the appearance of lice: theſe attack both root and leaves at the ſame time; and if they are not ſoon deſtroyed, will ſpread over a whole ſtove in a ſhort time, and in a few weeks entirely ſtop the growth of the plants by ſucking out the nutritious juice, ſo that the leaves will appear yellow and ſickly, and have generally a great number of yellow tranſparent ſpots all over them. Theſe inſects, after they are fully grown, appears like bugs, adhering ſo cloſely to the leaves as not to be eaſily waſhed off, and ſeem to have no local motion. They were originally brought from America, upon the plants which were imported from thence; and are probably the ſame inſects which have deſtroyed the ſugar canes in ſome of the Leeward Iſlands, for upon ſome ſugar-canes which were ſent Mr. Miller from Barbadoes, he obſerved great numbers of theſe inſects. Since they have been in England, they have ſpread greatly in ſuch ſtoves where there has not been more than ordinary care taken to deſtroy them. They have alſo attacked the orange-trees in many gardens near London, and have done them incredible damage; but they do not endure the cold of our climate in winter, ſo that they are never found on ſuch plants as live in the open air. The only method yet diſcovered for deſtroying theſe inſects, is by frequently waſhing the leaves, branches, and ſtems, of ſuch plants as they attack, with water in which there has been a ſtrong infuſion of tobacco ſtalks. But this method cannot be practiſed on the ananas plants, becauſe the inſects will faſten themſelves ſo low between the leaves, that it is impoſſible to come at them with a ſponge to waſh them off; ſo that if all thoſe which appear to ſight are cleared off, they will ſoon be ſucceeded by a freſh ſupply from below, and the roots will be alſo equally infeſted at the ſame time. Therefore, wherever theſe inſects appear on the plants, the ſafeſt method will be to take the plants out of the pots, and clear the earth from the roots; then prepare a large tub, which ſhould be filled with water in which there has been a ſtrong infuſion of tobacco ſtalks; into this tub you ſhould put the plants, placing ſome ſtick acroſs the tub to keep them immerſed in water. In this water they ſhould remain 24 hours; then take them out, and with a ſponge waſh off all the inſects from the leaves and roots, and dip the plants into a tub of fair water, waſhing them therein, which is the moſt effectual way to clear them from the inſects. After which, you ſhould pot them in freſh earth; and, having ſtirred up the bark-bed, and added ſome new tan to give a freſh heat to the bed, the pots ſhould be plunged again, obſerving to water them all over the leaves, and this ſhould be repeated once a-week during the ſummer ſeaſon; for theſe inſects always multiply much faſter where the plants are kept dry, than where they are ſometimes ſprinkled over with water, and kept in a growing ſtate. As theſe inſects are frequently brought over from America on the ananas plants which come from thence, thoſe perſons who procure their plants from thence, ſhould look carefully over them when they receive them, to ſee they have none of theſe inſects on them; for if they have, they will ſoon be propagated over all the plants in the ſtove where they are placed; therefore, whenever they are obſerved, the plants ſhould be ſoaked (as before directed) before they are planted into pots.

Such are the directions generally given with regard to the culture of the pine-apple in this country. Of late, however, ſome very conſiderable improvements have been made in that article. The leaves of the oak have been ſubſtituted for the more expenſive bark; and by treating the pines with them, they are found to thrive as well, and to produce as good fruit, as in the other method: of the proper way of managing theſe leaves for the rearing of exotic plants, an account is given under the article *Oak-Leaves*. But the moſt conſiderable improvement is that mentioned in the 67th volume of the Philoſophical Tranſactions, where a method is ſhown by William Baſtard, Eſq. of Devonſhire, of raiſing theſe fruits in water. His account of this method is as follows.

"Before I enter into the particulars of raiſing pine-apples in water, it will be neceſſary to tell you that my out-houſe is covered with the beſt crown-glaſs, which I apprehend gives more heat than the common ſort of green glaſs generally uſed for hot-houſes. In the front part of the houſe, and indeed any where in the loweſt parts of it, the pine-apple plants will not thrive well in water. The way in which I treat them is as follows. I place a ſhelf near the higheſt part of the back wall, ſo that the pine-plants may ſtand abſolutely without touching the glaſs, but as near it as can be; on this ſhelf I place pans full of water, about ſeven or eight inches deep; and in theſe pans I put the pine-apple plants, growing in the ſame pots of earth as they are generally planted in to be plunged into the bark-bed in the common way; that is, I put the pot of earth, with the pine-plant in it, in the pan full of water, and as the water decreaſes, I conſtantly fill up the pan. I place either plants in fruit, or young plants as ſoon as they are well rooted, in theſe pans of water, and find they thrive equally well: the fruit reared this way is always much larger, as well as better flavoured, than when ripened in the bark-bed. I have more than once put only the plants themſelves without any earth, I mean after they had roots, into theſe pans of water, with only water ſufficient to keep the roots always covered, and found them flouriſh beyond expectation. In my houſe, the ſhelf I mention is ſupported by irons from the top, and there is an intervening ſpace of about 10 inches between the back wall and the ſhelf. A neighbour of mine has placed a leaden ciſtern upon the top of the back flue (in which, as it is in contact with the flue, the water is always warm when there is fire in the houſe), and finds his fruit excellent and large. My ſhelf does not touch the back flue, but is about a foot above it; and conſequently the water is only warmed by the air in the houſe. Both theſe methods do well. The way I account for this ſucceſs is, that the warm air always aſcending to the part where this ſhelf is placed, as being the higheſt part of the houſe, keeps it much hotter than in any other part. The temperature at that place is, I believe, ſeldom leſs than what is indicated by the 73d degree of Farenheit's thermometer, and when the ſun ſhines it is often at above 100: the water the plants grow in ſeems to enable them to bear the greateſt heat, if ſufficient air be allowed; and I often ſee the roots of the plants growing out of the holes in the bottom of the pot of the earth, and ſhooting vigorouſly in the water.

"My hot-houſe (the dimenſions of which it may be proper to know) is 60 feet long and 11 feet wide, the flues included; ſix feet high in the front, and 11 feet at the back of the inſide of the houſe. It is warmed by two fires. A leaden trough or ciſtern on the top of the back flue is preferable to my ſhelf, as in it the pine-plants grow much faſter in the winter, the water being always warmed by the flue: of this I have ſeen the great benefit theſe laſt two months in my neighbourhood. It is not foreign to this purpoſe to mention, that, as a perſon was moving a large pine-plant from the hot-bed in my houſe laſt ſummer, which plant was juſt ſhowing fruit, by ſome accident he broke off the plant juſt above the earth in which it grew, and there was no root whatever left to it; by way of experiment I took the plant, and fixed it upright in a pan of water (without any earth whatever) on the ſhelf; it there ſoon threw out roots, and bore a pine-apple that weighed upwards of two pounds." For a further account of the cultivation of pines, ſee the concluſion of the Syſtem of Gardening.

BRONCHIA, in *Anatomy*, the little tubes into which the *trachea* is branched, at its entrance into the lungs; and which are diſtributed through every part thereof, ſerving for the conveyance of the air in reſpiration. The *bronchia* conſiſts of cartilages like the *trachea*; only here the cartilages are perfectly circular, without any membranous hard part; they are joined together by the membranes that inveſt them, and are capable of being ſhot out lengthwiſe in inſpiration; and of being drawn into each other in expiration. See the Syſtem, Part IV. Sect. 5.

BRONCHIAL *artery*, is an artery of the lungs, which ariſes from the deſcending trunk of the *aorta*, or intercoſtals: and, embracing the *trachea*, purſues the courſe of the *bronchia*, accompanying all the branches thereof through their whole progreſs. The artery brings blood to the *bronchia*, for the nutrition thereof, and of the veſicles of the lungs: and the vein carries it off again to the *cava*, where it ſoon terminates. The *bronchial* artery is ſometimes ſingle, but more frequently double; ſometimes triple. See the Syſtem, Part V. Sect. 1.

BRONCHIAL *glands*, are a ſoft ſucculent, blackiſh ſort of glands, adhering externally to the lower part of the *trachea*, the greateſt diviſions of the *bronchia* and the *æſophagus*, ſome larger ſome ſmaller; ſaid to be diſcovered by Verheven. Their uſe is uncertain; the generality hold them to furniſh an unctuous liquor, to moiſten and line the inſide of the *bronchia*. Verceillon will rather have them to ſecrete a juice for the ſervice of digeſtion,

tion, conveyed by minute ducts to the *æſophagus* and ſtomach; which, however, is called in queſtion by Heiſter. Verheyen is of opinion, that the hoarſeneſs which ariſes from a cold, may proceed from the obſtruction of theſe glands; and that the benefit which accrues from taking oil of almonds, or other ſmooth medicaments, may proceed from their ſupplying the defect of this juice, and lubricating artificially the inſide of the *bronchia*. But it ſhould rather ſeem, that the humidity furniſhed to the *trachea* and *bronchia*, comes from the miliary glands of thoſe parts, which are only lymphatics, and become tumid in morbid caſes, inſomuch that they frequently preſs the wind-pipe, or ſome of its branches, and cauſe an aſthma. See the Syſtem, Part IV. Sect. 5.

BRONCHIAL *vein* ariſes from the intercoſtals, or the azygos, accompanies the artery, and divides into the ſame number of branches with it. See the Syſtem, Part V. Sect. 1.

BRONCHOCELE, a pendent tumour, with a large round neck, riſing on the bronchial part of the *trachea*. The word is formed from βρογχος, *wind pipe*, and κηλη, *ſwelling*. The *bronchocele* is common in Lombardy, Savoy, and about the Alps; whence Horace,

Quis tumidum guttur miratur in Alpibus.

It is commonly ſuppoſed to derive its origin from the Alpine waters, which being impregnated and chilled with ice and ſnow, cauſes a *lentor* of the *lympha*, about the muſcles of the throat, whereby the veſſels are contracted, and the circulating humours thickened, whence an obſtruction, &c. Though there are ſome ſpecies of it ſuppoſed alſo to riſe from ſtrains, bruiſes, and other accidents. Several phyſicians have now rejected the notion that wens of this kind are owing to the uſe of ſnow-water. For in Greenland, where ſnow-water is commonly uſed, theſe unſightly protuberances are never met with; nor are they ſeen in Weſtmoreland, where the mountains are higher and the ſnow greater in quantity than in Derbyſhire, where they are common. Beſides, they are common in Sumatra, where there is no ſnow during any part of the year. Phil. Tranſ. vol. lxviii. part i. p. 165. The *bronchocele* has been called by ſome *hernia guttu-ralis*, or *bronchialis*, *gutteria*, and *gongrona*. Some medical writers have confounded it with the *ſtruma*, *ſcrophula*, or king's evil, and others have made it only a ſpecies of STRUAMA. It has been deſcribed by Celſus, Albucaſis, Heiceſter, and many latter writers. Some aſcribe it to a rupture of a lymphatic veſſel; others to ſome extravaſated, nutritious juice, converted into a fleſhy ſubſtance; and the tumour has been obſerved to conſiſt partly of a fluid, and partly of a more firm and glandular ſubſtance; but its conſiſtence is different in different caſes. The Engliſh *bronchocele*, as Mr. Proſſer has termed it, or as it is otherwiſe called, the *Derby-neck*, becauſe many of the women in the hills of Derbyſhire are ſubject to it, is a tumour ariſing on the fore-part of the neck, ſeated in the body of the neck, between the ſkin and wind-pipe, in the thyroid gland; and thus differs from the former, or Alpine *bronchocele*, which commonly hangs under the chin like dew-laps. Mr. Proſſer diſtinguiſhes it alſo from the ſimilar diſeaſe, which is cauſed by loud crying, coughing, or other means ſtraining the neck; this, he ſays, is incurable; whereas the other, called the natural or ſpontaneous *bronchocele*, is eaſily cured by proper and timely application. Dr. Hunter has obſerved, that it appears two or three years before or after menſtruating; and Mr. Proſſer has made the ſame obſervation, that it commonly appears firſt between the age of eight or twelve years. When the menſtruation approaches kindly, it ſometimes ſpontaneouſly diſappears. This diſeaſe is almoſt peculiar to women; it is ſoft, or rather flabby to the touch, and moveable; but when it is continued for ſome years after the time of its growing, it becomes more firm. It is attended with a conſiderable difficulty of breathing, in ſome caſes, to ſuch a degree as to occaſion a bad wheezing. The ſituation of this tumour is ſuch, that all attempts to extirpate it are extremely dangerous, and therefore the only method of cure is by diſcuſſion. The moſt celebrated remedy for this diſorder is one which is prepared and ſold at Coventry, and which Mr. Proſſer believes conſiſts of equal parts of ſponge, cork, and pumice-ſtone, calcined; half a dram of this is mixed with ſugar, and made into a bolus, and laid under the tongue every night. Mr. Proſſer recommends the following powders:

℞ Cinnab. Antimon. opt. levig. ℈j.
Milleped. pp. & pulv.
Spong. calcin, ää gr. xv. m. f. pulvis.

One of theſe is to be taken an hour or two before breakfaſt, for two or three weeks; and after the interval of about a fortnight, they are to be again renewed; and three of the following pills are to be taken at bed-time, during the ſecond courſe of the powders:

℞ Pil. Mercurial. ph. nov. ʒ ß.
Pil. No. 48. æquales.

The doſe is to be adjuſted to the age and conſtitution of the patient, who ſhould be prepared for this courſe by two or three previous purges, and avoid taking cold. If theſe means are uſed for about a month or ſix weeks, without any external application, he has no doubt of ſucceſs. However, the patient ſhould be under twenty-five years of age. At this age the cure is uncertain; but at a more advanced period of life much more improbable, and ſeldom or ever ſucceeds. Gooch, in his Medical Obſervations, mentions an *aqueous* BRONCHOCELE. Phil. Tranſ. No. 265. p. 681. Proſſer's Account and Method of Cure of the *Bronchocele*. 1771.

BRONCHOTOMY, in *Surgery*, the operation of cutting into the wind-pipe, to prevent ſuffocation, in the quinſy; or an inciſion made in the *trachea*, or wind-pipe, between two of its *annuli*, or rings, in order to give paſſage for the breath, when there is danger of ſuffocation, from an inflammation of the *larynx*, &c. The word comes from βρογχος, *wind-pipe*, and τεμνω, *I cut*.

Brochotomy, called alſo *Laryngotomy*, is thus performed.—The body of the patient being prepared, an inciſion is made between the third and fourth *annuli*, or rings, of the *aſperia arteria*, an inch below the bottom of the *larynx*; the ſkin and integuments divided, and the muſcles removed; a ſilver tube is applied, and the cauſe of the diſeaſe removed, and the wound healed; nouriſhing clyſters being applied in the mean time, if deglutition be impracticable. Dr. Muſgrave obſerves, that in all medicine there is not one method that works ſo great a change, for the better, in ſo ſhort a time. However, it is ſeldom practiſed, becauſe that gap which appears on the cutting a throat (the divided parts being then drawn towards their more fixed ends), together with the great efflux of blood when the jugulars and carotid arteries are alſo wounded, create in moſt men a dread of the operation, and make many believe all wounds of the *trachea* mortal.—The ſame author makes no ſcruple, however, to ſay it ought to be practiſed in quinſies, and other dangers of ſuffocation from cauſes of a like nature with them; from an extraordinary cure which he himſelf had wrought in this way. Bronchotomy is likewiſe recommended as the laſt thing to be done, in order to recover drowned people to life; and to this operation many have been indebted for their recovery. In the Philoſophical Tranſactions, vol. iii. part. ii. No. 81. there is an account of the caſe of a *cut throat*, that may ſerve to make us ſomewhat more ready and reſolute in the operation of *Bronchotomy* when it is neceſſary; ſuch is the very inference that Dr. Huxham, who relates it, draws from it. P. 515.

BRONZE, in *Chymiſtry*, a factitious metal, compounded of copper and tin, to which ſometimes other metallic ſubſtances are added, particularly *zinc*. It is brittle, hard, and ſonorous. It is employed for various uſes, as for making of bells, cannons, and ſtatues; and the proportions of the component metals are varied to ſuit the ſeveral purpoſes to which it is applied. This compound, like ſome others, is ſpecifically heavier than either of the metals taken ſeparately. A metalic maſs, compoſed of four fifths of copper and one-fifth part of tin, weights in water ſeven grains more than the ſame quantities of theſe two metals would together weigh in water if not allayed. This proves, that in the union of copper and tin there is a penetration of parts, the one metal entering into the pores of the other; and this is further confirmed by an obſervation of Mr. Tillet, member of the royal academy of ſciences. In his memoir concerning the ductility of metals, he takes notice, that when the mixture of copper and tin is made in the proportions above-mentioned, the colour of the copper is entirely annulled and covered by that of the tin, although the quantity of the firſt be four times greater; and this ſingular effect cannot be underſtood without admitting a total change in the ſize and diſpoſition of the pores of the compound metal.

Tin being leſs ſubject to ruſt than copper, bronze is alſo found to be leſs liable to be covered with verdigreaſe than pure copper is; and this is one reaſon why it is uſed for cannons, ſtatues, and works expoſed to the air and weather. The greater fuſibility of bronze than copper is alſo an advantageous property, and much facilitates the caſting of large works. See the Syſtem of CHYMISTRY, Part III. Chap. 1. Section 5.

BROOD, the young of fiſh and fowls. Malpighi had the curioſity to break ſeveral times all the eggs of a brood, one half an hour after another, and obſerve with a microſcope the ſucceſſive alteration produced therein till the moment of hatching; of all which he has given figures, curiouſly engraven.

BROODING, the act of a hen, or other bird, ſitting on a number of eggs, to keep them warm, till they hatch, or produce young ones. See HATCHING. In which ſenſe the word amounts to the ſame with *incubation*. There is a difference between the brooding of SNAKES and VIPERS; the former being oviparous, and the latter bringing forth their young alive.

BROOM, *Geniſta* in *Botany*. Among *Huſbandmen*, broom is conſidered as a weed very pernicious to the culture of lands; and, on that account, to be grubbed and deſtroyed. It roots deep, and, ſhedding no leaves, is continually ſucking the moiſture from the earth. The beſt method of deſtroying it, is the burning the land, then plowing it deep, and manuring it very well with dung and aſhes; the ſpreading on the land chalk or marle, or the manuring it with urine. If the ground be deſigned for paſture land, it is beſt to cut it cloſe to the ground in May, when the ſap is ſtrong in it. By this artifice, the roots are deſtroyed; whereas, in the common way of pulling up the young plants,

plants, ſome ſtrings will be left, and the leaſt of theſe will grow. Foddering of cattle upon broomy land, is one very good way of deſtroying the broom, their urine killing the roots, and their treading the land making it leſs proper for the roots of this plant; for the broom is never obſerved to grow in trodden places. This troubleſome and pernicious plant, is not, however, without its uſe to the farmer; for, when well laid, it will make an excellent and laſting kind of thatch for barns.

BROOM-*flowers* make a principal ingredient in divers medicated ales. Their aſhes are extolled for purging off waters in dropſies; in which reſpect, however, Dr. Quincy aſſures us, they are no better than any other lixivious aſhes.

Broom is an attenuant, abſtergent, and aperient. The juice of the green ſhoots of broom, or a ſtrong infuſion of them in wine is an excellent diuretic, and cleanſes the ureters and kidneys. If taken in large doſes it purges by ſtool, and therefore is doubly proper in dropſical caſes. The ſeed of broom is alſo a purge, and that of no weak kind, a dram and a half of it being a ſufficient doſe. The *lixivium* of broom with white wine is a powerful diuretic, but muſt be taken with caution. Some pickle the yellow buds with vinegar and ſalt, &c. after the manner of capers, from which they are then ſcarce to be diſtinguiſhed.

BRUTE, an ANIMAL deſtitute of the faculty and uſe of REASON. In which ſenſe, brute amounts to the ſame with BEAST. Brutes are the ſecond order of the claſs *Mammalia*, in the Linnæan ſyſtem; the character of which is, that they have no upper or under fore-teeth; their feet have long hoofs, not formed for ſwift or ſtately motion, and they maſticate their food. This order comprehends ſix genera, and ſeventeen ſpecies.

Among brutes, the monkey kind bears the neareſt reſemblance to man; and this, both in the external ſhape and internal ſtructure, though more in the former than the latter. In the monkey kind, the higheſt and the neareſt approaching the likeneſs of man, is the ORANG-OUTANG, or *homo ſylveſtris*. See the Syſtem and plate I.

The chief operation of a rational ſoul is judgment, by which we diſtinguiſh true from falſe; to which the memory and imagination are ſubſervient. But this cannot be aſcribed to brutes, ſince they do not make propoſitions. They are incapable of ſcience, for want of names and ſigns whereby to denote abſtract ideas; however, there is no talent peculiar to man, which we may not diſcover ſome reſemblance of in brutes, except ſpeech and curioſity. Is it any objection then to the reaſoning of brutes, that they have not the uſe of ſpeech, though, as a late author expreſſes it, they have all the organs neceſſary for that purpoſe; Budd. Annal. Phil. p. 102.

There is at leaſt a ſimilitude of ſpeech in brutes, for they know each other by their voices, and have their ſigns whereby they expreſs anger, joy, and other paſſions; thus a dog aſſaults in one ſtrain, fawns in another, howls in another, and cries when beaten in another. It is true, their ſpeech to us appears rude and inarticulate; but perhaps ours is the ſame in their ears. And if the voice of brutes be unintelligible to us, does not the ſame hold of the language of our own kind, till we have been inſtructed in it? The language of foreigners, what does it appear to us, but a confuſed unmeaning heap of ſounds? In fine, if laughter be peculiar to men, we ſee the image of it in brutes, ſignified by the motion of their ears, eyes, mouth, tongues, &c. Laſtly, what is ſo peculiar to man as foreſight of futurity; but have not beaſts this, which lay up ſtores with great care in their cells, as the ant, bee, &c. The generality of the antient philoſophers thought that brutes reaſoned: this, among the heathens, was the opinion of Anaxagoras, Plato, Porphyry, Celſus, Galen, Plutarch, and others. Among Chriſtians, Lactantius, and the whole body of Manichees and Gnoſtics: among the moderns, Valla, Sonnertus, Arriaga, Tho. Campanella, Gaſſendus, F. Daniel, and others, aſſert the ſame. Plutarch has a dialogue under this title, that brutes uſe reaſon. All the ſect of Pythagoras ſhould be of the ſame ſentiment, becauſe the *metempſychoſis* imports that human ſouls paſs into the bodies of brutes. Can any perſon, ſays Lactantius, deny that brutes have reaſon, when they often outwit man himſelf? Inſt. Div. liv. iii. cap. 10.

The Stoics holding that the Divine Being is diffuſed through all creatures, were neceſſitated to maintain the ſouls of brutes to be divine, and conſequently that they had reaſon. The ſceptics paralleled brutes with men. Sextus, more particularly, gives a compariſon between dogs and the human kind. The former excels the latter as to ſenſe; it has a quicker ſcent, whereby to purſue beaſts unſeen; it diſcovers them ſooner by the eye, and is more acute to hearing. Sext. Empir. Pyrrhon. lib. i. cap. 13.

A dog is not deſtitute of logic, as appears from Chryſippus's famous inſtance, who obſerved that a hound coming into a road which divides into three, makes choice of the third by virtue of an induction of ſyllogiſm; for that having ſcented the two ways by which the beaſt did not paſs, he run ſtraight upon the third without ſcenting it; where the reaſon is obvious: the beaſt paſſed either that way, or that way, or this way; but he neither paſſed that way, nor that way, and therefore this way. Stanley Hiſt Phil. p. 780.

That a dog is poſſeſſed of what they call internal reaſon appears from his chooſing things convenient, flying the hurtful, purſuing his food, and running away from the whip, and when wounded or ſick, acting prudently, as the circumſtances of his caſe, and his abilities and opportunities dictate. How many actions are to be obſerved of brutes, not to be accounted for without reaſon and argumentation? If we ſay that dogs, by long habits and force of rewards and puniſhments, may be taught many things; do not this teaching, docility, and remembrance of blows, argue memory, fear, and deſire, which cannot ſubſiſt without knowledge, ſenſe, pleaſure and pain? And if brutes have knowledge, it is allowed they muſt alſo have judgment and reaſon, and a ſcience of univerſals. Tavern. Trav. Ind. ap. Phil. Tranſ. No. 326. p. 65. Chauvin Lex. Phil. p. 377, &c.

The peripatetic philoſophers allowed them a ſenſitive power, but denied them a rational one. The Platoniſts, as is obſerved before, allowed them reaſon and underſtanding, though in a degree leſs pure and refined than that of men. Deſcartes maintained that brutes are mere inanimate machines, abſolutely deſtitute not only of reaſon, but of all thought and perception, and that all their actions are only conſequences of the exquiſite mechaniſm of their bodies. The opinion of Deſcartes was probably invented, or at leaſt adopted by him, to defeat two great objections: one againſt the immortality of the ſouls of brutes, if they were allowed to have any; the other againſt the goodneſs of God, in ſuffering creatures who had never ſinned, to be ſubjected to ſo many miſeries. The arguments in favour of it may be ſtated as follow: 1. It is certain, that a number of human actions are merely mechanical; becauſe they are done imperceptibly to the agent, and without any direction from the will; which are to be aſcribed to the impreſſion of objects and the primordial diſpoſition of the machine, wherein the influence of the ſoul has no ſhare; of which number are all habits of the body, acquired from the reiteration of certain actions. In all ſuch circumſtances, human beings are no better than automata. 2. There are ſome natural movements ſo involuntary, that we cannot reſtrain them; for example, that admirable mechaniſm ever on the watch to preſerve an equilibrium, when we ſtoop, bend, or incline our bodies in any way, and when we walk upon a narrow plank. 3. The natural liking for, and antipathy againſt, certain objects, which in children precede the power of knowing and diſcriminating them, and which ſometimes in grown perſons triumph over all the efforts of reaſon; are all phenomena to be accounted for from the wonderful mechaniſm of the body, and are ſo many cogent proofs of that irreſiſtible influence which objects have on the human frame. 4. Every one knows how much our paſſions depend on the degree of motion into which the blood is put, and the reciprocal impreſſions cauſed by the animal ſpirits between the heart and brain, that are ſo cloſely connected by their nerves; and if ſuch effects may be produced by ſuch ſimple mechanical means as the mere increaſe of motion in the blood, without any direction of the will, we are not to wonder at the actions of brutes being the effects only of a refined mechaniſm, without thought or perception. 5. A farther proof will ariſe from a conſideration of the many wonderful effects which even the ingenuity of men has contrived to bring about by mechanical means; the androide, for inſtance, of Mr. Kempell, which plays at cheſs. Now, it is not to be queſtioned, but that the mechaniſm of the body, of the meaneſt animal infinitely ſurpaſſes that of Mr. Kempell's machine; and what can be the conſequence of this, but that the actions of that animal muſt be proportionably more ſurpriſing than thoſe of the wooden cheſs-player? See ANDROIDES and AUTOMATON.

The above is a ſhort abſtract of all the arguments that are brought in favour of the Carteſian ſyſtem: but they are evidently very far from being concluſive. They are deficient in the firſt place, becauſe, though we allow them in the utmoſt extent the Carteſians themſelves can deſire, they prove only the poſſibility of brutes being inanimate, and that the power of God actually could produce ſuch and ſuch actions from inanimate machines; but that he actually hath done ſo, they have not the leaſt tendency to prove. In the ſecond place, the Carteſian argument is inſufficient, becauſe it hath no limits, and knows not where to ſtop; as, by the ſame method of arguing, every man might prove his neighbour to be an inanimate machine: for though every individual be conſcious of his own thoughts, he is not ſo of thoſe of his neighbours; and it no more exceeds the power of God to cauſe an inanimate machine to perform the actions of a man, than thoſe of a beaſt. Neither are the two objections which the hypotheſis is calculated to anſwer, to be at all admitted as arguments in its favour. They are, 1. That if we allow brutes to have ſouls, they muſt be immaterial, and conſequently immortal; and, 2. It ſeems a contradiction to the goodneſs of God to think that he ſhould ſubject innocent creatures to ſuch a multitude of evils as we ſee the brute creation endure in this world. The firſt of theſe is productive of no bad conſeqnences to us, though

The BINDER *is deſired to obſerve that this Sheet* [6 G—2] *is to be placed after* [6 G—1] *it being a duplicate Sheet, introduced in the New Edition of this Work, to enlarge upon the Article* BROMELIA *or* PINE-APPLE, BRUTES, &c.

though it ſhould be granted: and if it is ſuppoſed that the brute creatures are really immortal, the ſecond objection vaniſhes; becauſe, in the enjoyment of endleſs felicity, all temporary afflictions, how ſevere ſoever, muſt be ſwallowed up as though they had never been.

As to a poſitive proof on the other ſide, *viz.* that brutes are really endowed with ſenſation and conſciouſneſs, there is undoubtedly the ſame evidence for the ſenſibility of brutes that there is for that of mankind. We ſee brutes avoid pain as much as we do; and we likewiſe ſee them ſeek for pleaſure and expreſs their happineſs in the enjoyment of certain things by ſigns not at all equivocal. Therefore, though we grant the poſſibility of all this being the effect of mere mechaniſm; yet, as we are conſcious that in ourſelves ſimilar effects are produced by a ſentient principle, we have all the reaſon in the world to conclude that in brutes they are likewiſe derived from a principle of ſenſation: eſpecially ſeeing we know of no kind of mechaniſm in any other part of nature that produces any thing like the effects juſt mentioned; and until we ſee that a mechaniſm of this kind does take place in ſome part of nature, we have no right to ſuppoſe it in any. As to thoſe actions of the human body in which it ſeems to move ſpontaneouſly, like an automaton, without the direction of the mind or will, it is almoſt ſuperfluous to obſerve, that they were not performed in this manner originally, but required very great exertions of the will and intellectual faculty before the body could be brought to perform them eaſily; ſo that from this nothing can be inferred. Add to this, that divine revelation ſets forth to us in many places the brute creation as objects of mercy; which could not be done without the higheſt abſurdity, if they were not really capable of feeling pleaſure and pain as well as we.

The moſt rational oppoſers of the Carteſian ſcheme maintain, that the brutes are endowed with a principle of ſenſation as well as we; though of an inferior nature to ours. That the brutes are endowed only with ſenſation, and totally deſtitute of all power of reflection, or even reaſoning, is what can by no means be maintained on good grounds: neither can it be aſſerted that they act entirely from inſtinct, or a blind propenſity to certain things without knowing why or wherefore. In numberleſs inſtances, needleſs to be mentioned here, but which will readily occur to every reader, it is evident, that education will get the better of many of the natural inſtincts of brutes; which could never be the caſe were they abſolutely incapable of reaſoning.

Father Bougeant ſupports his opinion of the ſpirits of brute creatures being devils, in the following manner: Having proved at large that beaſts naturally have underſtanding, "Reaſon (ſays he) naturally inclines us to believe that beaſts have a ſpiritual ſoul; and the only thing that oppoſes this ſentiment is the conſequences that might be inferred from it. If brutes have a ſoul, that ſoul muſt be either matter or ſpirit; it muſt be one of the two, and yet you dare affirm neither. You dare not ſay it is matter, becauſe you muſt then neceſſarily ſuppoſe matter to be capable of thinking: nor will you ſay that it is ſpirit, this opinion bringing with it conſequences contrary to the principles of religion; and this, among others, that man would differ from beaſts only by the degrees of *plus* and *minus*; which would demoliſh the very foundation of all religion. Therefore, if I can elude all theſe conſequences; if I can aſſign to beaſts a ſpiritual ſoul, without ſtriking at the doctrines of religion; it is evident, that my ſyſtem, being moreover the moſt agreeable to reaſon, is the only warrantable hypotheſis. Now I ſhall, and can do it, with the greateſt eaſe imaginable. I even have means, by the ſame method, to explain many very obſcure paſſages in the Holy Scripture, and to reſolve ſome very great difficulties which are not well confuted. This we ſhall unfold in a more particular manner.

"Religion teaches us, that the devils, from the very moment they had ſinned, were reprobate, and that they were doomed to burn for ever in hell; but the church has not yet determined whether they do actually endure the torments to which they are condemned. It may then be thought that they do not yet ſuffer them, and that the execution of the verdict brought againſt them is reſerved for the day of the final judgment.—Now what I pretend to infer from hence is, that, till doomſday comes, God, in order not to ſuffer ſo many legions of reprobate ſpirits to be of no uſe, has diſtributed them through the ſeveral ſpaces of the world, to ſerve the deſigns of his providence, and make his Omnipotence to appear. Some, continuing in their natural ſtate, buſy themſelves in tempting men, in ſeducing and tormenting them; either immediately, as Job's devil, and thoſe that lay hold of human bodies; or by the miniſtry of ſorcerers or phantoms. Theſe wicked ſpirits are thoſe whom the ſcripture calls the *powers of darkneſs*, or the *powers of the air*. God, with the others, makes millions of beaſts of all kinds, which ſerve for the uſes of men, which fill the univerſe, and cauſe the wiſdom and omnipotence of the Creator to be admired. By that means I can eaſily conceive, on the one hand, how the devils can tempt us; and on the other, how beaſts can think, know, have ſentiments, and a ſpiritual ſoul, without any way ſtriking at the doctrines of religion. I am no longer ſurpriſed to ſee them have forecaſt, memory, and judgment. I ſhould rather have occaſion to wonder at their having no more, ſince their ſoul very likely is more perfect than ours. But I diſcover the reaſon of this: it is becauſe, in beaſts as well as in ourſelves, the operations of the mind are dependent on the material organs of the machine to which it is united; and thoſe organs being groſſer and leſs perfect than in us, it follows, that the knowledge, the thoughts, and the other ſpiritual operations of the beaſts, muſt of courſe be leſs perfect than ours: And if theſe proud ſpirits know their own diſmal ſtate, what an humiliation muſt it be to them thus to ſee themſelves reduced to the condition of beaſts! But, whether they know it or not, ſo ſhameful a degradation is ſtill, with regard to them, the primary effect of the divine vengeance I juſt mentioned; it is an anticipated Hell."

Having mentioned the prejudices againſt this hypotheſis, ſuch particularly as the pleaſure which people of ſenſe and religion take in beaſts and birds, eſpecially all ſorts of domeſtic animals; he procedes, "Do we love beaſts for their own ſakes? No. As they are altogether ſtrangers to human ſociety, they can have no other appointment but that of being uſeful and amuſing. And what care we whether it be a devil or any other creature that amuſes us? The thought of it, far from ſhocking, pleaſes me mightily. I with gratitude admire the goodneſs of the Creator, who gave me ſo many little devils to ſerve and amuſe me. If I am told that theſe poor devils are doomed to ſuffer eternal tortures, I admire God's decrees, but I have no manner of ſhare in that dreadful ſentence; I leave the execution of it to the ſovereign Judge; and notwithſtanding this, I live with my little devils as I do with a multitude of people, of whom religion informs me that a great number ſhall be damned. But the cure of a prejudice is not to be effected in a moment; it is done by time and reflection: give me leave then lightly to touch upon this difficulty in order to obſerve a very important thing to you.

"Perſuaded as we are that beaſts have intelligence, have we not all of us a thouſand times pitied them for the exceſſive evils which the majority of them are expoſed to, and in reality ſuffer? How unhappy is the condition of horſes! we are apt to ſay upon ſeeing a horſe whom an unmerciful carman is murdering with blows. How miſerable is a dog whom they are breaking for hunting! How diſmal is the fate of beaſts living in woods! they are perpetually expoſed to the injuries of the weather; always ſeized with apprehenſions of becoming the prey of hunters, or of ſome wilder animal; for ever obliged, after long fatigue, to look out for ſome poor inſipid food; often ſuffering cruel hunger; and ſubject, moreover, to illneſs and death! If men are ſubject to a multitude of miſeries that overwhelm them, religion acquaints us with the reaſon of it: viz. the being born ſinners. But what crimes can beaſts have committed by birth to be ſubject to evils ſo very cruel? What are we, then, to think of the horrible exceſſes of miſeries undergone by beaſts? miſeries, indeed, far greater than thoſe endured by men. This is, in any other ſyſtem, an incomprehenſible myſtery; whereas nothing is more eaſy to be conceived from the ſyſtem I propoſe.—The rebellious ſpirits deſerve a puniſhment ſtill more rigorous, and happy it is for them that their puniſhment is deferred. In a word, God's goodneſs is vindicated, man himſelf is juſtified: for what right can we have, without neceſſity, and often in the way of mere diverſion, to take away the life of millions of beaſts, if God had not authorized us ſo to do? And beaſts being as ſenſible as ourſelves of pain and death, how could a juſt and merciful God have given man that privilege, if they were not ſo many guilty victims of the divine vengeance?

"But hear ſtill ſomething more convincing, and of greater conſequence: beaſts, by nature, are extremely vicious. We know well that they never ſin, becauſe they are not free; but this is the only condition wanting to make them ſinners. The voracious birds and beaſts of prey are cruel. Many inſects of one and the ſame ſpecies devour one another. Cats are perfidious and ungrateful; monkeys are miſchievous; and dogs envious. All beaſts in general are jealous and revengeful to exceſs; not to mention many other vices we obſerve in them: and at the ſame time that they are by nature ſo very vicious, they have, ſay we, neither the liberty nor any helps to reſiſt the bias that hurries them into ſo many bad actions. They are, according to the ſchools, neceſſitated to do evil, to diſconcert the general order, to commit whatever is moſt contrary to the notion we have of natural juſtice and the principles of virtue. What monſters are theſe in a world originally created for order and juſtice to reign in? This is, in good part, what formerly perſuaded the Manicheans that there were of neceſſity two orders of things, one good, and the other bad; and that the beaſts were not the work of the good principle: a monſtrous error! But how then ſhall we believe that beaſts came out of the hands of their Creator with qualities ſo vicious as they are, and of giving us in them models of what is moſt ſhameful in the world; or that they have, like man, original ſin, which has perverted their primitive nature.

"The firſt of theſe propoſitions finds very difficult acceſs to the

the mind, and is an expreſs contradiction to the holy ſcriptures; which ſay, that whatever came out of God's hands, at the time of the creation of the world, was good, yea, very good. What good can there be in a monkey's being ſo very miſchievous, a dog ſo full of envy, a cat ſo malicious? But then many authors have pretended, that beaſts, before man's fall, were different from what they are now; and that it was in order to puniſh man that they became ſo wicked. But this opinion is a mere ſuppoſition, of which there is not the leaſt footſtep in Holy Scripture. It is a pitiful ſubterfuge to elude a real difficulty; this at moſt might be ſaid of the beaſts with whom man has a ſort of correſpondence; but not at all of the birds, fiſhes, and inſects, which have no manner of relation to him. We muſt then have recourſe to the ſecond propoſition. That the nature of beaſts has, like that of man, been corrupted by ſome original ſin: Another hypotheſis, void of foundation, and equally inconſiſtent with reaſon and religion, in all the ſyſtems which have been hitherto eſpouſed concerning the ſouls of beaſts. What party are we to take? Why, admit of my ſyſtem, and all is explained. The ſouls of beaſts are refractory ſpirits which have made themſelves guilty towards God. The ſin in beaſts is no original ſin; it is a perſonal crime, which has corrupted and perverted their nature in its whole ſubſtance; hence all the vices and corruption we obſerve in them, though they can be no longer criminal, becauſe God, by irrecoverably reprobating them, has at the ſame time diveſted them of their liberty."

Theſe quotations contain the ſtrength of Father Bougeant's hypotheſis, which alſo hath had its followers; but the reply to it is obvious. Beaſts, though remarkably miſchievous, are not completely ſo; they are in many inſtances capable of gratitude and love, which devils cannot poſſibly be. The very ſame paſſions that are in the brutes, exiſt in the human nature; and if we choſe to argue from the exiſtence of thoſe paſſions, and the aſcendency they have over mankind at ſome times, we may ſay, with as great juſtice, that the ſouls of men are devils, as that the ſouls of brutes are. All that can be reaſonably inferred from the greater prevalency of the malignant paſſions among the brutes than among men, is, that the former have leſs rationality than men: and accordingly it is found, that among ſavages, who exerciſe their reaſon leſs than other men, every ſpecies of barbarity is practiſed, without being deemed a crime.

On the preſent ſubject there is a very ingenious treatiſe in German, publiſhed by the late profeſſor Bergman, under the title (as tranſlated) of "Reſearches deſigned to ſhow what the brute animals certainly *are not*, and alſo what they probably *are*."—That they are *not* machines, he proves with more detail than ſeemed neceſſary for refuting an hypotheſis which would equally tend to make *us all* machines. It is certain, that the *half-reaſoning* elephant cannot be deemed a machine, by us, from any other conſideration, than that *he* goes upon four feet, while *we* go upon two; and he might as well take us for mere machines becauſe *we* go upon two feet, while *he* goes upon four. But if animals are not mere machines, what *are* they? Manifeſtly ſenſitive beings, with an immaterial principle; and thinking or reaſoning beings, to a *certain degree*. In certain claſſes of animals this appears evident to our author, who ſeems to have obſerved with great ſagacity and attention their *various* operations and proceedings, their ways and means, &c. He thinks it impoſſible to deduce this variety of action, in any animals (if we except thoſe of the loweſt claſſes in the gradation of intelligence,) from a general and uniform inſtinct. For they accommodate their operations to times and circumſtances. They combine; they chooſe the favourable moment; they avail themſelves of the occaſion, and ſeem to receive inſtruction by experience. Many of their operations announce reflection: the bird repairs a ſhattered neſt, inſtead of conſtructing inſtinctively a new one: the hen, who has been robbed of her eggs, changes her place in order to lay the remainder with more ſecurity: the cat diſcovers both care and artifice in concealing her kittens. Again, it is evident, that, on many occaſions, animals know their faults and miſtakes, and correct them; they ſometimes contrive the moſt ingenious methods of obtaining their ends, and when one method fails, have recourſe to another, and they have, without doubt, a kind of language for the mutual communication of their ideas. How is all this to be accounted for (ſays our author,) unleſs we ſuppoſe them endowed with the powers of perceiving, thinking, remembering, comparing, and judging? They have theſe powers, indeed, in a degree inferior to that in which they are poſſeſſed by the human ſpecies, and form claſſes below them in the graduated ſcale of intelligent beings. But ſtill it ſeems to our author unreaſonable to exclude them from the place which the principles of ſound philoſophy, and facts aſcertained by conſtant obſervation, aſſign to them in the great and diverſified ſphere of life, ſenſation, and intelligence;—he does not, however, conſider them as beings whoſe actions are directed to *moral* ends, nor conſequently as accountable and proper ſubjects for *reward* or *puniſhment* in a future world.

That brute animals poſſeſs reflection and ſentiment, and are ſuſceptible of the kindly, as well as the iraſcible paſſions, independently of ſexual attachment and natural affection, is evident from the numerous inſtances of affection and gratitude daily obſervable in different animals, particularly the dog. Of thoſe and other ſentiments, ſuch as pride, and even a ſenſe of glory, the elephant exhibits proofs equally ſurpriſing and indubitable, as the reader may ſee under the article ELEPHAS.

As to the natural affection of brutes, ſays an ingenious writer, "the more I reflect on it, the more I am aſtoniſhed at its effects. Nor is the violence of the affection more wonderful than the ſhortneſs of its duration. Thus every hen is in her turn the virago of the yard in proportion to the helpleſſneſs of her brood, and will fly in the face of a dog, or a ſow, in defence of thoſe chickens which in a few weeks ſhe will drive before her with relentleſs cruelty. This affection ſublimes the paſſions, quickens the invention, and ſharpens the ſagacity of the brute creation. Thus an hen, juſt become a mother, is no longer that placid bird ſhe uſed to be, but with feathers ſtanding on end, wings hovering, and clacking note, ſhe runs about like one poſſeſſed. Dams will throw themſelves in the way of the greateſt danger in order to avert it from their progeny. Thus a partridge will tumble along before a ſportſman in order to draw away the dogs from her helpleſs covey. In the time of nidification the moſt feeble birds will aſſault the moſt rapacious. All the ſwallows of a village are up in arms at the ſight of an hawk, whom they will perſecute till he leaves that diſtrict. If you ſtand near the neſt of a bird that has young, ſhe will not be induced to betray them by an inadvertent fondneſs, but will wait about at a diſtance with meat in her mouth for an hour together. The flycatcher builds every year in the vines that grow on the walls of my houſe. A pair of theſe little birds had one year inadvertently placed their neſt on a naked bough, perhaps in a ſhady time, not being aware of the inconvenience that followed: but an hot ſunny ſeaſon coming on before the brood was half-fledged, the reflection of the wall became inſupportable, and muſt inevitably have deſtroyed the tender young, had not affection ſuggeſted an expedient, and prompted the parent-birds to hover over the neſt all the hotter hours, while with wings expanded and mouths gaping for breath, they ſcreened off the heat for their ſuffering offſpring.

A wonderful ſpirit of ſociality in the brute creation, independent of ſexual attachment, has been frequently remarked. Many horſes, though quiet with company, will not ſtay one minute in a field by themſelves: the ſtrongeſt fences cannot reſtrain them. A horſe has been known to leap out of a ſtable window, after company; and yet in other reſpects is remarkably quiet. Oxen and cows will not fatten by themſelves; but will neglect the fineſt paſture that is not recommended by ſociety. It would be needleſs to inſtance in ſheep, which conſtantly flock together.

In the Gentleman's Magazine for March, 1788, we have the following anecdotes of a raven, communicated by a correſpondent who does not ſign his name, but who ſays it is at the ſervice of the doubtful. The raven alluded to "lives, or did live three years ſince, at the Red Lion at Hungerford; his name, I think, is *Rafe*. You muſt know then, that coming into that inn, my chaiſe run over or bruiſed the leg of my Newfoundland dog; and while we were examining the injury done to the dog's foot, *Rafe was evidently a concerned ſpectator*; for the minute the dog was tied up under the manger with my horſe, Rafe not only viſited, but fetched him bones, and attended upon him with particular and repeated marks of kindneſs. The bird's notice of the dog was ſo *marked*, that I obſerved it to the oſtler: for I had not heard a word *before* of the hiſtory of this benevolent creature. John then told me, that he had been bred from his pin-feather in intimacy with a dog; that the affection between them was mutual; and that all the neighbourhood had often been witneſſes of the innumerable acts of kindneſs they had conferred upon each other: Rafe's poor dog, after a while, unfortunately broke his leg; and during the long time he was confined, Rafe waited upon him conſtantly, carried him his proviſions daily, and never ſcarce left him alone! One night by accident the oſtler had ſhut the ſtable door, and Rafe was deprived of the company of his friend the whole night; but the oſtler found in the morning the bottom of the door ſo pecked away, that had it not been opened, Rafe would in another hour have made his own entrance-port. I then enquired of my landlady (a ſenſible woman), and heard what I have related confirmed by her, with ſeveral other ſingular traits of the kindneſſes this bird ſhows to all dogs in general, but particularly to *maimed* or wounded ones. I hope and believe, however, the bird is ſtill living; and the traveller will find I have not *over-rated* this wonderful bird's merit."

To theſe inſtances of attachment between incongruous animals, from a ſpirit of ſociality or the feelings of ſympathy, may be added the following inſtance of fondneſs from a different motive, recounted by Mr. White, in the work already ſo frequently quoted. "My friend had a little helpleſs leveret brought to him, which the ſervants fed with milk in a ſpoon; and about the ſame time his cat kittened, and the young were diſpatched and buried. The hare was ſoon loſt, and ſuppoſed to be gone the way of moſt fondlings, to be killed by ſome dog or cat. However, in about a fortnight,

fortnight, as the master was sitting in his garden in the dusk of the evening, he observed his cat, with tail erect, trotting towards him, and calling with little short inward notes of complacency, such as they use towards their kittens, and something gambling after, which proved to be the leveret, that the cat had supported with her milk, and continued to support with great affection. Thus was a graminivorous animal nurtured by a carnivorous and predaceous one!

"Why so cruel and sanguinary a beast as a cat, of the ferocious genus of *Felis*, the *murium leo*, as Linnæus calls it, should be affected with any tenderness towards an animal which is its natural prey, is not so easy to determine. This strange affection probably was occasioned by that desiderium, those tender maternal feelings, which the loss of her kittens had awakened in her breast, and by the complacency and ease she derived to herself from the procuring her teats to be drawn, which were too much distended with milk, till from habit she became as much delighted with this foundling as if it had been her real offspring. This incident is no bad solution of that strange circumstance which grave historians as well as the poets assert, of exposed children being sometimes nurtured by female wild beasts that probably had lost their young. For it is not one whit more marvellous that Romulus and Remus, in their infant state, should be nursed by a she-wolf, than that a poor little sucking leveret should be fostered and cherished by a bloody grimalkin.

It has been much disputed, whether the brutes have any language whereby they can express their minds to each other; or whether all the noise they make consists only of cries inarticulate, and unintelligible even to themselves. We are, however, too little acquainted with the intellectual faculties of these creatures to be able to determine this point. Certain it is, that their passions, when excited are generally productive of some peculiar cry; but whether this be designed as an expression of the passion to others, or only a mechanical motion of the muscles of the larynx, occasioned by the passion, is what we have no means of knowing. We may indeed, from analogy, conclude, with great reason, that some of the cries of beasts are really expressions of their sentiments; but whether one beast is capable of forming a design, and communicating that design by any kind of language to others, is what we submit to the judgement of the reader, after giving the following instance, which, among others, is brought as a proof of it by Father Bougeant. "A sparrow finding a nest that a martin had just built, standing very conveniently for him, possessed himself of it. The martin seeing the usurper in her house, called for help to expel him. A thousand martins came full speed, and attacked the sparrow; but the latter being covered on every side, and presenting only his large beak at the entrance of the nest, was invulnerable, and made the boldest of them who durst approach him repent of their temerity. After a quarter of an hour's combat, all the martins disappeared. The sparrow thought he had got the better, and the spectators judged that the martins had abandoned their undertaking. Not in the least. Immediately they returned to the charge; and each of them having procured a little of that tempered earth with which they make their nests, they all at once fell upon the sparrow, and inclosed him in the nest to perish there, though they could not drive him thence. Can it be imagined that the martins could have been able to hatch and concert this design all of them together, without speaking to each other, or without some medium of communication equivalent to language."

The common opinion of the untaught and unprejudiced part of mankind seems to be, that *brutes* have sense, imagination, memory, and passion, but that they are void of understanding and reason; that is, in the language of philosophers, they have the inferior faculties of the soul, but not the superior. Nor will the distinction appear groundless to those who attend to the difference between the objects of the mind, and its acts about these objects; as also to the difference between the confused and distinct comprehension of any thing. See Buffon's Hist. Natur. vol. ii. p. 443. See INSTINCT.

BRYONIA, BRYONY: A genus of the Syngenesia order, belonging to the Moncœcia class of plants: The calyx of the male is five-toothed, with a quinquefid corolla, and three filaments. In the female the calyx is dentated, the corolla quinquefid, the style trifid, with a roundish many-seeded berry.

The alba, rough, or white bryony with red flowers, is a native of dry banks under hedges in many parts of Britain. The roots of this plant have by impostors been brought into a human shape, and shown for mandrakes. The method practised by these people was to find a young thriving plant of bryony; then they opened the earth all round, being careful not to disturb the lower fibres; and being provided with such a mould as is used for making plaster figures, they fixed the mould close to the root, fastening it with wire to keep it in its proper situation: then they filled the earth about the root, leaving it to grow to the shape of the mould; which in one summer it will do; so that if this is done in March, by September it will have the shape. The leaves of this plant are also imposed on people for mandrake-leaves; although there is no resemblance between them, nor any agreement in quality.

Medicinal Uses, &c. The roots of the alba, rough or white bryony, are used in medicine. These are very large, sometimes as thick as a man's thigh: their smell, when fresh, is strong and disagreeable; the taste nauseously bitter, acrid, and biting; the juice is so sharp, as in a little time to excoriate the skin; in drying, they lose great part of their acrimony, and almost their whole scent. Bryony-root is a strong irritating cathartic; and as such has sometimes been successfully exhibited in maniacal cases, in some kinds of dropsies, and in several chronical disorders, where a quick solution of viscid juices and a sudden stimulus on the solids were required. An extract prepared by water acts more mildly, and with greater safety, than the root in substance: given from half a dram to a dram, it is said to prove a gentle purgative, and likewise to operate powerfully by urine. —Bryony-root, applied externally, is said to be a powerful discutient.

BUBALUS, the *buffalo*, a sort of wild bull, a species of the Genus Bos in the System of Mammalia. For description see BOS; for representation see plate 10, Genus 32; Species 5.

BUBBLES, BULÆ, in *Physics*, little round drops or vesicles of any fluid filled with air, and formed either on its surface, upon the addition of more of the fluid, as in raining; or in its substance, upon a vigorous intestine commotion of its parts. Bubbles are dilatable, or compressible, i. e. they take up more or less room, as the included air is more or less heated, or more or less pressed, from without; and are round, because the included aura acts equably from within all round. Their coat, or cover, is formed of the minute particles of the fluid, retained either by the velocity of the air, or by the brisk attraction between those minute parts and the air. These little bubbles, rising up from fluids, or hanging on the surface, form the white scum at top: and these same bubbles form the steam, or vapour, flying up from liquors in boiling, &c. the manner of which see under BOILING, VAPOUR, &c.

BUBBLE, in *Commerce*, is a cant name given to a sort of projects, for the raising of money on imaginary grounds, very frequent in the years 1720 and 1721. The pretended design of these undertakings was, to raise a stock, for the retrieving, setting on foot, or carrying on, some promising and useful branch of trade, manufacture, machinery, or the like. In order to which, proposals were given out, shewing the advantages of the design, and inviting persons into it. The sum necessary to carry on the affair, together with the profits expected from it, were divided into a certain number of shares, or subscriptions, to be purchased by persons disposed to adventure therein.—The real design, in some, was to raise a sum for the private advantage of the projectors, to be laid out by them in the South-sea stock, &c. in hopes, by the rise thereof, to be able to refund the subscribers money with profit to themselves. In others the design was absolutely to defraud the adventurers of their subscription-money, without any view to restitution. There was a third kind somewhat different: the projectors of these, to proceed the more securely, proposed to have books opened, and subscriptions taken at some time to come; and in the mean time took money, by way of *premium*, to entitle persons to be admitted subscribers, as soon as the affair should be ripe for dividing into shares. Several thousand shares were thus very frequently bespoke in one day; and *premiums*, from one shilling to some pounds, paid thereupon, to the profits of the projectors. The number of bubbles, and their qualities, are very extraordinary; some of them, too, authorized by patents; and, in others, the projectors and their proprietors formed into corporations: some for fisheries, some for insurances, some for the digging of mines, &c.

BUBO, in *Medicine* and *Surgery*, denotes a tumour, sometimes inflammatory, and sometimes schirrhous, gathering chiefly in the glands of the *inguen*, or groin. The word comes from the Greek βουβων *inguen*; the usual place of such tumours. There are two kinds of buboes, the one called *benign*, or mild, the other *malignant*.—Mild buboes are those which are preceded or attended with no manifest disease in the body; and they are easily cured by gentle mercurials, externally applied, and an occasional purge; or by encouraging suppuration, and proceeding as in a common abscess.—Malignant buboes are divided into *pestilential* and *venereal*: the former arise in pestilential fevers, &c. The latter are the product of impure embraces; and frequently the forerunner of the pox.—When a bubo is encompassed with a circle of several colours, it is a sign it is pestilential; and it is generally mortal. For a further description, and the most approved methods of treatment, see the System of MEDICINE, Genus 59.

Venereal BUBOES, are tumours arising principally in the groin, after contracting the venereal disease, and they are sometimes attended with the other symptoms of that disorder, sometimes they are themselves the only symptoms of it. These arise sometimes sooner, sometimes later, after contracting the infection. The tumour first appears with hardness, redness, and pain either in one or both the groins, and sometimes in the armpits. Great care is to be taken to distinguish, in those cases, whether the bubo be of a benign kind, or be really from a venereal infection; for mistakes of this matter are on both sides very

very dangerous. If a benign bubo be miſtaken for a venereal one, the patient is uſually treated in too harſh a method, and has more trouble and pain than are neceſſary; and, on the other hand, if a venereal bubo be miſtaken for a benign one, he is uſually treated ſo improperly as to be brought into a confirmed lues. The buboes are known to be venereal, when they are the conſequences of impure embraces, or are accompanied with, or preceded by, gonorrhœas, chancres, and other ſymptoms of the venereal diſeaſe. When from theſe attendant ſymptoms, and from the patient's confeſſion, the bubo is found to be venereal, a cure is immediately to be ſet about; for, though there is no great difficulty or danger in theſe caſes, when taken in time, yet there are few in which delays are of worſe conſequence; for, from theſe, from an irregular courſe of life, or from an improper method of treatment, the cure often becomes extremely difficult, and the patient too frequently gets into a confirmed lues.—It is much diſputed whether the cure of theſe tumours by diſcuſſion be ſafe; many are of opinion, it is by no means to be allowed in theſe any more than in peſtilential buboes, ſince in both caſes, by that means, the poiſon is driven back into the blood. But the caſe is not parallel, and the truth is, that in theſe tumours, the cure by ſuppuration is ſlow, tedious, and attended with many inconveniences, and that much better effects may be produced, and with the greateſt ſafety, by purging and mercurial medicines, with the decoctions of the woods, and other purifiers and ſweeteners of the blood. The beſt method, whether the bubo be attended with a gonorrhœa or not, is to purge frequently, and give proper doſes of calomel; for buboes can never be ſafely cured till the body is perfectly freed from the venereal venom; and, by this means, if there be a gonorrhœa in the caſe alſo, that is cured at the ſame time. When there is a great inflammation, and the patient is of a robuſt plethoric habit, it is always neceſſary to bleed; while this method is followed, diſcutient plaſters ſhould be applied externally to the tumour, as the mercurial plaſter, or the like, and the patient ſhould be kept to a regular courſe of life, and a proper diet. By this method, venereal buboes, which are not become inveterate, may be cured with great eaſe and ſafety. But if the ſurgeon be called in too late; if the bubo will not give way to theſe methods; or if, for any other reaſon, he determines to bring it to ſuppuration, the maturation is in this caſe to be promoted as faſt as poſſible; and one great method to bring on ſuppuration with ſpeed, is to order the part to be rubbed ſtrongly, and for a conſiderable time, either with the fingers wetted with a little oil, or with linen rags, till it looks very red and inflamed: and this is to be often repeated, applying after each time a plaſter of diachylon, with the gums, or ſome other of the maturating kind. While the patient is able to go abroad, violent exerciſes of all ſorts, as dancing and the like, are extremely proper, and do ſervice in haſtening a ſuppuration. When the pain will not ſuffer him to walk any longer, then it is proper to keep to the uſe of cataplaſms, inſtead of the plaſter, theſe are indeed ever much more ſerviceable to promote ſuppuration than plaſters, and the beſt on this occaſion are thoſe made of onions, roaſted under the aſhes, or of flour, honey, and yeaſt, or that of crumbs of bread boiled in milk, with the addition of a little ſaffron; theſe are to be applied warm to the parts, and frequently renewed; and it is always beſt to rub the parts, till they look very red, before the application of them. During the uſe of theſe external remedies, the patient ſhould be continually taking decoctions of the woods, and ſmall doſes of calomel; for theſe greatly attenuate the blood, drive it toward the ſkin, and correct the venereal venom. When theſe methods have brought the ſwelling to a perfect ſuppuration, the ſcalpel is to be taken in hand, to make the opening. Great caution is to be uſed in making the inciſion, not to hurt the larger blood-veſſels, which might occaſion very dangerous hæmorrhages. To avoid theſe miſchiefs, the protuberant part of the bubo is to be preſſed outward by the fingers, before the ſcalpel is introduced to make the inciſion. Great caution is alſo neceſſary as to the time of opening theſe tumours; for the doing this either too ſoon, or too late, is of very bad conſequence; the firſt brings on violent pains and inflammations, and other bad ſymptoms, and, by the latter, the venom has time given it to mix itſelf with the blood, and bring on a confirmed lues. If the patient dreads the knife, the bubo may be opened with a cauſtic; and by whatever means it is done, it muſt be afterwards well cleanſed. The proper dreſſing on this occaſion is the common digeſtive ointment, with a ſmall quantity of Venice treacle, and a little red precipitate mixed in it; over this is to be applied a plaſter of diachylon, with the gums, or the like; by which means the lips of the bubo will be ſufficiently ſoftened: and when ſufficiently deterged in this manner, it may be healed by ſome vulnerary balſam, applied on lint. It ſometimes happens, that the ulcerated bubo becomes ſo ſtubborn, that it will neither incarn nor cicatrize by the help of any medicines, but always diſcharges a copious quantity of matter. If, in this caſe, burnt alum and red precipitate prove of no ſervice, the actual cautery ought to be applied, and the lymphatics will, by this means, have their communications for ever cut off.

BUBONOCELE, a tumour in the groin; occaſioned by the deſcent either of the *epiploon*, or the inteſtines, through the perforation of the *muſculus obliquus deſcendens*. The word comes from the Greek βουβων, *inguen*, and κηλη, *tumour*. The *bubonocele* is the ſame with what is otherwiſe alſo called *rupture*, and HERNIA *inguinalis*. It is a ſpecies of rupture; though ſurgeons call it an *incomplete* one; and is common to women, as well as men. Some make two kinds of *bubonoceles*; the one owing to a deſcent of the *viſcera*, as the *omentum*, or inteſtines, ſtopping in the groin, and not falling ſo far as to the *ſcrotum*; the other a collection or ſtagnation of excrementitious humours in the inguinal glands; which latter is more properly called *bubo*, and differs little, except in ſeat, from the bubonocele.

BUCCANEERS, or BUCANEERS, a term frequent in the Weſt-Indies, properly uſed for a kind of ſavages, who prepare their meat on a grate, or hurdle, made of Braſil-wood, placed in the ſmoke, at a good height from the fire, and called *buccan*. Whence, alſo, the little lodges, raiſed for the preparation of their food, are called *buccans*; and the action of dreſſing it *buccaning*. Meat *buccaned* is ſaid to have an excellent taſte, the vermil colour of a roſe, and a charming ſmell; all which it retains many months. Oexmelia, from whom we have this, adds, that the neighbouring people ſend their ſick hither; that, by eating their *buccaned* meat, they may be recovered.

The *buccaneers* are of two diſtinct profeſſions: the one only hunt bulls for their ſkins; the other beaſts for their fleſh. The art of *buccaning*, Oexmelia deſcribes thus: the beaſt being flayed, and the bones ſtripped out, the fleſh is cut into pieces of the length of the arm, and ſalted, and the next day laid on the *buccan*; which conſiſts of twenty or thirty bars laid acroſs, half a foot from each other: under this they raiſe a thick ſmoke, adding the ſkin and bones of the beaſt, to heighten it. This is found vaſtly better than any ſimple fuel: becauſe the volatile ſalts of thoſe parts are by this means communicated to the fleſh, and give it ſuch a reliſh, as that, after a little of this *buccaning*, the niceſt palate will eat it without further preparation. *Buccaneers*, are uſually confounded with freebooters, from whom, in ſtrictneſs, they ought to be diſtinguiſhed. The ancient inhabitants of Hiſpaniola, and other Caribbee iſlands, after their conqueſt by the Europeans, conſiſted of four ranks or orders of perſons, viz. *buccaneers*, or bull-hunters, who ſcoured the woods; *freebooters*, who ſcoured the ſeas as pirates; *huſbandmen*, who tilled the lands; and *ſlaves*. Of theſe, the two firſt diſtinguiſhed themſelves moſt by their military diſpoſition, and the ravages they made, eſpecially among the Spaniards. The name is particularly given to the French inhabitants of the iſland of St. Domingo, whoſe ſole employment is to hunt bulls, or wild boars; in order to ſell the hides of the former, and the fleſh of the latter.

There is a great conſumption and trade of each of theſe articles in the French ſettlements of the iſlands of St. Domingo, and in thoſe of Tortuga; beſide which they ſend great quantities of them to the Antilles, and even into the continent of French America. There is alſo a great deal of it ſold for the ſupport of the crews of the ſhips that come from France for trading, or which the privateers of Tortuga fit out, for cruiſing againſt the Spaniards.

BUCCINATOR, in *Anatomy*, a muſcle on each ſide the face, common to the lips and cheeks; making the inner ſubſtance of the latter.—Its fibres run from the *proceſſus coronæ* of the lower jaw to the angle of the mouth, and adhere to the upper part of the gums of both jaws; through its middle paſs the upper *ductus ſalivales*. By this is contracted the cavity of the mouth, and the meal thruſt forward to the teeth in maſtication. It has its name from *buccina*, *trumpet*; becauſe, when ſwelled, it enlarges the cheeks, as in blowing a trumpet. See the Syſtem, Table of the Muſcles, Art. 6, and Plate II, fig. 3, letter e.—

BUCCINUM, or WHELK, a genus of ſhell-fiſh belonging to the order of Vermes Teſtacea. This animal is one of the ſnail kind. The ſhell is univalve, ſpiral, and gibbous. The aperture is oval, ending in a ſmall ſtrait canal. Linnæus enumerates about 60 ſpecies, moſt of which are found in the ſouthern ſeas. For the character of the Genus and deſcription of the moſt remarkable Species, ſee the Syſtem of CONCHOLOGY, Genus XXIV.

BUCK, a male horned beaſt of venery or chaſe, whoſe female is denominated a *doe*. A buck the firſt year is called a *fawn*, the ſecond a *pricket*, the third, a *ſorel*, the fourth a *ſore*, the fifth a *buck of the firſt head*, and the ſixth a *great buck*.

BUCK is alſo applied to the males of the hare and rabbit kind. Hares commonly go to buck in January, February, and March, and ſometimes all the warm months: ſometimes they ſeek the buck ſeven or eight miles from the place where they ſit. The buck rabbit is ſaid to kill all the young he can come at; on which account the doe is careful to hide her offspring in ſome remote corner, out of his way. The doe coney goes to buck as ſoon as ſhe has kindled. She cannot ſuckle her young till ſhe has been with the buck. When he has bucked, he uſually falls backward, and lies as in a trance half dead, at which time he is eaſily taken. See the Article LEPUS.

Buck-*bean*, this plant, though mentioned by ſeveral writers before Simon Pauli, yet was firſt recommended by him in ſcorbutic caſes. He ſays it is more ſubtle and penetrating than *naſturtium*, or creſſes. It ſeems at preſent to be coming into great repute in many chronical diſtempers; and is frequently preſcribed among alexipharmics. Many have got it into uſe in their families in the form of tea, and experience its conſtant uſe to be very effectual againſt ſcrophulas, the king's evil, and obſtinate ſcorbutic diſtempers. Its taſte, at firſt, is not very grateful, but time wears off that diſlike; its uſe in ſhop compoſitions is not yet known. Buck-bean ſerves in Hampſhire to a very remarkable uſe; the brewers uſing it in their beer in the place of hops. It is as good a preſerver of the drink, and is a bitter of as agreeable a flavour; it has this advantage alſo, that one-eighth part of the quantity is ſufficient; it is a very harmleſs plant, and is given by many as an antiſcorbutic, and by ſome in rheumatiſms, and other chronic caſes. It might be extremely worth while to try this practice in other parts, as the plant might be eaſily cultivated in any quantity, and with this advantage, that it will grow on the worſt kind of boggy land, which will produce nothing elſe.

BUCKTHORN, *Rhamnus*, in *Botany*, a genus of the *Pentandria Monogynia* claſs. The berries of buckthorn are larger than elder-berries, round and black, yielding a bitter purple juice, tinged with green, and holding three or four cornered ſeeds. The tree grows in woods and hedges, having its branches ſet with long ſtiff thorns. The ſyrup is the only preparation of thoſe berries now in phyſical uſe. It is a ſtrong purgative, and effectual in evacuating watry and flatulent humours; on which account it is eſteemed in dropſies, rheumatiſms, and even the gout.

BUCOLICS, *Paſtorals*; a kind of poems relating to ſhepherds, and their flocks. The word is derived from βες, and κολον, *cibus*, *meat*; hence βυκολεω, *to feed cattle*; and βυκολος, *bubulcus*, a *herdſman*.

Bucolic poetry is the moſt ancient of all the kinds of poetry; is ſuppoſed to have had its origin in Sicily, amidſt the mirth and diverſions of the ſhepherds, and to have been inſpired by love and idleneſs: by degrees, their rural gallantries were brought under rules, and became an art. The concerns of the flocks, the beauties of nature, and the pleaſures of a country life, were their principal ſubjects. Moſchus, Bion, Theocritus, and Virgil, were the moſt agreeable among the ancient *bucolic* poets. Theocritus's IDYLLIA, and Virgil's ECLOGUES, are the chief of the ancient *bucolics* now extant.

BUD primarily denotes that part of a SEED which firſt begins to ſprout or germinate. In which ſenſe, bud amounts to the ſame with germ, *germen*, gem, *gemma*. In moſt ſeeds is found a true bud, conſiſting of perfect leaves, only differing in bigneſs from thoſe which grow on the ſtalk. In many ſeeds this bud is very apparent, in others it lies ſo deep between the lobes, as to be indiſcernable. In ſome plants the leaves of the buds are but two, in others four, in others ſix, and in ſome more.

BUD is alſo uſed to denote the beginning of a bloſſom, or young ſprout, whether of a branch, foliage, or flower. The buds of flowers and fruits are formed at the ſame time as the branches themſelves on which they ariſe. Mem. Acad. Scienc. ann. 1711. p. 59. ſeq. The bud of a branch has its origin from the inner part of the ligneous body next the pith; by which it differs from a thorn, which has its origin from the outer and leſs fruitful part, and ſo produces no leaves, being as it were only the male of a bud. The buds or knots on branches ariſe from the inmoſt part of the branches, the ſtructure of the ligneous fibres and little bladders of the branch being ranged ſo nicely in this form, that, upon the putting out of the branch, the bud, which is compoſed of the ſame parts, may likewiſe ſhoot with it. Phil. Tranſ. No. 218, p. 404. See the Syſtem of BOTANY, Sect. II. under the head HYBERNACULUM.

BUFFALO, the Engliſh name of the ſpecies *Bubalus* or *Bubalis*, belonging to the Genus Bos, in the Syſtem of MAMMALIA. For deſcription ſee Bos. For repreſentation ſee plate 10. genus 32. ſpecies 5.

BUG, or BUGG, in Entomology, the Engliſh name of a ſpecies of Cimex. See the Syſtem, Order II. Genus 38.

Cheap, eaſy, and clean mixture for effectually deſtroying Bugs. Take of the higheſt rectified ſpirits of wine, (viz. lamp-ſpirits) that will burn all away dry, and leave not the leaſt moiſture behind it, half a pint; new diſtilled oil, or ſpirit, of turpentine, half a pint: mix them together; and break into it, in ſmall bits, half an ounce of camphire, which will diſſolve it in a few minutes: ſhake them well together; and with a piece of ſponge, or a bruſh, dipt in ſome of it, wet very well the bed or furniture wherein thoſe vermin harbour and breed, and it will infallibly kill and deſtroy both them and their nits, although they ſwarm everſomuch. But then the bed and furniture muſt be well and thoroughly wet with it (the duſt upon them being firſt bruſhed and ſhook off), by which means it will neither ſoil, ſtain, nor in the leaſt hurt, the fineſt ſilk or damaſk bed that is. The quantity here ordered of this mixture (that coſts but about a ſhilling) will rid any one bed whatever, tho' it ſwarms with bugs. If any bugs ſhould happen to appear after once uſing it, it will only be for want of well wetting the lacing, &c. of the bed, or the folding of the linens or curtains near the rings, or the joints or holes in and about the bed or head-board, wherein the bugs and nits neſtle and breed; and then their being wetted all again with more of the ſame mixture, which dries in as faſt as you uſe it, pouring ſome of it into the joints and holes where the bruſh or ſponge cannot reach, will never fail abſolutely to deſtroy them all. Some beds that have much wood-work can hardly be thoroughly cleared without being firſt taken down; but others that can be drawn out, or that you can get well behind, to be done as it ſhould be, may. The ſmell this mixture occaſions will be all gone in two or three days; which, yet is very wholeſome, and to many people agreeable. Remember always to ſhake the mixture together very well, whenever you uſe it, which muſt be in the day-time, not by candle-light, leſt the ſubtlety of the mixture ſhould catch the flame as you are uſing it, and occaſion damage.

Early in the ſpring, even in February, the larva of theſe creatures begins to burſt from the egg; and it is at this ſeaſon that attention is ſo very requiſite. The bed ought to be ſtripped of all its furniture; which ſhould be waſhed, and even boiled, if linen; if ſtuff, it ſhould be hot-preſſed. The bedſtead ſhould be taken to pieces, duſted, and waſhed with ſpirit of wine in the joints; for in thoſe parts the females lay their eggs. This done, the joints, crevices, cavities, &c. ſhould be well filled with the beſt ſoft ſoap mixed with verdigris and Scots ſnuff. On this ſubſtance the larva, if any eſcape the cleanſing, or any, which is common in old houſes, creep into the bedſtead, will ſeed at firſt, and of courſe be deſtroyed: this laſt will effect the purpoſe in houſes where theſe vermin are not ſo numerous, by repeating the operation every three months.—Profeſſor Kham mentions, that, from repeated trials, he has been convinced that ſulphur, if it be properly employed, entirely deſtroys bugs and their eggs in beds or walls, though they were ten times more numerous than the ants on an ant-hill.

BUILDING, a fabric erected by art, either for devotion, magnificence, or conveniency. Building is alſo uſed for the art of conſtructing and raiſing an edifice; in which ſenſe it comprehends as well the expences as the invention and execution of the deſign. For a copious account of which ſee the Syſtem of ARCHITECTURE, Part II. throughout.

The modern buildings are much more commodious, as well as beautiful, than thoſe of former times. Of old they uſed to dwell in houſes, moſt of them with a blind ſtair-caſe, low ceilings, and dark windows; the rooms built at random, without any thing of contrivance, and often with ſteps from one to another; ſo that one would think the people of former ages were afraid of light and freſh air: the genius of our times is altogether for light ſtair-caſes, fine ſaſh-windows, and lofty ceilings. And ſuch has been our builders induſtry in point of compactneſs and uniformity, that a houſe after the new way will afford, on the ſame quantity of ground, almoſt double the conveniences which could be had from an old one.

BULB, in the anatomy of plants, a kind of large bud, generally produced under the ground, upon or near the root of certain herbaceous plants, hence denominated *bulbous*. A bulb is defined by Linnæus to be a ſpecies of hybernaculum, produced upon the deſcending caudex or root; conſiſting of ſtipulæ, petioli, the rudiments of the former leaves, and ſcales or bark. See the Syſtem of BOTANY, Sect. II. under the head HYBERNACULUM.

To elucidate this definition, it is proper to remark, that every bud contains, in miniature or embryo, a plant in every reſpect ſimilar to the parent plant upon which it is ſeated. Plants therefore are perpetuated in the buds, as well as in the ſeeds; and the ſpecies may be renewed with equal efficacy in either way. The tender rudiments of the future vegetable of which the bud is compoſed, are incloſed, and during the ſeverities of winter, defended from cold and other external injuries, by a hard bark or rind, which generally conſiſts of a number of ſcales placed over each other like tiles, and faſtened together by means of a tenacious, reſinous, and frequently odoriferous, ſubſtance. Thus defended, the buds remain upon different parts of the mother plant, till the enſuing ſpring; and are, therefore, with great propriety, denominated by Linnæus the *hybernaculum* or winter-quarters of the future vegetable. With reſpect to their place, buds are ſituated either upon the ſtem and branches, or upon the roots: the former are ſtyled *gemmæ*, or buds properly ſo called; but as they ſubſiſt ſeveral years by their roots, may be furniſhed with the other ſpecies of *hybernaculum*, called bulbs, which, according to the definition, are ſeated upon the deſcending *caudex* or root. Again, trees which are perennial, with a woody and durable ſtem or trunk, have generally proper buds or gemmæ, but no bulbs. In bulbous plants, as the tulip, onion, or lily, what we generally call the root, is in fact a bulb or hybernaculum, which incloſes and ſecures the embryo or future ſhoot. At the lower part of this bulb may be obſerved a fleſhy knob or tubercle, from whence proceed a number of fibres or threads. This knob, with the fibres attached to and hanging from it, is

properly

properly ſpeaking, the true root: the upper part being only the cradle or nurſery of the future ſtem, which after the bulb has repaired a certain number of times, it periſhes; but not till it has produced at its ſides a number of ſmaller bulbs or ſuckers for perpetuating the ſpecies. One part of Linnæus's definition ſtill remains obſcure. The bulb, ſays he, is compoſed of the remains or rudiments of the former leaves of the plant; *e rudimento foliorum præteritorum.* It is eaſy to comprehend that buds contain the rudiments of the future leaves: but how can bulbs be ſaid to contain the rudiments of leaves that, to all appearance, are already periſhed? To explain this, let it be obſerved, that, in the opinion of very eminent botaniſts, the root, in a very great number of perennial herbs, is annually renewed or repaired out of the trunk or ſtalk itſelf; in which ſenſe only, roots are properly ſaid to deſcend. In the perennials alluded to, the baſis of the ſtalk continually, and by inſenſible degrees, deſcends below the ſurface of the earth, and is thus changed into a true root; which root, by the continuance of the ſaid motion of the ſtalk, alſo deſcends; and thus, according to the durableneſs of its ſubſtance, becomes a longer or ſhorter root; the elder or lower part rotting off in proportion as the upper is generated out of the ſtalk. Thus, in brownwort, the baſis of the ſtalk, ſinking down by degrees till it is hid under the ground, becomes the upper part of the root; and continuing ſtill to ſink, the next year becomes the lower part, and the following year rots away. This is exactly what obtains in bulbous roots, as well as in the far greater number of other herbaceous perennials, as arum, valerian, tanſy, ſamphire, primroſe, woodſorrel, iris, and others. The immediate viſible cauſe of this deſcent is the ſtring-roots which this kind of trunks frequently put forth; which deſcending themſelves directly into the ground, ſerve like ſo many ropes for pulling the trunk after them. Hence the tuberous roots of iris are ſometimes obſerved to reaſcend a little upon the rotting of fading away of the ſtring-roots which hang at them. In bulbous roots, where the ſtalk and former leaves of the plants are ſunk below, and formed into what is called the bulb or wintering of the future vegetable, the radicles or ſmall fibres that hang from the bulb are to be conſidered as the root; that is, the part which furniſhes nouriſhment to the plant: the ſeveral rinds and ſhells whereof chiefly the bulb conſiſts, ſucceſſively periſh, and ſhrink up into ſo many dry ſkins; betwixt which, and in their centre, are formed other leaves and ſhells, and thus the bulb is perpetuated. What has been ſaid of the deſcent of roots by the ſinking of the ſtalk, is further confirmed by the appearance of certain roots; as of valerian, plantago major, and devil's-bit, in which the lower part appears bitten or chopped off. In theſe the lower part rotting off as the upper deſcends, the living remainder becomes ſtumped, or ſeems bitten. All bulbous roots, ſays the learned Dr. Grew in his anatomy of plants, may be conſidered as hermaphrodite roots, or root and trunk both together: for the radicles or ſtrings only are abſolute roots; the bulb actually containing thoſe parts which ſpringing up make the body or leaves of the plant; ſo that it may be regarded as a large bud under ground.

Bulbous roots are ſaid to be ſolid, when compoſed of one uniform lump of matter: tunicated, when formed of multitudes of coats ſurrounding one another; ſquamoſe, when compoſed of, or covered with, leſſer flakes; duplicate, when there are only two to each plant; and aggregate, when there is ſuch a congeries of ſuch roots to each plant. For the method of flowering bulbous roots, ſee FLOWERING.

BULL, in *Eccleſiaſtical Writers*, denotes an inſtrument diſpatched out of the Roman chancery, ſealed with lead; anſwering to the edicts, letters patent, and proviſions, of ſecular princes.

The word bull is derived from *bulla, a ſeal;* and that from *bulla, a drop*, or *bubble:* or, according to others, from the Greek βυλη, *council:* according to Pezron from the Celtic *buil*, or *bul*, a *bubble.*

BULL, the Engliſh name of the ſpecies TAURUS, belonging to the Genus BOS, in the Syſtem of MAMMALIA. For deſcription ſee BOS. For repreſentation ſee plate 10. genus 32. ſpecies 1.

Wild BULLS. The wild bulls now ſo numerous on the continent of America, are ſaid to have ſprung from one bull and ſeven cows, which were carried thither by ſome of the firſt conquerors. For the manner of preparing them for food, ſee BUCCANEERS. In the iſland of Hiſpaniola, the French buccaneers purſue bulls with dogs, and kill them with fire-arms. At Buenos Ayres, the Spaniſh torreadores chaſe them on horſeback, armed with a long lance, at the end of which is a half-moon of ſharp ſteel. Having drawn a number of the horned kind together, they let the cows eſcape, but dexterouſly take the bulls with their half-moons on the hind-legs, by which, diſabling them from flight, they are eaſily diſpatched.

BULL-*Fighting*, a ſport or exerciſe much in vogue among the Spaniards and Portugueſe, conſiſting in a kind of combat of a cavalier or torredore againſt a wild bull, either on foot or on horſeback, by riding at him with a lance. The Spaniards have bull-fights, i. e. feaſts attended with ſhews, in honour of St. John, the Virgin Mary, &c. A ſtriking relic of barbarity in the Spaniſh manners of the preſent day, is the exceſſive attachment of that nation to bull-fights, a ſpectacle which ſhocks the delicacy of every other people in Europe. Many Spaniards conſider this practice as the ſure means of preſerving that energy by which they are characteriſed, and of habituating them to violent emotions, which are terrible only to timid minds. But it ſeems difficult to comprehend what relation there is between bravery and a ſpectacle where the aſſiſtants now run no danger; where the actors prove by the few accidents which befal them, that their's has nothing in it very intereſting; and where the unhappy victims meet only with certain death as the reward of their vigour and courage. Another proof that theſe ſpectacles have little or no influence on the diſpoſition of the mind is, that children, old men, and people of all ages, ſtations, and characters, aſſiſt at them; and yet their being accuſtomed to ſuch bloody entertainments appears neither to correct their weakneſs and timidity, nor alter the mildneſs of their manners. It is only during ſummer that theſe combats are exhibited, becauſe the ſeaſon then permits the ſpectators to ſit in the open air, and becauſe the bulls are then more vigorous. Thoſe which are of the beſt breed are condemned to this kind of ſacrifice; and connoiſſeurs are ſo well acquainted with their diſtinguiſhing marks, that as ſoon as a bull appears upon the arena, they can mention the place where he was reared. This arena is a kind of circus ſurrounded by about a dozen of ſeats, riſing one above another; the higheſt of which only is covered. The boxes occupy the lower part of the edifice. In ſome cities, Valladolid for example, which have no place particularly ſet apart for theſe combats, the principal ſquare is converted into a theatre. The balconies of the houſes are widened, ſo as to project over the ſtreets which end there; and it is really a very intereſting ſight to ſee the different claſſes of people aſſembled around this ſquare, waiting for the ſignal when the entertainment is to commence, and exhibiting every external ſign of impatience and joy. The ſpectacle commences by a kind of proceſſion around the ſquare, in which appear, both on horſeback and on foot, the combatants who are to attack the fierce animal; after which two Alguazils, dreſſed in perukes and black robes, advance with great gravity on horſeback; who go and aſk from the preſident of the entertainment an order for it to commence. A ſignal is immediately given; and the animal, which was before ſhut up in a kind of hovel with a door opening into the ſquare, ſoon makes his appearance. The officers of juſtice, who have nothing to do with the bull, prudently haſten to retire, and their fright is a prelude to the cruel pleaſure which the ſpectators are about to enjoy. The bull, however, is received with loud ſhouts, and almoſt ſtunned by the noiſy expreſſions of their joy. He has to contend firſt againſt the picadores, combatants on horſeback, who, dreſſed according to the ancient Spaniſh manner, and as it were fixed to their ſaddles, wait for him, each being armed with a long lance. This exerciſe, which requires ſtrength, courage, and dexterity, is not conſidered as diſgraceful. Formerly the greateſt lords did not diſdain to practiſe it; even at the preſent ſome of the hidalgos ſolicit for the honour of fighting the bull on horſeback, and they are then previouſly preſented to the people, under the auſpices of a patron, who is commonly one of the principal perſonages at court.

The picadores, whoever they may be, open the ſcene. It often happens that the bull, without being provoked, darts upon them, and every body entertains a favourable opinion of his courage. If, notwithſtanding the ſharp pointed weapon which defends his attack, he returns immediately to the charge, their ſhouts are redoubled, as their joy is converted into enthuſiaſm; but if the bull, ſtruck with terror, appears pacific, and avoids his perſecutors, by walking round the ſquare in a timid manner, he is hooted at and hiſſed by the whole ſpectators, and all thoſe near whom he paſſes load him with blows and reproaches. He ſeems then to be a common enemy, who has ſome great crime to expiate; or a victim, in the ſacrifice of which all the people are intereſted. If nothing can awaken his courage, he is judged unworthy of being tormented by men; the cry of *perros, perros*, brings forth new enemies againſt him, and large dogs are let looſe upon him, which ſeize him by the neck and ears in a furious manner. The animal then finds the uſe of thoſe weapons with which nature has furniſhed him; he toſſes the dogs into the air, who fall down ſtunned, and ſometimes mangled; they however recover, renew the combat, and generally finiſh by overcoming their adverſary, who thus periſhes ignobly. If, on the other hand, he preſents himſelf with a good grace, he runs a longer and nobler, but a much more painful career. The firſt act of the tragedy belongs to the combatants on horſeback; this is the moſt animated and bloody of all the ſcenes, and often the moſt diſguſting. The irritated animal braves the pointed ſteel which makes deep wounds in his neck, attacks with fury the innocent horſe who carries his enemy, rips up his ſides, and overturns him together with his rider. The latter, then diſmounted and diſarmed, would be expoſed to imminent danger, did not combatants on foot, called *chulos*, come to divert the bull's attention, and to provoke him, by ſhaking before him different pieces of cloth of various colours. It is, however, at their own

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riſk that they thus ſave the diſmounted horſeman; for the bull ſometimes purſues them, and they have then need for all their agility. They often eſcape from him by letting fall in his way the piece of ſtuff which was their only arms, and againſt which the deceived animal expends all his fury. Sometimes he does not accept this ſubſtitute, and the combatant has no other reſource but to throw himſelf ſpeedily over a barrier, ſix feet high, which incloſes the interior part of the arena. In ſome places this barrier is double, and the intermediate ſpace forms a kind of circular gallery, behind which the purſued torreadore is in ſafety. But when the barrier is ſingle, the bull attempts to jump over it, and often ſucceeds. The reader may eaſily imagine in what conſternation the neareſt of the ſpectators then are; their haſte to get out of the way, and to crowd to the upper benches, becomes often more fatal to them than even the fury of the bull, who, ſtumbling at every ſtep, on account of the narrowneſs of the place and the inequality of the ground, thinks rather of his own ſafety than of revenge, and beſides ſoon falls under the blows which are given him from all quarters. Except in ſuch caſes, which are very rare, he immediately returns. His adverſary recovered, has had time to get up; he immediately remounts his horſe, provided the latter is not killed or rendered unfit for ſervice, and the attack commences; but he is often obliged to change his horſe ſeveral times. Expreſſions cannot then be found to celebrate theſe acts of proweſs, which for ſeveral days become the favourite topic of converſation. The horſes, very affecting models of patience, courage, and docility, may be ſeen treading under their feet their own bloody entrails, which drop from their ſides half torn open, and yet obeying, for ſome time after, the hand which conducts them to new tortures. Spectators of delicacy are then filled with diſguſt, which converts their pleaſure into pain. A new act is however preparing, which reconciles them to the entertainment. As ſoon as it is concluded that the bull has been ſufficiently tormented by the combatants on horſeback, they retire and leave him to be irritated by thoſe on foot. The latter, who are called *banderilleros*, go before the animal; and the moment he darts upon them they plunge into his neck, two by two, a kind of darts called *banderillas*, the points of which are hooked, and which are ornamented with ſmall ſtreamers made of coloured paper. The fury of the bull is now redoubled; he roars, toſſes his head, and the vain efforts which he makes ſerve only to increaſe the pain of his wounds: this laſt ſcene calls forth all the agility of his adverſaries. The ſpectators at firſt tremble for them, when they behold them braving ſo near the horns of this formidable animal; but their hands, well exerciſed, aim their blows ſo ſkilfully; and they avoid the danger ſo nimbly, that after having ſeen them a few times, one neither pities nor admires them, and their addreſs and dexterity ſeem only to be a ſmall epiſode of the tragedy, which concludes in the following manner: When the vigour of the bull appears to be almoſt exhauſted; when his blood, iſſuing from twenty wounds, ſtreams along his neck and moiſtens his robuſt ſides; and when the people, tired of one object, demand another victim; the preſident of the entertainment gives the ſignal of death, which is announced by the ſound of trumpets. The matador then advances, and all the reſt quit the arena: with one hand he holds a long dagger, and with the other a kind of flag, which he waves backwards and forwards before his adverſary. They both ſtop and gaze at one another; and while the agility of the matador deceives the impetuoſity of the bull, the pleaſure of the ſpectators, which was for ſome time ſuſpended, is again awakened into life. Sometimes the bull remains motionleſs, throws up the earth with his foot, and appears as if meditating revenge. The bull in this condition, and the matador who calculates his motions and divines his projects, form a group which an able pencil might not diſdain to delineate. The aſſembly in ſilence behold this dumb ſcene. The matador at length gives the mortal blow; and if the animal immediately falls, a thouſand voices proclaim with loud ſhouts the triumph of the conqueror; but if the blow is not deciſive, if the bull ſurvives and ſeeks ſtill to brave the fatal ſteel, murmurs ſucceed to applauſe, and the matador, whoſe glory was about to be raiſed to the ſkies, is conſidered only as an unſkilful butcher. He endeavours to be ſoon revenged, and to diſarm his judges of their ſeverity. His zeal ſometimes degenerates into blind fury, and his partizans tremble for the conſequences of his imprudence. He at length directs his blow better. The animal vomits up blood; he ſtaggers and falls, while his conqueror is intoxicated with the applauſes of the people. Three mules, ornamented with bells and ſtreamers, come to terminate the tragedy. A rope is tied around the bull's horns, which have betrayed his valour, and the animal, which but a little before was furious and proud, is dragged ignominiouſly from the arena which he has honoured, and leaves only the traces of his blood and the remembrance of his exploits, which are ſoon effaced on the appearance of his ſucceſſor. On each of the days ſet apart for theſe entertainments, ſix are thus ſacrificed in the morning, and twelve in the afternoon, at leaſt in Madrid. The three laſt are given excluſively to the matador, who, without the aſſiſtance of the picadores, exerts his ingenuity to vary the pleaſure of the ſpectators. Sometimes he cauſes them to be combated by ſome intrepid ſtranger, who attacks them mounted on the back of another bull, and ſometimes he matches them with a bear: this laſt method is generally deſtined for the pleaſure of the populace. The points of the bull's horns are concealed by ſomething wrapped round them, which breaks their force. The animal, which in this ſtate is called *Embolado*, has power neither to pierce nor to tear his antagoniſt. The amateurs then deſcend in great numbers to torment him, each after his own manner, and often expiate this cruel pleaſure by violent contuſions; but the bull aways falls at length under the ſtroke of the matador. The few ſpectators who are not infected by the general madneſs for this ſport, regret that thoſe wretched animals do not, at leaſt, purchaſe their lives at the expence of ſo many torments and ſo many efforts of courage; they would willingly aſſiſt them to eſcape from their perſecutors. In the minds of ſuch ſpectators diſguſt ſucceeds compaſſion, and ſafety ſucceeds diſguſt. Such a ſeries of uniform ſcenes makes that intereſt become languid, which this ſpectacle, on its commencement, ſeemed to promiſe. But to connoiſſeurs, who have thoroughly ſtudied all the ſtratagems of the bull, the reſources of his addreſs and fury, and the different methods of irritating, tormenting, and deceiving him, not one of theſe ſcenes reſembles another, and they pity thoſe frivolous obſervers who cannot remark all their varieties.

The Spaniſh government are very ſenſible of the moral and political inconveniences ariſing from this ſpecies of phrenzy. They have long ſince perceived that among a people whom they wiſh to encourage to labour, it is the cauſe of much diſorder and diſſipation; and that it hurts agriculture, by deſtroying a great number of robuſt animals, which might be uſefully employed: but they are obliged to manage with caution a taſte which it might be dangerous to attempt to aboliſh precipitately. They are, however, far from encouraging it. The court itſelf formerly reckoned bull-fights among the number of its feſtivals, which were given at certain periods. The *Plaza-Mayor* was the theatre of them, and the king and the royal family honoured them with their preſence. His guards preſided there in good order. His halberdiers formed the interior circle of the ſcene; and their long weapons, held out in a defenſive poſture, were the only barrier which they oppoſed againſt the dangerous caprices of the bull. Theſe entertainments, which, by way of excellence, were called *Fieſtas Reales*, are become very rare. Charles III. who endeavoured to poliſh the nation, and to direct their attention to uſeful objects, was very deſirous of deſtroying a taſte in which he ſaw nothing but inconveniences; but he was too wiſe to employ violent means for that purpoſe. He, however, confined the number of bull-fights to thoſe, the profits of which were applied to the ſupport of ſome charitable inſtitution, with an intention of ſubſtituting for theſe other funds afterwards. Bull-fights, by theſe means being rendered leſs frequent, will, perhaps, gradually loſe their attractions, until more favourable circumſtances permit the entire abolition of them.

BUNTING, in ornithology, the Engliſh name of the genus Emberiza. For deſcription ſee Emberiza. For repreſentation ſee plate II. Genus 35.

BUPHAGA, or Beef-eater, in ornithology, a genus belonging to the order of picæ. The beak is ſtraight and quadrangular; the mandibles are gibbous, entire, and the gibboſity is greater on the outſide. The feet are of the ambulatory kind. The body is greyiſh above, and of a dirty yellow below; the tail is ſhaped like a wedge. There is but one ſpecies, viz. the Africana, a native of Senegal. It frequently perches upon oxen, and picks out the worms from their backs. For repreſentation ſee the Syſtem, Plate 1, Genus 9.

BUPRESTIS, in Entomology, the 23d Genus of inſects, belonging to the order of Coleoptera. The antennæ are ſetaceous, and as long as the thorax: The head is half drawn back within the thorax; to which maybe added, that the antennæ is ſerrated: The mouth is armed with jaws, and furniſhed with palpi: The elytra are margined, and cover the abdomen; and the tarſi have five articulations: The feet are ſaltatorii. There are 27 ſpecies of this inſect, moſt of them natives of the Indies. The French have given the name of *Richard* to this genus, on account of the beautiful rich colours with which moſt of the inſects belonging to it are adorned. Inſects of this genus are not common in England. They are of the richeſt ſplendour; and ſome appear, when alive, to be united in colour with the refulgent particles of emeralds, rubies, diamonds, and gold. Applied to the microſcope, the ſplendor is ſo great as to dazzle the eye. The guttata is one of the moſt oblong ſpecies. The whole body is green and gold, with a bluiſh caſt underneath; but what diſtinguiſhes it, are four white dents or depreſſed ſpots that are ſeen upon the elytra, two upon each. One of thoſe dots is on the outward rim of the elytrum, about the middle of it, near the abdomen, and is the larger one. The other is on the inner edge, cloſe to the future, about three-fourths of that future downwards, and exactly oppoſite its fellow on the other elytrum. This latter one is the ſmaller. The whole upper part of the inſect, viewed through a glaſs, appears finely dotted. They are a ſort of cantharides, of a ſtinking ſmell,

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and very ſevere bite. It is of the ſame nature with the common cantharides, or Spaniſh fly, and does great injury to the cattle which eat it.

BURDOCK, *Arctium*, in Botany, a genus of the *polygamia æqualis order of the Syngeneſia* claſs of plants. There are three ſpecies; the two firſt of which are common weeds, growing on the ſides of the roads and foot-paths in moſt parts of England. As theſe plants are ſeldom cultivated, it is needleſs to give any inſtructions for that purpoſe: but where they are troubleſome weeds, it may not be amiſs to mention, that their roots laſt but two years; they may therefore be deſtroyed with much leſs trouble than ſuch as have abiding roots; for the plants which come up from ſeed do not flower until the ſecond year, and when their ſeeds are perfected, their roots decay.

The root of the common Burdock is a very powerful diuretic and diaphoretic. It is given with great ſucceſs in decoctions, in obſtructions of the ſpleen, and in dropſies. It is alſo recommended by ſome in all diſeaſes of the breaſt and lungs, in aſthmas, in the ſtone, and in the ſciatica. The ſeed of it is eſteemed by many to be one of the greateſt lithontriptics known: and, by the inſtances that have been produced of its doing ſervice in nephritic complaints, it ſeems to merit a fair trial. The freſh leaves are by ſome recommended as a dreſſing for old ulcers, and for burns and luxations. They are alſo applied by the good women to the ſoles of the feet, as a remedy in hyſteric complaints.

BURGAGE, or TENURE IN BURGAGE, is where the king, or other perſon, is lord of an ancient borough, in which the tenements are held by a rent certain. It is indeed only a kind of town ſoccage; as common ſoccage, by which other lands are holden, is uſually of a rural nature. A borough is diſtinguiſhed from other towns by the right of ſending members to parliament; and where the right of election is by burgage-tenure, that alone is a proof of the antiquity of the borough. Tenure in burgage, therefore, or burgage-tenure, is where houſes or lands, which were formerly the ſcite of houſes in an ancient borough, are held of ſome lord in common ſoccage, by a certain eſtabliſhed rent. And theſe ſeem to have withſtood the ſhock of the Norman encroachments, principally on account of their inſignificancy, which made it not worth while to compel them to an alteration of tenure, as 100 of them put together would ſcarce have amounted to a knight's fee. Beſides, the owners of them, being chiefly artificers, and perſons engaged in trade, could not, with any tolerable propriety, be put on ſuch a military eſtabliſhment as the tenure in chivalry was. The free ſoccage, therefore, in which theſe tenements are held, ſeems to be plainly a remnant of Saxon liberty; which may alſo account for the great variety of cuſtoms affecting many of theſe tenements, ſo held in ancient burgage; the principal and moſt remarkable of which is that called Borough-Engliſh. See the Article BOROUGH-ENGLISH.

BURGAU, in Vermeology, the name of a large ſpecies of ſea ſnail, of the lunar or round-mouthed kind. It is very beautifully lined with a coat, of the nature of the mother-of-pearl; and the artificers take this out, to uſe under the name of mother-of-pearl; though ſome call it, after the name of the ſhell they take it from, Burgaudine.

BURGESS, an inhabitant of a borough or a walled town, or one who poſſeſſes a tenement therein. In other countries burgeſs and citizen are confounded together; but with us they are diſtinguiſhed. See BOROUGH. The word is alſo applied to the magiſtrates of ſome towns; as the Bailiff and Burgeſſes of Leominſter. Anciently Burgeſſes were held in great contempt, being reputed ſervile, baſe, and unfit for war; ſo that the gentry were not allowed to intermarry in their families, or fight with them, but, in lieu thereof, were to appoint champions.

BURGESS is now ordinarily uſed for the repreſentative of a borough town in parliament. It is much to be regretted, that the members for boroughs bear above a quadruple proportion to thoſe for counties. The right of election of Burgeſſes depends on ſeveral local charters and cuſtoms; though, by 2 George II. c. 24. the right, for the future, ſhall be allowed according to the laſt determination of the houſe of commons concerning it: and, by 3 Geo. III. c. 15, no freeman, except ſuch as claim by birth, ſervitude, or marriage, ſhall be entitled to vote, unleſs he hath been admitted to his freedom twelve months before. No perſon is eligible as a Burgeſs, who hath not a clear eſtate of 300l. a year. Stat. 9 Anne c. 7.

BURGLARY, or NOCTURNAL HOUSE-BREAKING, (*burgi latrocinium*) which, by the ancient Engliſh law was called *hameſucken*, a word alſo uſed in the law of Scotland, but in a ſomewhat different ſenſe, has always been looked upon as a very heinous offence, not only becauſe of the abundant terror it carries with it, but alſo as it is a forcible invaſion and diſturbance of that right of habitation which every individual might acquire, even in a ſtate of nature; an invaſion which, in ſuch a ſtate, would be ſure to be puniſhed with death, unleſs the aſſailant were ſtronger. But, in civil ſociety, the laws come to the aſſiſtance of the weaker party: and, beſides that they leave him this natural right of killing the aggreſſor, if he can, they alſo protect and avenge him in caſe the aſſailant is too powerful. And the law has ſo particular and tender a regard to the immunity of a man's houſe, that it ſtyles it his caſtle, and will never ſuffer it to be violated with impunity; agreeing herein with the ſentiments of ancient Rome. For this reaſon no outward doors can in general be broken open to execute any civil proceſs; though in criminal cauſes the public ſafety ſuperſedes the private.

Hence alſo in part ariſes the animadverſion of the law upon eaves-droppers, nuiſancers, and incendiaries: and to this principle it muſt be aſſigned, that a man may aſſemble people together lawfully (at leaſt if they do not exceed eleven) without danger of raiſing a riot, rout, or unlawful aſſembly, in order to protect his houſe, which he is not permitted to do in any other caſe.

The definition of a burglar, as given by Sir Edward Coke, is, "he that by night breaketh and entereth into a manſion-houſe, with intent to commit a felony." In this definition there are four things to be conſidered; the time, the place, the manner, and the intent.

1. The time muſt be by night, and not by day; for in the day-time there is no burglary; *i. e.* if there be day-light or crepuſculum enough, begun or left, to diſcern a man's face withal. But this does not extend to moon-light; for then many midnight burglaries would go unpuniſhed; and beſides, the malignity of the offence does not conſiſt ſo much in its being done in the dark, as at the dead of night; when all the creation, except beaſts of prey, are at reſt; when ſleep has diſarmed the owner, and rendered his caſtle defenceleſs.

2. As to the place. It muſt be, according to Sir Edward Coke's definition, in a manſion-houſe: for no diſtant barn, warehouſe, or the like, are under the ſame privileges, nor looked upon as a man's caſtle of defence: nor is a breaking open of houſes wherein no man reſides, and which, for the time being, are not manſion-houſes, attended with the ſame circumſtances of midnight terror. A houſe, however, wherein a man ſometimes reſides, and which the owner hath left only for a ſhort ſeaſon, *animo revertendi*, is the object of burglary, though no one be in it at the time of the fact being committed. And if the barn, ſtable, or warehouſe, be parcel of the manſion-houſe, though not under the ſame roof, or contiguous, a burglary may be committed therein; for the capital houſe protects and privileges all its branches and appurtenants, if within the curtilage or homeſtall. A chamber in a college, or an inn of court, where each inhabitant hath a diſtinct property, is, to all other purpoſes, as well as this, the manſion-houſe of the owner. So alſo is a room or lodging in any private houſe, the manſion for the time being of the lodger; if the owner doth not himſelf dwell in the houſe, or if he and the lodger enter by different outward doors. But if the owner himſelf lies in the houſe, and hath but one outward door at which he and his lodgers enter, ſuch lodgers ſeem only to be inmates, and all their apartments to be parcel of the one dwelling-houſe of the owner.

3. As to the manner of committing burglary: there muſt be both a breaking and an entry to compleat it. But they need not be both done at once; for if a hole be broken one night, and the ſame breakers enter the next night through the ſame, they are burglars. There muſt be an actual breaking; as, at leaſt, by breaking or taking out the glaſs of, or otherwiſe opening, a window; picking a lock, or opening it with a key; nay, by lifting up the latch of a door, or unlooſing any other faſtening, which the owner has provided. But if a perſon leaves his doors or windows open, it is his own folly and negligence; and if a man enters therein, it is no burglary; yet, if he afterwards unlocks an inner or chamber-door, it is ſo. But to come down a chimney, is held a burglarious entry; for that is as much cloſed as the nature of things will permit. So alſo, to knock at a door, and, upon opening it, to ruſh in with a felonious intent; or, under pretence of taking lodgings, to fall upon the landlord and rob him; or to procure a conſtable to gain admittance, in order to ſearch for traitors, and then to bind the conſtable, and rob the houſe; all theſe entries have been adjudged burglarious, though there was no actual breaking: for the law will not ſuffer itſelf to be trifled with by ſuch evaſions, eſpecially under the cloak of legal proceſs. As for the entry, any, the leaſt degree of it, with any part of the body, or with an inſtrument held in the hand, is ſufficient: as to ſtep over the threſhold, to put a hand or hook in at a window to draw out goods, or a piſtol to demand one's money, are all of them burglarious entries. The entry may be before the breaking, as well as after; for, by ſtatute 12 Anne c. 7. if a perſon enters into the dwelling-houſe of another, without breaking in, either by day or by night, or with an intent to commit any felony, or, being in ſuch houſe, ſhall commit any felony; and ſhall, in the night, break out of the ſame; this is declared to be felony.

4. As to the intent; it is clear that ſuch breaking and entry muſt be with a felonious intent, otherwiſe it is only a treſpaſs. And it is the ſame, whether ſuch intention be actually carried into execution, or only demonſtrated by ſome attempt or overt act, of which the jury is to judge.

Burglary is felony at common law, but within the benefit of clergy. Burglary in any houſe belonging to the plate-glaſs

company, with intent to ſteal the ſtock or utenſils, is, by ſtatute 13 Geo. III. c. 38. declared to be ſingle felony, and puniſhed with tranſportation for ſeven years.

BURLESQUE, a ſpecies of compoſition, which, though a great engine of ridicule, is not confined to that ſubject; for it is clearly diſtinguiſhable into burleſque that excites laughter merely, and burleſque that excites deriſion or ridicule. A grave ſubject, in which there is no impropriety, may be brought down by a certain colouring, ſo as to be riſible, as in Virgil Traveſtie: the author firſt laughs at every turn, in order to make his readers laugh. The Lutrin is a burleſque poem of the other ſort, laying hold of a low and trifling incident to expoſe the luxury, indolence, and contentious ſpirit of a ſet of Monks. Boileau, the author, turns the ſubject into ridicule, by dreſſing it in the heroic ſtyle, and affecting to conſider it as of the utmoſt dignity and importance.

Though the burleſque that aims at ridicule produces its effects by elevating the ſtyle far above the ſubject; yet the poet ought to confine himſelf to ſuch images as are lively, and readily apprehended. A ſtrained elevation, ſoaring above the ordinary reach of fancy, makes not a pleaſant impreſſion. The mind is ſoon diſguſted by being kept long on the ſtretch. Machinery may be employed in a burleſque poem, ſuch as the Lutrin, the Diſpenſary, or Hudibras, with more ſucceſs and propriety than in any other ſpecies of poetry. For burleſque poems, though they aſſume the air of hiſtory, give entertainment chiefly by their pleaſant and ludicrous pictures. It is not the aim of ſuch a poem to raiſe ſympathy; and for that reaſon, a ſtrict imitation of nature is not neceſſary. And hence, the more extravagant the machinery, in a ludicrous poem, the more entertainment it affords.

The Italians ſeem to have the juſteſt claim to the invention of Burleſque. The firſt author in this kind was Bernia; he was followed by Lalli, Caporalli, &c. From Italy it paſſed into France, and became there ſo much the mode, that in 1649, a book was printed under the title of "The Paſſion of Our Saviour, in Burleſque Verſe." Thence it came into England; but the good ſenſe of the Engliſh never adopted, or owned it, notwithſtanding one or two have excelled in it.

BURN, in a medicinal ſenſe, denotes a ſolution of the continuity of a part of the body by the force of fire. As Burns nearly reſemble inflammatory diſorders in their ſeveral degrees, ſo they alſo do in their method of cure. In the ſlighteſt degree of Burns, the beſt method is to have recourſe to emollients and aſtringents. The beſt ſlight aſtringent is either common proof ſpirit, or rectified ſpirit of wine, or, when it is neceſſary, ſpirit of wine camphorated: theſe may be applied to the part with linen rags, as may alſo oxycrate, or the pickle of cabbages, or litharge vinegar; and theſe applications muſt be repeated as there is occaſion. Oil of turpentine has alſo very good effects, if applied in time, and repeated frequently. And the vulgar method of holding the injured part, when that is the hand or finger, to the fire, as long and as near as can be borne, is often attended with ſucceſs; for the ſtagnating fluids are, by this degree of heat, driven back into their proper channels, and, by that means, the veſication, and other troubleſome ſymptoms, which naturally ſucceed, are often prevented.

When the Burn is ſomething greater than this, and attended with veſication, or puſtules, the puſtules are by no means to be opened, which always brings on great pain; ſome of the remedies before-mentioned will always prove of more ſervice, applied while the bliſters are whole; and, by the uſe of them, the heat and pain will go off, and the cuticle will ſeparate from the cutis, without either deformity or pain. But if theſe remedies do not abate the pain, the part is to be dreſſed with linſeed oil, or the litharge ointment, or the *unguentum diapompholigos*, or ſomething of a like kind. Theſe are to be applied, either by rubbing them frequently on the parts, or ſpreading them on a linen rag, and applying that, and often renewing it. After theſe, a plaſter of the *emplaſtrum de minio*, or any of a like kind, will keep the ſkin ſmooth, and forward the renovation of the cuticle. If the Burn or Scald, which ever it be, be very conſiderable in extent, and great part of the body be burnt, it is neceſſary to bleed plentifully, even till the patient faints, and to give a briſk purge. This method will often prevent ill conſequences, that too frequently elſe attend large Burns: ſuch as foul ulcers, large cicatrices, and ſometimes even gangrenes. When infants are the ſubjects of theſe accidents, bleeding being not ſo convenient, the revulſion is to be made by repeated purges; and, in grown perſons, a regularity of diet is, above all things, to be obſerved.

In the yet greater degree of Burns, where the burnt part is covered by a cruſt or eſchar, the cure cannot be performed without ſuppuration. When this accident happens to the face, great caution is neceſſary, to avoid making a deformed cicatrix: for this reaſon, all ointments and plaſters whatever are to be forbidden, even though they are the moſt valuable ſecrets, as there are in almoſt all families many ſuch; for the miſchief of theſe remedies is, that they all dry up the wound too faſt, and contract the fibres and the ſkin, and by ſuch means leave an uneven cicatrix. The forwarding the caſting off the eſchar, is by all means to be attempted, and the diſcharge of the matter that is contained under it. The eaſieſt and moſt ſucceſsful method of doing this is, by the repeated application of emollients. Three or four times every day the dreſſings are to be changed; and if, at any of theſe times, any part of the eſchar is found to be looſe, it muſt be raiſed by the forceps, and removed, if that conveniently may be; at the ſame time the reſt of the eſchar muſt be anointed with butter, and warm fomentations, made of emollient herbs, &c. applied. Two, three, or four days, employed in this manner, generally afford a ſeparation of all the cruſt or eſchar; and the next intention is then to heal the wound. It is firſt to be thoroughly cleanſed, by means of ſome mild digeſtive, mixed with honey of roſes, and afterwards healed up with any of the lead or litharge ointments. If the eſchar, in theſe caſes, ſhould not ſeparate in proper time, it will be neceſſary to make a deep inciſion through the middle of it, to let out the included ſanies. Burns of the moſt extreme and worſt kind, where the burn has penetrated ſo deep as to deſtroy all the parts quite down to the bone, can have no relief from medicines; nor is there any thing in the ſurgeon's power, but amputating the limb.

BURNING, the action of fire on ſome pabulum, or fuel, whereby the minute parts thereof are torn from each other, and put into a violent motion; and ſome of them aſſuming the nature of fire themſelves, flying off *in orbem*, while the reſt are diſſipated in form of vapour, or reduced to aſhes. The appearances of burning ariſe ſucceſſively, and in a certain order: a heat muſt precede, greater than what ſuffices to boil oil; the lighteſt and moſt volatile parts of the body burn the firſt; the heavier are ſlower in taking fire, but burn the longeſt.

Burning is a ſeparation of the parts of bodies made by means of fire. Some conſider it as a ſpecies of ſolution, and ſuppoſe it effected by a diſſolvent power inherent in fire, which acts as a menſtruum in reſpect of the ſulphureous parts of bodies. Dr. Hooke, conſidering the neceſſity of air to burning, and that heat, however great, does not alone ſuffice to burn a body, does indeed take burning for a ſolution of the ſulphureous parts of bodies; but ſuppoſes the menſtruum, by which it is done, to be the air, or at leaſt ſome ſubtile, ſaline, nitrous ſubſtance, diffuſed in the air.

BURNING, *Uſtia*, in Chymiſtry, is diſtinguiſhed from calcining as the former is performed in cloſe veſſels, and terminates in charring, or reducing the body to a blackneſs; whereas the latter turns them white, being performed in the open air. A dextrous burning volatilizes ſalt, as common ſalt, *Sal alkali*. Burning alſo produces ſomewhat of a mineral ſulphur out of tartar, &c. See the Syſtem, Part I. Chap. V. Sect. II. Art. 1, 2, and 3.

BURNING, in Antiquity, was a practice much uſed by the Greeks, Romans, and northern nations; and ſtill retained by many people in both Indies, with reſpect to their dead. Phil. Tranſ. No. 126. See BURIAL. In this ſenſe burning ſtands oppoſite to burial; though, after burning, the bones remaining, and aſhes, have been uſually collected into urns, and depoſited in the earth. Phil. Tranſ. No. 285.

BURNING *glaſs*, or burning mirror, a machine whereby the ſun's rays are collected into a point; and by that means their force and effect extremely heightened, ſo as to burn objects placed therein. Burning-glaſſes are of two kinds: the firſt convex, called *lentes cauſticæ*; which tranſmit the rays of light, and in their paſſage refract, or incline them towards the axis; having the property of lenſes, and acting according to the laws of refraction. The ſecond, which are the more uſual, are concave; very improperly called burning-glaſſes, being uſually made of metal: theſe reflect the rays of light, and, in that reflection, incline them to a point in their axis; having the properties of *ſpecula* of mirrors, and acting according to the laws of reflection.

Settala, canon of Padua, made a parabolic mirror, which, according to Schottus, burnt pieces of wood at the diſtance of 15 or 16 paces. The following things are noted of it in the *Acta Eruditorum*. 1. Green wood takes fire inſtantaneouſly, ſo as a ſtrong wind cannot extinguiſh it. 2. Water boils immediately; and eggs in it are preſently edible. 3. A mixture of tin and lead, three inches thick, drops preſently; and iron and ſteel plate becomes red-hot preſently, and a little after burns into holes. 4. Things not capable of melting, as ſtones, bricks, &c. become ſoon red-hot, like iron. 5. Slate becomes firſt white, then a black glaſs. 6. Tiles are converted into a yellow glaſs, and ſhells into a blackiſh yellow one. 7. A pumice ſtone, emitted from a volcano, melts into white glaſs; and, 8. A piece of crucible alſo vitrifies in eight minutes. 9. Bones are ſoon turned into an opaque glaſs, and earth into a black one. The breadth of this mirror is near three Leipſic ells, its focus two ells from it; it is made of copper, and its ſubſtance is not above double the thickneſs of the back of a knife.

Villette, a French artiſt of Lyons, made a large mirror, which was bought by Tavernier, and preſented to the king of Perſia; a ſecond, bought by the king of Denmark; a third, preſented by the French king to the royal academy: a fourth has been in England,

England, where it was publicly expoſed. The effects hereof, as found by Dr. Harris and Dr. Deſaguliers, are, that a ſilver ſixpence is melted in 7″ and ¼, a king George's halfpenny in 16″, and runs with a hole in 34. Tin melts in 3″, caſt iron in 16″, ſlate in 3″; a foſſil ſhell calcines in 7″; a piece of Pompey's pillar at Alexandria vitrifies in the black part in 50″, in the white in 54″; copper ore in 8″; bone calcines in 4″, vitrifies in 33. An emerald melts into a ſubſtance like a torquois ſtone; a diamond weighing four grains loſes ⅓ of its weight: the aſbeſtos vitrifies; as all other bodies will do, if kept long enough in the focus; but when once vitrified, the mirror can go no farther with them. This mirror is 47 inches wide, and is ground to a ſphere of 76 inches radius; ſo that its focus is about 38 inches from the vertex. Its ſubſtance is a compoſition of tin, copper, and tin-glaſs.

Every lens, whether convex, plano-convex, or convexo-convex, collects the ſun's rays, diſperſed over its convexity, into a point by refraction; and is therefore a burning-glaſs. The moſt conſiderable of this kind is that made by M. de Tſchirnhauſen: the diameters of his lenſes are three and four feet, the focus at the diſtance of 12 feet, and its diameter an inch and a half. To make the focus the more vivid, it is collected a ſecond time by a ſecond lens parallel to the firſt, and placed in that point where the diameter of the cone of rays formed by the firſt lens is equal to the diameter of the ſecond; ſo that it receives them all; and the focus, from an inch and a half, is contracted into the ſpace of eight lines, and its force increaſed proportionably. This glaſs vitrifies tiles, ſlates, pumice ſtones, &c. in a moment. It melts ſulphur, pitch, and all roſins under water; the aſhes of vegetables, woods, and other matters, are tranſmuted into glaſs; and every thing applied to its focus is either melted, turned into a calx, or into ſmoke. Tſchirnhauſen obſerves, that it ſucceeds beſt when the matter applied is laid on a hard charcoal well burnt.

Sir Iſaac Newton preſented a burning glaſs to the royal ſociety, conſiſting of ſeven concave glaſſes, ſo placed, as that all their foci join in one phyſical point. Each glaſs is about 11 inches and a half in diameter: ſix of them are placed round the ſeventh, to which they are all contiguous; and they form a kind of ſegment of a ſphere, whoſe ſubtenſe is about 34 inches and a half, and the central glaſs lies about an inch farther in than the reſt. The common focus is about 22 inches and a half diſtant, and about an inch in diameter. This glaſs vitrifies brick or tile in 1″, and melts gold in 30″.

It would appear, however, that glaſs quickſilvered is a more proper material for burning glaſſes than metals; for the effects of that ſpeculum wherewith Mr. Macquer melted the platina, ſeem to have been ſuperior to thoſe above mentioned, though the mirror itſelf was much ſmaller. The diameter of this glaſs was only 22 inches, and its focal diſtance 28. Black flint, when expoſed to the focus, being powdered to prevent its crackling and flying about, and ſecured in a large piece of charcoal, bubbled up, and ran into tranſparent glaſs in leſs than half a minute. Heſſian crucibles, and glaſs-houſe pots, vitrified completely in three or four ſeconds. Forged iron ſmoked, boiled, and changed into a vitreſcent ſcoria as ſoon as it was expoſed to the focus. The gypſum of Montmartre, when the flat ſides of the plates or leaves of which it is compoſed were preſented to the glaſs, did not ſhow the leaſt diſpoſition to melt; but, on preſenting a tranſverſe ſection of it, at the edges of the plates, it melted in an inſtant, with a hiſſing noiſe, into a browniſh yellow matter.

BURNING of land, called alſo burn-beating, and vulgarly denſhiring, from Devonſhire, a county in which it has been long practiſed, is a method of preparing and fertilizing lands barren, ſour, heathy, and ruſhy, for corn, by paring off the turf, and drying and burning it on the ground.—The ſame method alſo obtains for meadows and paſture ground, moiſt, clayey, or ruſhy, to improve the hay. See the Syſtem of AGRICULTURE, Sect. II. Art. 2.

BURNING *Mountains*. See VOLCANO, EARTHQUAKE, MOUNTAIN, &c.

Travellers into Italy deſcribe a burning ſpot of ground at Firenzuolo, in the Appennines, out of which a crackling flame continually ariſes, yet without any cleft for it to iſſue out at. Maffei ſuppoſes the ſteams which the place yields to be a kind of native *phoſphorus ardens*, which take fire on their coming in contact with the air.

BURNING *Springs*. Of theſe there are many in different parts of the world; particularly one in Dauphiny near Grenoble; another near Hermanſtadt in Tranſylvania; a third at Chermay, a village near Switzerland; a fourth in the canton of Friburg; and a fifth not far from the city of Cracow in Poland. There alſo is, or was, a famous ſpring of the ſame kind at Wigan in Lancaſhire, which, upon the approach of a lighted candle, would take fire, and burn like ſpirit of wine for a whole day. But the moſt remarkable one of this kind, or at leaſt that of which we have the moſt particular deſcription, was diſcovered in 1711 at Broſely in Shropſhire. The following account of this remarkable ſpring was given by the reverend Mr. Maſon, Woodwardian profeſſor at Cambridge, dated February 18th, 1746. "The well for four or five feet deep is ſix or ſeven feet wide; within that is another leſs hole of like depth dug in the clay, in the bottom whereof is placed a cylindric earthen veſſel, of about four or five inches diameter at the mouth, having the bottom taken off, and the ſides well fixed in the clay rammed cloſe about it. Within the pot is a brown water, thick as puddle, continually forced up with a violent motion beyond that of boiling water, and a rumbling hollow noiſe, riſing or falling by fits five or ſix inches; but there was no appearance of any vapour riſing, which perhaps might have been viſible, had not the ſun ſhone ſo bright. Upon putting a candle down at the end of a ſtick, at about a quarter of a yard diſtance, it took fire, darting and flaſhing after a very violent manner for about half a yard high, much in the manner of ſpirits in a lamp, but with great agitation. It was ſaid, that a tea-kettle had been made to boil in about nine minutes time, and that it had been left burning for 48 hours without any ſenſible diminution. It was extinguiſhed by putting a wet mop upon it; which muſt be kept there for a little time, otherwiſe it would not go out. Upon the removal of the mop, there ariſes a ſulphureous ſmoke laſting about a minute, and yet the water is very cold to the touch." In 1755, this well totally diſappeared by the ſinking of a coal-pit in its neighbourhood.

The cauſe of the inflammable property of ſuch waters, is with great probability ſuppoſed to be their mixture with petroleum, which is one of the moſt inflammable ſubſtances in nature, and has the property of burning on the ſurface of water.

BUSHEL, a meaſure of capacity for things dry; as grains, pulſe, dry fruits, &c. containing four pecks, or eight gallons, or one eighth of a quarter.

By 12 Hen. VII. cap. 5. a buſhel is to contain eight gallons of wheat: the gallon eight pounds of wheat, troy-weight; the pound twelve ounces troy-weight; the ounce twenty ſterlings; and the ſterling thirty-two grains, or corns of wheat growing in the midſt of the ear.

Beſides the ſtandard or legal buſhel, we have ſeveral local buſhels of different dimenſions in different places. At Abingdon, and Andover, a buſhel contains nine gallons; at Appleby, and Penrith, a buſhel of peaſe, rye, and wheat, contains 16 gallons; of barley, big, malt, mixt malt, and oats, 20 gallons. A buſhel contains at Carliſle, 24 gallons; at Cheſter, a buſhel of wheat, rye, &c. contains 32 gallons, and of oats 40; at Dorcheſter, a buſhel of malt and oats contains 10 gallons; at Falmouth, the buſhel of ſtricken coals is 16 gallons; of other things 20, and uſually 21 gallons; at Kingſton upon Thames, the buſhel contains eight and a half; at Newbury 9; at Wycomb and Reading, eight and three fourths; at Stamford, 16 gallons. Houghton. Collect. tom. i. n. 46. p. 42.

BUSKIN, *Cothurnus*, a kind of garment ſomewhat in manner of a boot, covering the foot and mid-leg, and tied beneath the knee: very rich and fine, and uſed principally on the ſtage by the actors in tragedy. The buſkin is ſaid to have been firſt introduced by Æſchylus: it was of a quadrangular form, and might be worn indifferently on either leg. Its ſole was made ſo thick, as, by means hereof, men of ordinary ſtature might be raiſed to the pitch and elevation of the heroes they perſonated: in which it was diſtinguiſhed from the ſock, worn in comedy; which was a low, faſhionable ſhoe. Dempſter obſerves, that the buſkin was not confined to actors only, but girls likewiſe uſed it to raiſe their height; and travellers and hunters to defend themſelves from the mire, &c. As the buſkin was the diſtinguiſhing mark of tragedy on the ſtage, we find it in claſſic authors frequently uſed to ſignify tragedy itſelf.

BUSTARD, in Ornithology, the Engliſh name of the Genus Otis. For a deſcription of which, ſee OTIS. For claſſification, ſee the Syſtem; and for the repreſentation, ſee Plate III. Order 5. Genus 56.

BUTCHER. There are ſome good laws made for the better regulation, and for preventing the abuſes committed by butchers. Butchers, ſelling ſwine's fleſh meaſlead, or dead of the murrain, or that buy fleſh of Jews, and ſell the ſame to Chriſtians, for the firſt time ſhall be grievouſly amerced, the ſecond time ſuffer the pillory, the third time be impriſoned and fined, and the fourth time forſwear the town. 17 Edw. II. cap. 7. vide 51 Hen. III. Stat. 4 Hen. VII. cap. 3. no butcher ſhall ſlay beaſts within the wall of London, upon pain to forfeit for every ox 12d. and for every cow and other beaſt, 8d. and this law ſhall be obſerved in every city and town walled in England, and in the town of Cambridge; except Berwick and Carliſle.

BUTCHER BIRD, or *Shrike*, in Ornithology, the Engliſh name of a ſpecies of the Genus *Lanius*. For a deſcription of which ſee the Article *Lanius*. For claſſification, ſee the Syſtem; and for the repreſentation, ſee Plate I. Order 2. Genus 4.

BUTMENTS, or ABUTMENTS of a bridge, denote the two maſſives at the end of a bridge, whereby the two extreme arches are ſuſtained and joined with the ſhore on either ſide. The butments of bridges next the banks ſhould be built more firm and ſolid, as ſerving to ſuſtain the whole ſeries of arches, and hinder them from ſpreading.

BUTTER, a fat, unctuous ſubſtance, prepared, or ſeparated from milk, by heating or burning it.

BUTTER is the fat, oily, and inflammable part of the milk. This kind of oil is naturally diſtributed through all the ſubſtance of the milk in very ſmall particles, which are interpoſed betwixt the

the caſeous and ſerous parts, amongſt which it is ſuſpended by a ſlight adheſion, but without being diſſolved. It is in the ſame ſtate in which oil is in emulſions: hence the ſame whiteneſs of milk and emulſions; and hence, by reſt, the oily parts ſeparate from both theſe liquors to the ſurface, and form a cream. See EMULSION.

When butter is in the ſtate of cream, its proper oily parts are not yet ſufficiently united together to form an homogeneous maſs. They are ſtill half ſeparated by the interpoſition of a pretty large quantity of ſerous and caſeous particles. The butter is completely formed by preſſing out theſe heterogeneous parts by means of continued percuſſion. It then becomes an uniform ſoft maſs.

Freſh butter which has undergone no change, has ſcarcely any ſmell; its taſte is mild and agreeable, it melts with a weak heat, and none of its principles are diſengaged by the heat of boiling water. Theſe properties prove, that the oily part of butter is of the nature of the fat, fixed, and mild oils obtained from many vegetable ſubſtances by expreſſion. See OILS.—The half fluid conſiſtence of butter, as of moſt other concrete oily matters, is thought to be owing to a conſiderable quantity of acid united with the oily part; which acid is ſo well combined, that it is not perceptible while the butter is freſh, and has undergone no change; but when it grows old, and undergoes ſome kind of fermentation, then the acid is diſengaged more and more; and this is the cauſe that butter, like oils of the ſame kind, becomes rancid by age.

BUTTER is conſtantly uſed in food, from its agreeable taſte: but to be wholeſome, it muſt be very freſh, and free from rancidity, and alſo not fried or burnt; otherwiſe its acrid and even cauſtic acid, being diſengaged, obſtructs digeſtion, renders it difficult and painful, excites acrid empyreumatic belchings, and introduces much acrimony into the blood. Some perſons have ſtomachs ſo delicate, that they are even affected with theſe inconveniencies by freſh butter and milk. This obſervation is alſo applicable to oil, fat, chocolate, and in general to all oleaginous matters.

For the making of butter: When it has been churned, open the churn, and with both hands gather it well together; take it out of the butter milk, and lay it into a very clean bowl, or earthen pan; and if the butter be deſigned to be uſed ſweet, fill the pan with clear water, and work the butter in it to and fro, till it is brought to a firm conſiſtence of itſelf, without any moiſture. When this has been done, it muſt be ſcotched and ſliced over with the point of a knife, every way as thick as poſſible, in order to fetch out the ſmalleſt hair, mote, bit of rag, ſtrainer, or any thing that may have happened to fall into it. Then ſpread it thin in a bowl, and work it well together, with ſuch a quantity of ſalt, as you think fit, and make it up into diſhes, pounds, half pounds, &c.

In the Georgical Eſſays, Vol. V. p. 209. we have the following method of making well-taſted butter from the milk of cows fed on turnips. "Let the bowls, either lead or wood, be kept conſtantly clean, and well ſcalded with boiling water before uſing. When the milk is brought into the dairy, to every eight quarts mix one quart of boiling water; then put up the milk into the bowls to ſtand for cream."

The trade in butter is very conſiderable. Some compute 50,000 tons annually conſumed in London. It is chiefly made within 40 miles round the city. Fifty thouſand firkins are ſaid to be ſent yearly from Cambridge and Suffolk alone; each firkin containing 56 lbs. Uttoxeter in Staffordſhire is a market famous for good butter, inſomuch that the London merchants have eſtabliſhed a factory there for that article. It is bought by the pot, of a long cylindrical form, weighing 14lb.

But no butter is eſteemed equal to that which is made in the county of Eſſex, well known by the name of Epping butter, and which in almoſt every ſeaſon of the year yields at London from one ſhilling to 14 pence per pound averdupoiſe. The following directions concerning the making and management of butter, including the Epping method, are extracted from the 3d volume of the Bath Society Papers.

In general it is to be obſerved, that the greater the quantity made from a few cows, the greater will be the farmer's profit; therefore he ſhould never keep any but what are eſteemed good milkers. A bad cow will be equally expenſive in her keep, and will not perhaps (by the butter and cheeſe that is made from her) bring in more than from three to ſix pounds a-year; whereas a good one will bring from ſeven to ten pounds per annum: therefore it is obvious that bad cows ſhould be parted with, and good ones purchaſed in their room. When ſuch are obtained, a good ſervant ſhould be employed to milk them; as through the neglect and miſmanagement of ſervants, it frequently happens that the beſt cows are ſpoiled. No farmer ſhould truſt entirely to ſervants, but ſometimes to ſee themſelves that their cows are milked clean; for if any milk is ſuffered to remain in the udder, the cow will daily give leſs, till at length ſhe will become dry before the proper time, and the next ſeaſon ſhe will ſcarce give milk ſufficient to pay for her keep.

The milk which is conveyed to the dairy-houſe ſhould remain in the pail till it is nearly cool, before it be ſtrained; that is, if the weather be warm; but in froſty weather it ſhould be immediately ſtrained; and a ſmall quantity of boiling water may be mixed with it, which will cauſe it to produce cream in abundance, and the more ſo if the pans or vats have a large ſurface.

During the hot ſummer-months, it is right to riſe with or before the ſun, that the cream may be ſkimmed from the milk ere the dairy becomes warm; nor ſhould the milk at that ſeaſon ſtand longer in the vats, &c. than 24 hours, nor be ſkimmed in the evening till after ſun-ſet. In winter milk may remain unſkimmed for 36 or 48 hours; the cream ſhould be depoſited in a deep pan, which ſhould be kept during the ſummer in the cooleſt part of the dairy; or in a cool cellar where a free air is admitted, which is ſtill better. Where people have not an opportunity of churning every other day, they ſhould ſhift the cream daily into clean pans, which will keep it cool; but they ſhould never fail to churn at leaſt twice in the week in hot weather; and this work ſhould be done in a morning before the ſun appears, taking care to fix the churn where there is a free draught of air. If a pump-churn be to be uſed, it may be plunged a foot deep into a tub of cold water, and ſhould remain there during the whole time of churning, which will very much harden the butter. A ſtrong rancid flavour will be given to butter, if we churn ſo near the fire as to heat the wood in the winter ſeaſon.

After the butter is churned, it ſhould be immediately waſhed in many different waters till it is perfectly cleanſed from the milk; but here it muſt be remarked, that a warm hand will ſoften it, and make it appear greaſy, ſo that it will be impoſſible to obtain the beſt price for it.

BUTTER will require and endure more working in winter than in ſummer. Thoſe who uſe a pump-churn muſt endeavour to keep a regular ſtroke; nor ſhould they admit any perſon to aſſiſt them, except they keep nearly the ſame ſtroke; for if they churn more ſlowly, the butter will in the winter go back, as it is called; and if the ſtroke be more quick and violent in the ſummer, it will cauſe a fermentation, by which means the butter will imbibe a very diſagreeable flavour.

Where people keep many cows, a barrel-churn is to be preferred; but if this be not kept very clean, the bad effects will be diſcovered in the butter: nor muſt we forget to ſhift the ſituation of the churn when we uſe it, as the ſeaſons alter, ſo as to fix it in a warm place in winter, and where there is a free air in ſummer.

Land whereon cows feed does very often affect the butter. If wild garlic, charlock, or May-weed, be found in a paſture ground, cows ſhould not feed therein till after they have been mown, when ſuch pernicious plants will appear no more till the following ſpring; but thoſe cows that give milk muſt not partake of the hay made therefrom, as that will alſo diffuſe its bad qualities. Great part of the Epping butter is made from cows that feed during the ſummer months on Epping foreſt, where the leaves and ſhrubby plants contribute greatly to the flavour of butter. The mountains of Wales, the highlands of Scotland, and the moors, commons, and heaths in England, produce excellent butter where it is properly managed; and though not equal in quantity, yet far ſuperior in quality to that which is produced from the richeſt meadows; and the land is often blamed when the butter is bad through miſmanagement, ſluttiſhneſs, or inattention.

Turnips and rape affect milk and butter; but brewers grains are ſweet and wholeſome food, and will make cows give abundance of milk; yet the cream thereon will be thin, except good hay be given at the ſame time, after every meal of grains. Coleworts and cabbages are alſo excellent food; and if theſe and ſavoys were cultivated for this purpoſe, the farmers in general would find their account in it. Cows ſhould never be ſuffered to drink improper water; ſtagnated pools, water wherein frogs, &c. ſpawn, common ſewers, and ponds that receive the drainings of ſtables, are improper.

BUXUS, *the box-tree*: A genus of the tetandria order, belonging to the monœtia claſs of plants.

Species. 1. The arboreſcens, with oval leaves. 2. The anguſtifolia, or narrow-leaved box. Theſe two ſorts grow in great plenty upon Boxhill, near Dorking in Surry, in England. Here were formerly large trees of this kind, but now they are much fewer in number. There are two or three varieties of the firſt ſort which are propagated in gardens: one with yellow, and the other with white ſtriped leaves. Another hath the tips of the leaves only marked with yellow, and is called *tipped box*. 3. The ſuffruticoſa, dwarf, or Dutch box, commonly uſed for bordering of flower-beds.

Culture. The two firſt ſorts may be raiſed from ſeeds, and may be alſo propagated by cuttings, which are to be planted in the Autumn, in a ſhady border. The beſt ſeaſon for removing theſe trees is in October; though, if care be uſed to take them up with a good ball of earth, they may be tranſplated almoſt at any time, except the middle of ſummer. The dwarf box is increaſed by parting the roots, or planting the ſlips; but as it makes ſo great an increaſe of itſelf, and ſo eaſily parts, it is hardly worth while to plant the ſlips that have no roots.

Uſes. The tree, or large box, is proper to intermix in clumps of ever-greens, &c. where it adds to the variety of ſuch plantations: they are a very great ornament to cold and barren ſoils, where few other things will grow. The dwarf kind of box is uſed for bordering flower-beds, or other purpoſes of that nature. Boxwood is extremely hard and ſmooth, and therefore uſed by turners.